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Effectiveness of a Clinical Skills Workshop for drug-dosage calculation in a nursing program

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SUMMARY

Background: Mathematical and calculation skills are widely acknowledged as being key nursing competences if patients are to receive care that is both effective and safe. Indeed, weaknesses in mathematical competence may lead to the administration of miscalculated drug doses, which in turn may harm or endanger patients' lives. However, little attention has been given to identifying appropriate teaching and learning strategies that will effectively facilitate the development of these skills in nurses. One such approach may be simulation.
Objectives: To evaluate the effectiveness of a Clinical Skills Workshop on drug administration that focused on improving the drug-dosage calculation skills of second-year nursing students, with a view to promoting safety in drugs administration.
Design: A descriptive pre-post test design.
Settings: Educational. Simulation center.
Participants: The sample population included 77 nursing students from a Northern Italian University who attended a 30-hour Clinical Skills Workshop over a period of two weeks.
Methods: The workshop covered integrated teaching strategies and innovative drug-calculation methodologies which have been described to improve psychomotor skills and build cognitive abilities through a greater understanding of mathematics linked to clinical practice.
Results: Study results showed a significant improvement between the pre- and the post-test phases, after the intervention. Pre-test scores ranged between 0 and 25 out of a maximum of 30 points, with a mean score of 15.96 (SD 4.85), and a median score of 17. Post-test scores ranged between 15 and 30 out of 30, with a mean score of 25.2 (SD 3.63) and a median score of 26 ($p < 0.001$).
Conclusions: Our study shows that Clinical Skills Workshops may be tailored to include teaching techniques that encourage the development of drug-dosage calculation skills, and that training strategies implemented during a Clinical skills Workshop can enhance students' comprehension of mathematical calculations.

Introduction

Mathematical and calculation skills are widely acknowledged as being the key nursing competences if patients are to receive care that is both effective and safe. Indeed, weaknesses in mathematical competence may lead to the administration of miscalculated drug doses, which in turn may harm or endanger patients' lives. Nurses must therefore be well prepared and able to perform drug-dosage calculations (Bindler and Bayne, 1991; Blays and Bath, 1992; Grandell-Niemi et al, 2005; Harvey et al, 2010; Wright, 2004; Elliott and Joyce, 2005).

One of the earliest reports on drug calculation difficulties in nursing dates back to over seventy years (Faddis, 1939). Current international nursing research confirms that weak mathematical skills in drug calculation remain a major concern, and a number of studies have shown that nursing students often fail mathematics and drug calculation assessment tests (Brady et al., 2009, Blays and Bath, 1992; Bliss Holtz, 1994; Grandell-Niemi et al., 2001, 2005; Harvey et al, 2010; Wright, 2004, 2005, 2006).

According to some investigators, the fact that nurses perform poorly in drug calculation tests may be associated with 10–20% of all the mistakes that occur during clinical practice (Wilson, 2003; Wright, 2004). Other authors believe that such tests do not reflect performance in clinical practice (Jukes and Gilchrist, 2006; Hutton, 1998, 2010; Wright, 2007, 2009). Hutton (1998), however, posit that math tests help highlight calculation weaknesses in student nurses, which can then be addressed within a clinical setting.

Several of the mistake types reported in the literature have to do with solving equations or with simple arithmetic (Blays and Bath, 1992; Rice

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and Bell, 2005; Dilles et al., 2011; Weeks et al, 2000; Wright, 2005, 2007). Mistakes in arithmetic can be avoided by using a calculator, but conceptual errors still cause problems (Wright, 2007). Indeed, calculating a drug dose correctly requires both computational and conceptual skills.

Background

To perform drug dosage calculations confidently and effectively nursing students need to acquire and master three skills: 1) basic mathematics; 2) conceptualizing clinical information and identifying the data that will allow the problem to be formulated and solved through mathematical calculations (Wright, 2004), and 3) the ability to construct a mental image of the units of measurements needed to perform drug-dose calculations (Wright, 2005). However, little attention has been given to identifying appropriate teaching/learning strategies that will effectively facilitate the development of these skills in nurses (Wright, 2007). One such approach may be simulation, an interactive teaching/learning environment where tutors act as facilitators and students take on active roles (Jeffries, 2005).

It has been suggested that including simulations in pre-registration nursing programs may facilitate the development of competence in the clinical skills required for fitness for award, practice and purpose (McCallum, 2007). According to Brown and Knight (1998) simulation with peer assessment promotes the interchange of ideas as well as involvement, group work, leadership, teamwork, creative thinking, and problem-solving, and thus motivates students.

Furthermore, Moule et al. (2008) state that simulation may encourage collaborative work between education providers and clinical staff while Houghton and colleagues recently indicated that, with the appropriate use of teaching strategies the Clinical Skills Laboratory should provide an authentic learning environment (Houghton et al., 2012; Struys et al., 2008).

Active learning strategies foster critical thinking by activating cognitive processes, and critical thinking is paramount in nursing if safe and effective care is to be given. Nurses apply critical thinking to problem solving (Popil, 2011) and using clinical case studies as a teaching device promotes critical thinking and encourages students to develop their problem-solving skills to the fullest, thereby nurturing the ability to bring theory and practice together (Popil, 2011).

Costs of simulator-based educational programs include facility, equipment and personnel.

According to Good (2003), additional studies are needed to assess the effectiveness of patient simulators in achieving learning and performance assessment objectives.

Methods

Aim

The purpose of this study was to evaluate the effectiveness of a Clinical Skills Workshop (CSW) on drug administration. The aim of the CSW was to improve the medication-dosage calculation skills of second-year nursing students from a Northern Italian University.

Study Design

Assessment was performed by administering pre- and post-tests. We implemented a quasi-experimental, pre- and post-test design in order to reflect the natural setting.

Participants and Setting

In December 2011 our work-team set up a CSW that aimed to encourage undergraduate nursing students to develop their conceptual, mathematical and practical skills concurrently. To this purpose, a newly devised, integrated-strategies teaching approach was adopted.

The CSW lasted 30 h and took place over a period of two weeks during the first semester of the academic year. It was attended by 77 second-year nursing students who were all enrolled in the same undergraduate nursing program. Their curriculum includes progressively sequenced classes on drug administration and drug-dosage calculation skills at every year of the program. None of these classes, however, include practical work.

The students were divided into 4 groups of 19–20 participants each, with two tutors per group. Each participant had the opportunity to try out and simulate drug-dose calculations by using the methodological approaches taught during the direct input stage.

Training Strategies

The CWS was designed by the course planners to envisage a real-life clinical setting. Drug dosage calculation practice was built into each clinical case study, featuring real-life medical prescriptions reported on medication charts, as well as medical equipment and aids that are actually used in clinical settings. Proportional, scalar and problem solving approaches were adopted to teach mathematical calculations (Fig. 1). Fig. 2 exemplifies a clinical situation requiring students to calculate a drug dosage.

This teaching approach and the CSW aimed at helping students acquire the following: increased knowledge and understanding of mathematical calculations; the ability to use the pharmaceutical formulary and handbook and read medication labels on drug packages effectively and efficiently; the ability to correctly identify medical prescriptions reported on medication charts; the ability to clearly identify and use equipment and aids needed to prepare and administer drugs; the ability to prepare and appropriately administer drugs via different infusion routes (oral, im, iv, sc). The latter was achieved through practice, using the full range of equipment needed for the preparation and administration of drugs to simulation mannequins.

Ethics

This study was given written approval by the University Academic Committee. All of the participants were given detailed information regarding the study aims and methodologies, the CSW and the intended teaching and learning process. They were also informed that, while test results would be disclosed to each of them individually, all the results would be deemed confidential for study-related purposes and anonymized prior to being entered into a database and analyzed. Finally, participants were asked to fill in and sign an informed consent form.

Data Collection Tool

The tool deployed in this study was divided into two sections: the first was used to collect general demographics, such as age, sex, nationality and education; the second focused on the assessment test, called the Maths Skill Test, which was compiled by a panel of expert trainers and included 30 problem-questions ranging over 3 main subject areas: 1) low complexity drug calculations (10 questions), 2) intermediate complexity drug calculations (10 questions), and 3) high complexity drug calculations (10 questions).

Data Collection

The calculation abilities of nursing students were evaluated by way of a pre and post-maths/drug calculation test. The participants were given 90 min to complete the test. They were asked to describe the method they chose to answer the questions, to justify their choice and to explain why their answer made sense. Calculators were not allowed.

Pre- and post-test problems were identical, except for post-test dosage data, and the problem-solving strategies required to engage with