CONCEPT ANALYSIS

A concept analysis of abductive reasoning

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Abstract

Aim. To describe an analysis of the concept of abductive reasoning.

Background. In the discipline of nursing, abductive reasoning has received only philosophical attention and remains a vague concept. In addition to deductive and inductive reasoning, abductive reasoning is not recognized even in prominent nursing knowledge development literature. Therefore, what abductive reasoning is and how it can inform nursing practice and education was explored.

Design. Concept analysis.

Data sources. Combinations of specific keywords were searched in Web of Science, CINAHL, PsychINFO, PubMed, Medline and EMBASE. The analysis was conducted in June 2012 and only literature before this period was included. No time limits were set.

Methods. Rodger’s evolutionary method for conducting concept analysis was used.

Results. Twelve records were included in the analysis. The most common surrogate term was retroduction, whereas related terms included intuition and pattern and similarity recognition. Antecedents consisted of a complex, puzzling situation and a clinician with creativity, experience and knowledge. Consequences included the formation of broad hypotheses that enhance understanding of care situations. Overall, abductive reasoning was described as the process of hypothesis or theory generation and evaluation. It was also viewed as inference to the best explanation.

Conclusion. As a new approach, abductive reasoning could enhance reasoning abilities of novice clinicians. It can not only incorporate various ways of knowing but also its holistic approach to learning appears to be promising in problem-based learning. As nursing literature on abductive reasoning is predominantly philosophical, practical consequences of abductive reasoning warrant further research.

Keywords: abduction, abductive reasoning, clinical reasoning, concept analysis, hypothesis generation, hypothetico-deductive method, problem-based learning, ways of knowing
Introduction

Abductive reasoning is a form of synthetic inference through which meaningful underlying patterns of selected phenomena are recognized to comprehend a complex reality and expand scientific knowledge (Raholm 2010a,b). According to Eriksson and Lindström (1997), abductive reasoning guides the generation of hypotheses, the consequences of which are explicated logically through deductive reasoning and empirically through inductive reasoning. Reasoning associated with clinical practice, or clinical reasoning, has been declared to be utilizing a hypothetico-deductive method, which promotes deductive and inductive approaches to reasoning (Simmons 2010), while an abductive approach is lacking.

After recognizing the importance of abductive reasoning as a first stage of inquiry and noticing its absence in the current hypothetico-deductive method of clinical reasoning, nursing scholars have made attempts to introduce the idea of abductive reasoning in nursing literature as a new way of thinking about clinical practice and clinical reasoning (Reed 1995, Eriksson & Lindström 1997, Rolfe 1997, Raholm 2010a). However, their accounts of abductive reasoning either vary from one another, lack depth in elucidating the entire process of abductive reasoning, or present very brief interdisciplinary comparisons often incorporating philosophical concepts into nursing or comparing nursing to medicine. As these limited discussions on abductive reasoning and its relation to clinical nursing practice fall short in capturing the abductive reasoning process in its entirety, a comprehensive interdisciplinary exploration of abductive reasoning as a concept is warranted.

Reported in this paper, is a concept analysis of abductive reasoning. The purpose of this analysis is to determine what abductive reasoning is, how it differs from other forms of reasoning such as deduction and induction in relation to clinical reasoning and how it is understood in the context of clinical practice in the disciplines of nursing, medicine and psychology. To the best of our knowledge, a concept analysis of abductive reasoning has not been performed before in the literature. Therefore, this analysis aims to enrich understanding of abductive reasoning while offering direction for further research, which can contribute to nursing practice and education. As abductive reasoning is a developing concept that has been drawing interdisciplinary debate, Rodgers’ evolutionary and inductive method of concept analysis is used (Rodgers 2000, Tothagen & Fagerstrøm 2010).

While previous approaches to concept analysis value reduction in an attempt to isolate the essence of a concept from its dynamic interrelationships with the world (Smith & Medin 1981, Chinn & Jacobs 1983, Walker & Avant 1983), Rodgers’ (1989)’s method to analysis is founded on the assumption that concepts are continually changing and do not remain constant across contexts. This makes it an ideal choice for exploring abductive reasoning, which is still evolving as a concept in several disciplines including music, art, mathematics and information technology. For systematic reporting, the concept analysis on abductive reasoning is divided into four major sections: (1) background; (2) data collection; (3) results and analysis; and (4) discussion. Each of these sections is further divided into sub-sections that correspond with the evolutionary phases outlined by Rodgers’ concept analysis method.

Background

Emergence of clinical reasoning

Rimoldi (1961) perhaps conducted the first experiment that compared diagnostic reasoning abilities of students and
clinicians. He found that expert physicians had increased ability in selecting relevant data and narrowing diagnostic possibilities. This was followed by Newell and Simon (1972)’s work on problem-solving, after which research focusing on information-processing psychology began to flourish. A few years later, Elstein et al. (1978) investigated clinical competency. This influenced the development of the hypothetico-deductive method of reasoning in medicine, which became the established approach of diagnostic reasoning that allowed clinicians to think like scientists (Coderre et al. 2003).

The hypothetico-deductive method also made its way into clinical psychology and nursing practice. In their work, Ward and Haig (1997) declare that models of clinical reasoning found in the psychology and behavioural literature employ the hypothetico-deductive method to clinical reasoning. In nursing, not only do nurses use the hypothetico-deductive method when making clinical decisions (Tanner 1982, Gordon 1987, Tanner et al. 1987, McNhaden & Gunnett 1992, White et al. 1992, Radwin 1995) but also their education immerses them in a form of clinical reasoning that is rooted in the hypothetico-deductive method (Wong & Chung 2002). In her concept analysis of clinical reasoning, Simmons (2010) claims that clinical reasoning in nursing is founded on the hypothetico-deductive method. She further mentions that clinical reasoning in nursing relies on both deductive and inductive reasoning. However, Simmons does not discuss abductive reasoning.

Hypothetico-deductive reasoning

While ‘deductive reasoning’ (i.e. deduction) derives a particular conclusion from a general premise, ‘inductive reasoning’ (i.e. induction) derives a general conclusion from a set of particular statements (Patel et al. 2005). The hypothetico-deductive method focuses on hypothesis-testing and consists of deduction, which is initiated by a hypothesis (hence the name ‘hypothetical’ or ‘hypothetico’ deduction). For example, when faced with a particular clinical situation, a clinician following the hypothetico-deductive method develops a set of hypotheses based on previous knowledge or recognition of patterns. She then tests these hypotheses indirectly by collecting data, which either confirm or disconfirm the predictions in her hypotheses. The clinician then reasons inductively when she extracts conclusions from the results of her hypothesis-testing efforts to consider and implement various treatment or intervention options to deal with the presented clinical situation or client complaint (Ward & Haig 1997).

The methods employed by clinicians as part of clinical reasoning emphasize the process of either induction or hypothetico-deduction for explaining clinical situations (Patel et al. 2005, Simmons 2010). However, both forms of reasoning fail to describe the initial phase of inquiry, which is related to the discovery of hypotheses (Ward & Haig 1997, Haig 1999, Raholm 2010a). This form of inference is referred to as ‘abductive reasoning’ (i.e. abduction), which involves both the generation and refinement of explanatory hypotheses, which is a prerequisite for deductive reasoning (Eriksson & Lindström 1997).

Abductive reasoning

Abduction, deduction and induction were originally derived from the work of Aristotle and reintroduced in present times by the American philosopher and father of pragmatism, Charles Sanders Peirce (Eriksson & Lindström 1997, Raholm 2010a). Dissatisfied with the explanation that hypotheses are mere guesses and do not have a logic of discovery, Peirce’s purpose was to uncover the logic through which new ideas come into existence (Fann 1970). Peirce called this stage abduction and described it as the first stage of inquiry where new ideas or hypotheses are invented to explain meaningful underlying patterns of selected phenomena (Peirce 1903, 1931–1958). As hypotheses are still plausible at this first stage of inquiry, Peirce (1931–1958) recommends that they be further explicated logically through deductive reasoning and empirically through inductive reasoning.

Abductive reasoning is a creative inference, which involves integration and justification of ideas to develop new knowledge. While abductive reasoning allows one to conceive ideas from vague, possible or potentially possible phenomena, deductive and inductive reasoning allow for the consequent processing of those ideas (Raholm 2010a). This process can be explained as such: (1) Surprising phenomena emerge and require an explanation because they do not follow an accepted hypothesis; (2) a new hypothesis that predicts these phenomena is adopted through abduction; (3) necessary and probable experimental consequences of the hypothesis are traced out through deduction; (4) when tests verify prediction after prediction, the hypothesis is stationed among scientific results through induction (Haig 1999, Raholm 2010a, Lawson & Daniel 2011).

Data sources

Several databases and search strategies were employed to review the literature and yield an ample number of records for analysis. The concept of ‘abductive reasoning’
and its synonym, abduction, were constantly used as major keywords. As the search was related to ‘nursing’, ‘health’ and ‘caring’ in the context of ‘clinical reasoning’ and ‘clinical practice’, these terms were also included in the search strategy as keywords. Combinations of these terms were searched in several databases that focused on literature from clinical disciplines of nursing, medicine and psychology. These included Web of Science, CINAHL, PsychINFO, PubMed, Medline and EMBASE. The search strategy is presented in Figure 1 and Table 1. The analysis was conducted in June 2012 and time limits were not set as a previous preliminary search using a combination of the above-mentioned keywords generated only a handful of records.

In addition to the term ‘abductive reasoning’, ‘abduct*’ was also used to indicate abduct, abductive and abduction. These terms were often combined with the term ‘clinical’ and/or ‘reasoning’ to avoid results focusing on the anatomical definition of abduction and to facilitate the retrieval of sources focusing on the cognitive thinking process. Due to the low number of results in nursing literature, ‘artificial intelligence’ was also used in combination with ‘abduction’ in CINAHL to maximize the opportunity for retrieving more nursing-based articles on abductive reasoning. However, this attempt did not yield any results. In instances where the use of clinical failed to generate sufficient results, other terms such as ‘caring’ or ‘health’ were utilized.

A total of 601 records were found with the search terms, while one of these was found through citation. Abstracts of these records were read to determine their relevance to the concept analysis. On occasion, full-text of some articles was also explored. Of the 601 records, 561 were excluded as they were irrelevant to the purpose of the concept analysis. Many of these records were excluded because they did not discuss abductive reasoning or abduction in relation to clinical reasoning, clinical practice or any activity associated with the clinical context, while some were excluded because of their focus on disciplines other than the three identified. From the remaining 40 records, 28 were found to be duplicates and were also excluded. This resulted in a total number of 12 records, which were included in the concept analysis.

Results

The 12 articles included in the analysis were read once to obtain a general understanding of how abductive reasoning was understood in the specified context. All articles were then re-read and critically analysed. Data were extracted from these articles using a tool that was based on the various items of Rodgers (1989)’s evolutionary method of concept analysis. These allowed for the identification of the

![Figure 1](image-url) Flow diagram of search strategy. *Abduction/abductive reasoning briefly mentioned or referenced but not thoroughly discussed as a process of reasoning as related to decision-making, problem-solving and clinical judgment, **Irrelevant to context of clinical reasoning (i.e. abduction/abductive reasoning discussed in general context rather than a clinical reasoning or clinical practice context).
According to Rodgers (1989), ‘surrogate terms’ have the same meaning as the identified concept, while ‘related terms’ have different characteristics but maintain some common similarity with the concept. Rodgers defines ‘antecedents’ as events or phenomena that precede an instance of the chosen concept, whereas ‘consequences’ are events or phenomena that follow an occurrence of the concept. She further describes ‘defining attributes’ as characteristics of the concept and ‘examples’ as the concrete instances described in the data sources that discuss the concept. The development of a ‘model case’, which is an everyday example that validates the concept and its characteristics, is the end-result of the previously outlined steps.

A total of 12 articles ranging from 1997–2011 were reviewed for the concept analysis. Of these, five were from the discipline or nursing, while three were from medicine and four from psychology. Extracted data are presented in Table 2 based on specific items outlined by Rodgers (1989)’s evolutionary method of concept analysis. These items are also discussed individually in the subsequent sections and relevant interdisciplinary comparisons are made. After examining all 12 articles, saturation within and between disciplines was achieved regarding the characteristics of abductive reasoning as a concept within the context of clinical reasoning and clinical practice. However, some outliers were also identified, which are described and analysed further with literature support.

**Surrogate terms**

Several terms were interchangeably used with abductive reasoning. Of these, most had the same root word such as ‘abduction’, ‘abductive method’, ‘abductive model’, ‘abductive thinking’, ‘abductive inference’, ‘abductive logic’ and ‘abductive theory of method’. A commonly used synonym with a different root word was ‘retroduct’ or ‘retroduction’. Moreover, other uncommon surrogate terms were also used, which aimed to convey the same meaning as abductive reasoning. These included: ‘synthetic reasoning’, ‘fuzzy logic’, ‘if/then/therefore reasoning’.

As a synonym of abductive reasoning, synthetic reasoning allows data to be synthesized to figure out what one ought to do and, as a result, leads to the formation of a theory or hypothesis (Raholm 2010a,b). The term fuzzy logic is a form of vague, imprecise and probabilistic reasoning (Rolfe 1997), which is similar to the if/then/therefore way of thinking concerned with plausible hypothesis generation. Retroduction, which has been used interchangeably with...
<table>
<thead>
<tr>
<th>Article</th>
<th>Context</th>
<th>Surrogate terms</th>
<th>Related terms</th>
<th>Antecedents</th>
<th>Attributes</th>
<th>Consequences</th>
<th>Examples</th>
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<tr>
<td>Haig (2008)</td>
<td>Clinical reasoning</td>
<td>Abduction</td>
<td>Exploratory factor analysis, analogical modelling, explanatory coherence</td>
<td>Cognitive ability</td>
<td>Hypothesis generation, inference to the best explanation</td>
<td>Plausible explanation, hypothesis</td>
<td>*</td>
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<tr>
<td>Vertue and Haig (2008)</td>
<td>Clinical reasoning and case formulation</td>
<td>Abductive theory of method</td>
<td>Exploratory factor analysis, data-driven reasoning, forward reasoning, bottom-up reasoning</td>
<td>Data collection</td>
<td>Phenomena detection, inferring causal mechanisms, developing and evaluating the causal model, formulating the case, explanatory coherence</td>
<td>Narrative, case, breadth</td>
<td>*</td>
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<td>Ward and Haig (1997)</td>
<td>Clinical assessment</td>
<td>Abductive method/model</td>
<td>*</td>
<td>Phenomena detection</td>
<td>Explanatory theory, hypothesis/theory generation</td>
<td>Case</td>
<td>*</td>
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<tr>
<td>Nursing</td>
<td>Eriksson and Lindström (1997)</td>
<td>Nursing knowledge development</td>
<td>Abduction, abductive method, retroduction, abductive thinking, abductive inference, retroductive inference</td>
<td>Complex patterns of reality, broad and deep theoretical base, strong knowledge base</td>
<td>Hypothesis generation, recognition, interpretation, pattern seeking/creating/renewing</td>
<td>Explanatory hypothesis, explanation</td>
<td>*</td>
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<tr>
<td>Raholm (2010a)</td>
<td>Scientific knowledge formation</td>
<td>Abduction, abductive model, retroduction, abductive logic, abductive inference</td>
<td>*</td>
<td>Previous knowledge, deep theoretical basis, creativity, boldness, tacit knowledge</td>
<td>Instinct, hypothesis invention, creative insight</td>
<td>Hypothesis, deduction, induction</td>
<td>Detectives anticipate disturbing phenomena yet seek explanation</td>
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<td>Raholm (2010b)</td>
<td>Theory development</td>
<td>Abduction, synthetic reasoning</td>
<td>*</td>
<td>Surprising fact, puzzling data</td>
<td>Hypothesis creation, deeper knowledge and understanding, scientific progress, deduction</td>
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<tr>
<td>Article</td>
<td>Context</td>
<td>Surrogate terms</td>
<td>Related terms</td>
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<td>Attributes</td>
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<td>Reed (1995)</td>
<td>Knowledge development</td>
<td>Abduction, retroductive reasoning</td>
<td>*</td>
<td>Phenomena, experience, beliefs, pre-existing conceptual and empirical knowledge of patterns</td>
<td>Generation of theories and educated guesses</td>
<td>Deduction, induction, empirical testing</td>
<td>*</td>
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<tr>
<td>Lawson and Daniel (2011)</td>
<td>Clinical diagnostic reasoning and diagnostic error</td>
<td>Abduction, If/then/therefore reasoning, retroduction</td>
<td>Analogical modelling/reasoning/transfer/inference</td>
<td>Declarative knowledge, puzzling symptoms</td>
<td>Hypothesis generation</td>
<td>Explanation</td>
<td>Patient continues to have symptoms of gallbladder stones even after surgery</td>
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<td>Magnani (1997)</td>
<td>Clinical reasoning and medical education</td>
<td>Abduction</td>
<td>*</td>
<td>Established medical knowledge, previous similar experience</td>
<td>Visual abduction, creative abduction, selective abduction, inference to the best explanation, uncertainty</td>
<td>Diagnostic hypothesis, decision-making</td>
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<td>Upshur (1997)</td>
<td>Clinical reasoning and evidence-based medicine</td>
<td>Abduction</td>
<td>*</td>
<td>Surprising data</td>
<td>Inference to the best explanation</td>
<td>Explanation</td>
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*Not described in the article.
abductive reasoning, is an inference through which events are explained by suggesting the existence of mechanisms that could have produced them (Sayer 1992). This is similar to the definition of abductive reasoning that has been declared earlier as synthetic reasoning, which focuses on underlying patterns of phenomena to generate plausible hypotheses.

Related terms or concepts

Terms such as ‘data-driven reasoning’, ‘forward reasoning’ and ‘bottom-up reasoning’ are similar to abductive reasoning. These forms of reasoning aim to generate a hypothesis or explanation from observations or data (i.e. data-to-hypothesis or data-to-explanation). This is similar to inductive reasoning where the explanation or hypothesis is a confirmation of the presented data and not a plausible inference from the underlying patterns of certain phenomena to which the data are hinting. However, terms such as deduction, induction, clinical reasoning and their synonyms were not included in the list of related terms because they have been discussed earlier as background information and straying into a lengthy discussion on them goes beyond the scope of this concept analysis.

Other terms related to abductive reasoning included: ‘exploratory factor analysis’, ‘analogical modelling/reasoning/transfer/inference’, ‘similarity recognition’ and ‘intuition’. ‘Exploratory factor analysis’ and ‘analogical modelling/reasoning/transfer/inference’ were specific to the psychology and medical literature. These two terms were neither explained nor elaborated on in the sources, which could be due to their common use in the field of statistics. While the former is involved in the identification of underlying relationships between variables (Norris & Lecavalier 2010), the latter is a way of using analogy to represent a certain phenomenon in the world, so the problem can be examined in new ways and with newer ideas (Truitt & Rogers 1960).

Similarity recognition refers to the unconscious matching of a presenting clinical situation to a similar, previously encountered one (Brooks et al. 1991, Norman & Brooks 1997). Rolfe (1997) critiques Benner (1984)’s work and states that she was unable to explain expertise and labelled it as intuition. Intuition, as it is understood, fails to allow a nurse to verbalize and justify professional judgments and clinical decisions as it is based on some form of instinctive cognitive process that lacks conscious reasoning and is often based on similarity or pattern recognition. In contrast, abductive reasoning allows a nurse to systematically explain and justify how he came to his clinical decisions (Rolfe 1997, Raholm 2010a).

Antecedents and consequences

Antecedents of abductive reasoning were divided into two domains. The first domain was related to the clinical situation presented before a clinician, which warranted explanation. This domain included terms such as: ‘complex patterns of reality’ and several combinations of ‘surprising or puzzling facts’, ‘data’, ‘experience’, ‘phenomena’ and/or ‘symptoms’. The second domain was related to the characteristics a clinician must possess, successfully, to detect, extract and draw meaning from the surprising or puzzling clinical situation. Terms included in this domain were as follows: ‘creativity’; ‘boldness’; ‘similar previous experience’; and ‘strong knowledge’ that were ‘tacit’, ‘pre-existing’, ‘theoretical’, ‘established’, ‘declarative’, ‘conceptual’, ‘experiential’ and/or ‘empirical’.

Consequences of abductive reasoning were also divided into two categories. The first category suggested endpoints that would result from engaging in the process of abductive reasoning. This category contained specific items such as: ‘deeper knowledge and/or understanding’; ‘narratives’; ‘breadth’; ‘cases’; and ‘hypotheses’ or ‘explanations’, which were ‘explanatory’, ‘diagnostic’ and/or ‘plausible’. These narratives and cases could be described as hypothetical explanations, which are formulated to describe a breadth of nursing issues in a care situation. For example, after thorough assessment of a newly admitted client, a nurse may write a hypothetical case describing his interaction with the patient and nursing-related issues that will guide further care planning. The second category emphasized cognitive processes such as: ‘deduction’, ‘induction’ and ‘scientific progress’. This shows that once hypotheses are formulated through abduction, they are explicated logically through deduction and then empirically through induction (Eriksson & Lindström 1997).

Defining attributes

Several defining attributes of abductive reasoning surfaced in the concept analysis. First, abductive reasoning was defined by characteristics that included: ‘uncertainty’; ‘educated guess’; and ‘fuzzy reasoning’. These terms emphasize that abductive reasoning generates plausible explanations, which are vague and imprecise (i.e. fuzzy), could be considered educated guesses and have an element of uncertainty. Secondly, abductive reasoning was described as: ‘visual abduction’, ‘creative abduction and selective abduction’; while other defining attributes included ‘inference to the best explanation’ and ‘explanatory coherence’.
According to Magnani (1997), visual abduction is based on similarity recognition; creative abduction is an overarching term that deals with the field concerned with scientific growth; while selective abduction allows for a diagnostic hypothesis to be selected from a pre-specified set of hypotheses that have been established. As abductive reasoning involves two types of reasoning approaches: (1) generation of hypothesis; and (2) evaluation of hypothesis, Haig (2008) distinguishes between the two by explaining hypothesis generation as such (p. 1014):

- The surprising empirical fact F is detected.
- However, if hypothesis H were approximately true, then F would follow as a matter of course.
- Hence, there is reason to believe that H is plausible.

The second form of abductive reasoning is referred to as inference to the best explanation, which allows for the evaluation of competing explanatory hypotheses to select the best among them. This form of inference is centrally concerned with the establishment of explanatory coherence, which argues that a theory’s propositions remain unified mainly because of their explanatory relations (Thagard 1978). Explanatory coherence is used to evaluate explanatory theories or hypotheses and consists of three criteria: (a) ‘explanatory breadth’ determines whether the hypothesis explains the greatest range of facts that cannot be explained by rival explanations; (b) ‘simplicity’ ensures that the hypothesis is a simple explanation with the fewest assumptions and (c) ‘analogy’ is used as a credible explanation to support the hypothesis (Thagard 1978). Haig (2008) describes inference to the best explanation in the following general schema (p. 1015):

- \( F_1, F_2, \ldots \) are surprising empirical facts.
- Hypothesis H explains \( F_1, F_2, \ldots \)
- No other hypothesis can explain \( F_1, F_2, \ldots \) as well as H does.
- Therefore, H is accepted as the best explanation.

Abductive reasoning has also been described as the process of ‘hypothesis or theory generation/creation’. The process of generating a hypothesis in the context of clinical reasoning has been explained by Vertue and Haig (2008)’s a five-step process (Table 3), which is based on Haig (2005)’s Abductive Theory of Method. The first phase, ‘phenomena detection’, involves both data collection and analysis. Several data collection strategies are utilized to collect high-quality data associated with the phenomena being investigated. Data are then analysed according to pre-existing knowledge, experience, etc., to recognize emerging patterns that evince the presence of several phenomena. In the second phase, ‘inferring causal mechanisms’, the clinician uses a framework (e.g. biopsychosocial model) to identify and group relevant plausible causal factors and suggests their potential relationship with the detected phenomena (Vertue & Haig 2008).

The third phase, ‘developing a causal model’, allows a clinician to develop a model where the relationships and interactions of the various causal mechanisms are considered. Core mechanisms that are more centrally involved in causal relationships are often the ones that require immediate intervention. Once all causal relationships are described, the fourth phase, ‘evaluating the causal model’, allows the clinician to evaluate the causal model by determining its explanatory coherence. Following this, the clinician conceptualizes the clinical situation in the most explanatorily

<table>
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<tr>
<th>Phenomena detection</th>
<th>Inferring causal mechanism</th>
<th>Developing a causal model</th>
<th>Evaluating the causal model</th>
<th>Formulating the case</th>
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<tbody>
<tr>
<td>Clinician collects and analyzes cues from the presenting situation.</td>
<td>Clinician identifies and groups relevant plausible causal factors and suggests their possible relationship with the detected phenomena.</td>
<td>Clinician develops an illustration where various causal mechanisms are considered.</td>
<td>Clinician ensures that all relationships are coherent and supported by data.</td>
<td>Clinician emphasizes the possible links between the various aspects of a care situation through comprehensive and integrated conceptualization of descriptive and explanatory hypotheses.</td>
</tr>
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<td><strong>Table 3</strong> Abductive reasoning process*.</td>
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*Based on Vertue and Haig (2008).
coherent way. The final phase, ‘formulating the case’, marks the conclusion of the abductive clinical reasoning process. The formulated case is a comprehensive and integrated conceptualization of descriptive and explanatory hypotheses. It emphasizes the possible links between the various aspects of a care situation (Vertue & Haig 2008).

Examples and model case

While an article related abductive reasoning to jury decision-making and crime detection (Haig 1999), another related it to detectives who search for anomalous phenomena (Raholm 2010a). Both examples, however, did not elaborate nor clearly explained how abductive reasoning was used. Another paper explained how computers flew helicopters because abductive reasoning allowed them to learn fuzzy rules that could be justified and verbalized to show patterns of thinking that resembled those of experts (Rolfe 1997). An example based on the use of the hypothetico-deductive method of reasoning showed how a clinician recommended surgery after erroneously deducing from a client’s blood results, ultrasound and abdominal inspection that gallbladder stones were the cause of her pain symptoms without entertaining other tentative hypotheses (Lawson & Daniel 2011).

While other articles did not present daily-life examples of abductive reasoning, they did, however, present general schema of the process of abductive reasoning compared with the process of inductive and deductive reasoning. As Rodgers (1989) recommends that a model case to validate the concept and its characteristics be identified rather than constructed, a general schema (Niiniluoto 1999) and a similar medical exemplar schema (Magnani 1997) were identified and presented in Table 4. Building on these examples, a nursing-focused schema was also proposed (Table 4) as an additional model case to show a practice example of how abductive reasoning could be used in everyday clinical nursing practice.

Discussion

Analysis method and data sources

The concept analysis of abductive reasoning followed Rodgers (1989)’s evolutionary approach to concept analysis. This method was easy to use and apply. It was also suitable for abductive reasoning because abductive reasoning is an evolving concept. Although only 12 articles were used for the concept analysis, saturation was achieved within and between disciplines regarding what abductive reasoning is and is not as a concept. Of the three articles found in medicine, Lawson and Daniel (2011)’s and Magnani (1997)’s articles were specific to medical practice and provided concrete examples, while Upshur (1997)’s paper was only partially relevant and consisted of vague conclusions, of which one was an incorrect abductive inference that was presented as an example along with the general schema.

Table 4 Model case of abductive reasoning.

<table>
<thead>
<tr>
<th>Deduction</th>
<th>Induction</th>
<th>Abduction</th>
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</table>
| Niiniluoto (1999) | • All the beans from this bag are white.  
• These beans are from this bag.  
• These beans are white. | • These beans are from this bag.  
• These beans are white.  
• All the beans from this bag are white. | • All the beans from this bag are white.  
• These beans are white.  
• These beans are from this bag.* |
| Magnani (1997) | • If a patient is affected by a beta-thalassaemia, his level of haemoglobin A2 is increased.  
• John is affected by a beta-thalassaemia.  
• John’s level of haemoglobin A2 is increased. | • John is affected by a beta-thalassaemia.  
• John’s level of haemoglobin A2 is increased.  
• If a patient is affected by a beta-thalassaemia, his level of haemoglobin A2 is increased.  
• John is affected by a beta-thalassaemia.* | • If a patient is affected by a beta-thalassaemia, his level of haemoglobin A2 is increased.  
• John is affected by a beta-thalassaemia.* |
| Proposed nurturing-focused model case | • If a patient takes calcium, she could have constipation.  
• Mrs. Smith takes calcium.  
• Mrs. Smith could be constipated. | • Mrs. Smith takes calcium.  
• Mrs. Smith is constipated.  
• If a patient takes calcium, she could have constipation. | • If a patient takes calcium, she could have constipation.  
• Mrs. Smith is constipated.  
• Mrs. Smith takes calcium.* |

*Plausible abductive inferences.
All articles from the discipline of psychology were very useful in highlighting the importance of abductive reasoning in clinical reasoning and practice. However, all of these articles were either authored or co-authored by Brian Haig, whose five-step process of abductive reasoning (Vertue & Haig 2008) has been described in the analysis and is a useful method that can also be applied to nursing practice. Nursing articles on abductive reasoning were primarily philosophy-based and lacked concrete nursing practice examples to highlight how abductive reasoning could be implemented into nursing practice or nursing education. This was mainly due to the context of four of the five nursing articles that focused on knowledge or theory development and not on clinical practice. The remaining paper (Rolfe 1997) examined clinical expertise, but compared nurses to computers.

**Nursing implications**

Novice nurses readily retrieve clinical data, but often overlook important cues when confronted with increasing complexity of situation and heightened degree of uncertainty (O’Neill et al. 2005, Andersson et al. 2006). This is mainly because nursing curricula immerse nursing students in either the hypothetico-deductive method of reasoning (Wong & Chung 2002), or both inductive and deductive approaches to reasoning (Chinn & Kramer 2011). It has been discussed that while the hypothetico-deductive method develops and tests specific testable hypotheses based on limited data, induction focuses on forming generalizations. As an alternative approach, the holistic approach of abductive reasoning can allow nursing students (and students of other health disciplines) to build hypotheses through maximum data retrieval and to develop causal models that illustrate and explain the underlying structures of the situation.

Many prominent experts in the area of knowledge development in nursing recognize only inductive and deductive modes of reasoning (Chinn & Kramer 2011). These experts further discuss various patterns or ways of knowing that include: empirical, ethical, aesthetic, personal and emancipatory knowing. It can be argued that inductive and deductive modes of reasoning are limited in their scope and cannot cater to the various ways of knowing altogether. While the hypothetico-deductive approach comes from an empirical paradigm, it mainly favours empirical knowing while the inductive approach, which comes from an interpretive paradigm, favours non-empirical forms of knowing (Monti & Tingen 1999).

Arising from pragmatism, abductive reasoning appears to favour both empirical and non-empirical forms of knowing. This is illustrated in this concept analysis where both subjective and objective data must be entertained and analysed to recognize phenomena. This describes ‘personal’, ‘empirical’ and ‘aesthetic’ ways of knowing where empirical is the objective data, aesthetic is the subjective data and personal is the interpreter’s analysis of these data. Furthermore, Rahlom (2010a) points out that abductive reasoning is related to what nurses ought to do, which relates to nurses’ ethical obligation and points towards ‘ethical’ knowing. Although ‘emancipatory’ knowing is not discussed in the limited literature explored for this concept analysis, it can be proposed that this form of knowing is recognized during the causal model phase of abductive reasoning where the underlying patterns of certain phenomena are explored and understood in the light of the presenting situation.

In problem-based learning (PBL), which is founded on the hypothetico-deductive approach (Barrows & Tamblyn 1980) and is commonly used in several nursing programmes (Rideout & Carpio 2001), abductive reasoning can offer an alternative approach to learning that not only focuses on hypothesis-building but also incorporates different ways of knowing to encourage students to examine situations from various perspectives. While the hypothetico-deductive approach uses limited data to generate early hypotheses, which are tested through further data collection, the abductive reasoning approach examines all sorts of data through the use of different ways of knowing and then discovers phenomena and their possible causes, which are interlinked with one another to generate a plausible explanation that explains all or most of the issues in a presenting situation. Hence, in PBL curricula where the emphasis is to explore situations and explain them through learning and knowledge-building, abductive reasoning may be a more appropriate choice than the hypothetico-deductive method, which aims to test hypotheses and resolve situations based on limited and goal-oriented data collection.

**Reasoning model**

Proposed in Figure 2 is a visual model that attempts to show different types of reasoning approaches discussed in the analysis. After confrontation with a ‘situation’, initial ‘data’ from the situation are obtained. According to the hypothetico-deductive method, a clinician recognizes cues, articulates early hypotheses or propositions, collects more data either to confirm or to refute his initial propositions and formulates an explanation based on the accepted
propositions to ensure that their consequences are ‘explained’ logically. This hypothetico-deductive process is shown by arrows 1–5.

In abductive reasoning, a clinician detects cues or ‘phenomena’ and infers their causal mechanisms to develop a visual ‘causal model’. In this illustration, various causal mechanisms and ‘propositions’ are considered and evaluated to generate a coherent ‘explanation’. This abductive reasoning process is represented by arrows 1, 6, 7, 8 and 9. Inductive reasoning, demonstrated by arrow 10, allows a clinician to formulate an explanation through intuition or pattern recognition where the clinician automatically links the present situation to a similar situation that he has learnt about or witnessed in the past. Arrow 11 displays deductive reasoning that confirms specific ‘data’ from general ‘explanations’ that are known.

Limitations

There were several limitations in this concept analysis. Data sources that were used for the analysis were limited to electronic databases only. The focus of the data sources was also only on three disciplines, while literature from other disciplines that also engage in clinical reasoning were not included such as: physiotherapy; occupational therapy; speech language pathology; dietetics; etc. Although these disciplines were not included, there was no intention to exclude them either. Should publications focused on abductive reasoning and clinical practice had emerged from their disciplinary bodies of literature, they would have been included. However, in the databases used, key literature from only three disciplines surfaced.

A major limitation in this concept analysis was that clinical reasoning as a key word was used, while its surrogate terms were left out such as decision-making, problem-solving, diagnostic reasoning and clinical judgment. This could have opened up other branches of literature, perhaps even literature from other health disciplines. What is important is that saturation was achieved. However, as concepts are always evolving, the concept of abductive reasoning may continue to change in the future as newer literature emerges that examines it in the context of clinical reasoning and clinical practice, or another context unknown or unfamiliar to us now.
Conclusion

It is important for nurses to be aware of the reasoning strategies they use when engaged in clinical practice. Abductive reasoning can allow nurses to recognize the deeper underlying patterns or phenomena in complex clinical situations (Eriksson & Lindström 1997). It is predicted that novice nurses and other clinicians can begin to use expert approaches to reasoning if they are taught how to think like experts (Rolfe 1997). Vertue and Haig (2008) offer a model that highlights the various phases of abductive reasoning that nurses and other clinicians can follow to develop abductive reasoning skills and consequently improve their clinical reasoning abilities. These steps, along with steps of inductive and hypothetico-deductive reasoning, are also outlined in the proposed reasoning model in Figure-1.

Training nursing students or practicing nurses in abductive reasoning could help them develop hypothesis-building skills that can enhance their reasoning abilities both in educational and in clinical contexts. However, research is needed to determine how attributes of abductive reasoning can be strengthened. This can include both quantitative and qualitative research approaches that aim to develop and test specific educational interventions that target certain attributes of abductive reasoning such as the breadth and depth of phenomena detection; accuracy, relevancy and coherence of generated causal mechanisms and their relationships; the breadth and depth of causal models; and the accuracy of case conceptualizations in explaining a particular situation.

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- drafting the article or revising it critically for important intellectual content.

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