Integrated undergraduate nursing curriculum for pharmacology

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Summary Undergraduate pharmacology education for nurses has tended to follow one of two broad approaches, either specific courses in pharmacology or an integrated approach, where the pharmacology content is blended with other content. The School of Nursing at the University of Auckland selected an integrated approach to pharmacology education for nurses aligned with constructivist learning theory. The weaving of pharmacology through the three-year undergraduate curriculum is described, showing the development of a pharmacology curricula thread. The significance of supporting curricula content in areas such as communication skills, law and ethics, as well as sound biological science and physiology knowledge are highlighted. A sound understanding of pharmacology knowledge does not develop in isolation. Rather pharmacology education in the undergraduate nurse is the beginning of developing pharmacological reasoning and providing the skills for life-long learning in this ever changing subject.

Pharmacology education for nurses

Pharmacology education for undergraduate nurses has undergone considerable scrutiny over the last few years mainly in relation to content, relevance to nursing and clinical practice (Bullock and Manias, 2002; Courtenay, 1991; Latter et al., 2000). Essentially, there are two main approaches to pharmacology for nursing education at the undergraduate level. Either a specific course or courses in pharmacology is provided, or content related to pharmacology is woven within other courses. With either approach emphasis needs to be on the principles, concepts and parameters, rather than just the content about specific drugs. Emphasis on learning supports the likelihood that nurses will develop knowledge, skills and expertise in pharmacology and these will be transferred from the education environment to the practice setting. With the complexity of health care and the development of new roles for nurses a change in
pharmacology education for nurses has been necessary. The development of new roles for nurses and nurse prescribing has a profound impact on the undergraduate preparation for nurses who may aspire to advanced practice roles. Advance practice roles that include prescribing rights require that nurses have knowledge of pharmacology as well as the skills to apply pharmacology principles in the clinical setting. Previous studies from Australia and the United Kingdom have questioned the breadth and depth of pharmacology education offered in undergraduate programmes (King, 2004; Manias and Bullock, 2002) and it has been proposed that opportunities for integration of knowledge and skills are necessary to ensure competent pharmacological decision making skills.

**Undergraduate nursing pharmacology education**

There has long been recognition of the significance of pharmacology in undergraduate nursing education but previously this has focused on drug administration, education and specific drug knowledge (Courtenay, 1991). With the advent of new drug developments and technology, it is important that pharmacology education include greater emphasis on drug monitoring, evaluation, misuse, abuse and inappropriate drug therapy. Manias and Bullock (2002) suggest that comprehensive pharmacology knowledge, which involves an understanding of the scientific principles underpinning medications, as well as contextualizing medication management to the complex and changing needs of patients, are essential for clinical nursing. Clearly the teaching of pharmacology to undergraduate nurses must prepare them to be competent and safe clinicians. Undergraduate pharmacology education must also be designed with patient outcomes in mind. A study on the impact of nurse prescribing (Luker et al., 1998a) emphasized that the nurse patient relationship is paramount in nurse prescribing. Therefore, communication skills are essential in planning an integrated curriculum that includes pharmacology.

Learning and doing pharmacology may be viewed as a continuum. At the undergraduate level, pharmacology education need to be integrated with the learning of basic nursing skills and the clinical significance highlighted, especially in relation to the safe administration of medications. Students learn subjects, such as communication, law and ethics, as well as biological sciences and apply this knowledge to pharmacology. Finally nursing knowledge is consolidated in the clinical context. Such an approach therefore will mean that learning pharmacology will be an ongoing process. Applied pharmacology should be presented to undergraduate students as a set of skills and knowledge that require self-direction and life-long learning (Latter et al., 2000). As nursing students become exposed to patient care in the clinical setting pharmacology education then becomes integrated into the clinical context where pharmacological reasoning can be developed. With an integrated pharmacology curriculum, pharmacological principles are integrated throughout, not just in the classroom but in the clinical setting as well.

**Nursing in New Zealand**

The nature of health care in New Zealand has changed with increasing advances in technology, population changes and new models of care delivery and these impact on nursing (Nursing Council of New Zealand, 2001). New roles are emerging for nurses especially in advanced spheres of practice. One of these new roles is that of the Nurse Practitioner, and in New Zealand it is now possible to be a Nurse Practitioner with prescribing rights. The Nursing Council of New Zealand (Nursing Council of New Zealand, 2002) does not identify any specific pharmacological skills within competencies that registered nurses are required to attain but have developed a set of competencies for nurse prescribers in New Zealand that include (Nursing Council of New Zealand, 2001):

- Uses professional judgement.
- Collaborates and consults with, and provides accurate information to the client, the client’s family and other health professionals about prescribing relevant interventions, appliances, treatments or medications.
- Prescribes and administers medications within legislation, codes, scope of practice and according to the established prescribing process and guidelines.
- Understands the age-related implications of prescriptive practice on clients within the particular scope.
- Evaluates the effectiveness of the client’s response to prescribed medications, and monitors decisions about prescribing, taking remedial action and/or referring accordingly.
- Demonstrates an ability to limit and manage adverse reactions/emergencies/crises recognises situations of drug misuse and acts appropriately.
• Understands the regulatory framework associated with prescribing, including the legislation, contractual environment, subsidies, professional ethics, and roles of key government agencies.

Pharmacology knowledge will be important to the nurse of the future and so needs to be an integral part of the undergraduate nursing curriculum. Ideally, teaching is in a manner that reflects the way students will apply their knowledge upon graduation. In this sense, the educational process should foster and support the development of pharmacology knowledge.

The bachelor of nursing University of Auckland

The School of Nursing at the University of Auckland was established in 1999. As a new school of nursing a fresh approach to developing the curriculum was possible, within the guidelines stipulated by the Nursing Council of New Zealand (Nursing Council of New Zealand, 2002). The Bachelor of Nursing, a three-year degree programme, has been developed as an integrated curriculum based on constructivist theory of learning. Integrated curricula focus on the development of broad graduate capabilities such as analysis, critique and synthesis, integrating learning and application of knowledge to nursing practice. The student progressively develops nursing capabilities, which are applied in increasingly complex situations.

The degree programme is designed to meet the needs of contemporary nursing practice. The organising criteria of the curriculum are built on an integrated approach to learning for both the professional and practice aspects of nursing theory and practice. An integrated approach was selected to ensure the student develops an overview of health care problems and the way the various disciplines contribute to health care, "presenting a multi-disciplinary view of health care rather than a fragmented, subject, or discipline oriented view" (The University of Auckland, 2003). The curriculum model is three dimensional, consisting of areas of practice, capabilities or competencies (Nursing Council of New Zealand, 2002), and content threads. The content threads run through each semester. Pharmacology is one of these curricula threads that permeate each semester and level of the programme and this detail is summarised in Table 1. By integrating pharmacology in this way it is expected that all graduates will be equipped with fundamental skills in pharmacological reasoning.

Alongside the planned curricula content students also undertake placements in clinical settings and are exposed to pharmacology in practice. Clinical experience reiterates, consolidates and develops beginning pharmacological skills.

The pharmacology content (Table 1) is outlined, but this does not identify the other related subjects that support pharmacology. Pharmacology content is interwoven and integrated within each course in the undergraduate programme. For example, in year one the students learn bioscience including anatomy and physiology, applied nursing science and fundamental nursing knowledge. Pharmacology is integrated into the first-year curriculum by using the pharmacology principles of drug development, clinical trials, and formulation interwoven into basic nursing skills, such as client assessment and drug administration. Legal and ethical dimensions are covered in first, second and third year of the programme and include the statues and best practice guidelines that inform drug administration, research and storage. Biological knowledge of the hepatic and renal systems is reviewed in pharmacology and applied to metabolism and clearance. Case studies are used in year two, with an emphasis on client pathophysiology and health outcomes. Each case study includes non-pharmacological and pharmacological interventions. Complementary and alternative remedies are incorporated, in conjunction with the risk/benefit effects. Pharmacological parameters are emphasised within year two of the programme, once the basic pharmacological concepts have been provided as a foundation. Knowledge of the pharmacological principles, concepts and parameters forms the basis of pharmacological decision making skills, which are applied more within the third year of the programme and as a graduate.

To summarise, much of the pharmacology content is integrated into the nursing undergraduate curriculum alongside other subjects with students continually bringing in therapeutic knowledge. This ensures an application rich approach to learning both in theory, and when applying theory and learning to practice.

Assessing students pharmacology knowledge

Student motivation and learning of pharmacology knowledge is enhanced by assessments that require students to demonstrate this understanding within assessment criteria supporting the notion that motivation and assessment are linked (Rideout, 2001).
Student involvement in learning is seen as an intrinsic motivator, while the assessment of learning provides strong extrinsic motivation. Students perceive material to be relevant when there is an integration of pharmacology education and course content in assessment processes. The assessment types used within each year of the programme are multi-choice (MCQ) and short answer questions. These are usually

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<th>Year</th>
<th>Pharmacological principles</th>
<th>Pharmacological concepts</th>
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| One  | Introduction to pharmacology for nursing practice | • Properties of an ideal drug  
• Therapeutic objective  
• Factors that determine the intensity of the drug  
• Introduction to pharmacokinetics  
• Introduction to pharmacodynamics  
Formulations and routes for drug delivery and rationale for choice | • Oral formulations — sublingual, liquid, capsules and tablets  
• Topical formulations  
• Rectal  
• Inhalations  
• Intramuscular (kinetics) including blood flow and absorption from site citing physiological differences  
• Intravenous (kinetics)  
Basic application of pharmacological reasoning | • Pre-administration assessment  
• Dosage and administration  
• Evaluating and promoting effects  
Two  | Pharmacodynamics | • Dose–response relationship  
• Drug–receptor interactions  
• What is a receptor?  
• Receptor selectivity and occupancy  
• Agonist, antagonist and partial agonist  
• Drugs that do not involve receptors  
• Therapeutic indexa  
Pharmacokinetics | • Absorption  
• Distribution  
• Volume of distributiona  
• Metabolism — first-order kinetics, zero-order kinetics and CYP P450  
• Hepatic clearancea  
• Elimination — glomerular filtration, tubular secretion and reabsorption  
• Half lifea  
• Renal clearancea  
Drug interactions, adverse drug effects (ADE) and toxicology | • Pharmacodynamic interactions  
• Pharmacokinetic interactions  
Application of concepts related to case studies | • Microbiology and antibiotics  
• Sympathetic nervous system and pain pathway  
• Analgesics  
• Inflammation and anti-inflammatory  
Three  | Physiological differences | • Elderly kinetics  
• Paediatric kinetics  
• Pregnancy and breastfeeding, teratogenic effects  
Pharmacological reasoning applied | • Drugs in the clinical setting  
• Revision of legal dimensions and dosage calculations  
• Monitoring parameters  

a Key pharmacological parameter.
linked to scenarios, and pharmacology questions may be within a series of questions related to the scenarios. Examples of pharmacology short answer questions are provided in Table 2.

First year questions focus on basic pharmacology principles, while second year questions test understanding of pharmacological parameters. By year three the pharmacology questions emphasise the pharmacological reasoning and application to practice.

Impact of an integrated curriculum approach on teaching pharmacology

Advantages

Integration of pharmacology within the Bachelor of Nursing curriculum at the School of Nursing was essential to provide congruency with the remainder of the curriculum that utilises an integrated approach. Congruency ensures a consistent approach within the programme as a whole. It promotes the links between theory and practice and reduces the likelihood of focusing on separate silos of knowledge.

Pharmacology requires sound understanding of key concepts. Integrating knowledge for the students is achieved by using an approach to focus on the underlying physiological and pharmacological concepts. This is an important aspect of constructivist learning because the student needs to access their previous knowledge and utilise this as a firm base for pharmacological concepts. For example, the physiology of a body system and the related actions of many drugs on the system will allow a clear understanding of how drugs work and what to anticipate in other situations when giving a particular drug. There are thousands of drugs available for use and it is impossible to memorize all of the individual differences among drug classes. Key pharmacological parameters form the basis or guide for nurses to anticipate therapeutic effect, side effects and so ensure the most effective drug regimen for the patient. Learning pharmacology focuses on the unifying elements in specific drug groups that have the same mechanism of action and effects. Drug regimens and patients are dynamic; therefore the

<table>
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<th>Table 2</th>
<th>Examples of assessment questions for pharmacology</th>
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<td>Year</td>
<td>Example</td>
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| One     | - Pharmacokinetics is the movement of the drug in the body. Describe the four pharmacokinetic processes  
          - Why is it important NOT to administer half tablets that are unscored? |
| Two     | - David is a 16-year old who has been admitted to your ward with an acute exacerbation of asthma secondary to pneumonia  
          What are the differences and similarities between preventer and reliever medications used in the treatment of asthma?  
          - A man admitted with a stroke had a urinary catheter inserted. Five days later a specimen of catheter urine grew >10^8 organisms/L of two bacteria  
            (a) What is the pathogenesis of catheter-associated urinary tract infection (UTI)?  
            (b) Discuss if or when these organisms should be treated. What would guide this decision and antibiotic selection? |
| Three   | - Mrs. T is a 77-year old widow from the Cook Islands. She lives with her daughter in South Auckland. She presents to the clinic with mild exacerbation of bronchitis. The following medications has been prescribed for Mrs. T:  
          Flixotide 250 mgs BD  
          Serevent 25 mcg 2 puffs BD  
          Ventolin 1–2 puffs prn when SOB  
          Hydrocortisone 10 mgs daily  
          Plendil 5 mgs daily  
          Frusemide  
          The older adult population may be at risk for polypharmacy and hence adverse drug reactions because of the physiological changes that happen as we age. Explain the pharmacological considerations that you need to take into account when caring for Mrs. T  
          - Sally 30-year old mother of two girls, is 32 weeks pregnant. She asks you if she can take paracetamol for headache.  
            Using your knowledge on pharmacology, explain the physiological changes in pregnancy that can affect the absorption, distribution, metabolism and elimination of drugs |
understanding of key concepts is paramount as clinical use of drugs change over time.

When pharmacology is integrated within the curriculum there is a merging of theory and practice. Praxis occurs, combining skills and theoretical understanding, with a strong clinical focus within the Bachelor of Nursing programme. Clinical placements provide valuable real-life experience. The use of pharmacological knowledge is role modelled by health professionals in the clinical setting. Students see registered nurses, as well as other health professionals, accessing client data such as drug charts, laboratory results, and use the information to inform their clinical decisions and health care.

Challenges

Integrating pharmacology has implications for faculty. It is likely to involve more members of faculty, which means faculty need to be prepared to support the pharmacology component of the curricula. This includes faculty being comfortable and able to role model and demonstrate a positive approach to pharmacology as part of their teaching practice. It is important to acknowledge that pharmacology and applied pharmacology is a changing dimension of health care. New developments of drug discovery, administration, and technology have continued. Although nursing faculty has attempted to keep abreast with the changes, remaining current with pharmacology can be overwhelming. Ongoing staff development opportunities become essential.

The lack of clinical nurses with the pharmacological knowledge and skills who are able to role model decision-making process, is a challenge. The extent and depth of pharmacology knowledge amongst clinical nurses has been lacking and there has been enormous debate about nurses’ lack of confidence in drug therapy (Bullock and Manias, 2002; Courtenay, 1991; Jordan and Hughes, 1998). Much of the criticism has been on the lack of pharmacology knowledge and the application of knowledge in the clinical setting. There may be two good reasons why this may be the case. Historically, prescribing has always been the domain of the physician and nurses may feel insecure and less certain about their ability to make appropriate decisions especially when drugs are involved (Luker et al., 1998b).

With the integrated curriculum approach the emphasis in the learning process is on the nurse as a clinician. It is the nurses’ skill in assessment, evaluation and decision-making that becomes important. There is a dearth of studies examining the relationship between nurses’ pharmacology knowledge and patient outcomes and this is a significant area for future research to validate the importance of pharmacology within nursing education.

Conclusion

To ensure provision of safe and effective nursing care, nurses need to base that care on a good grounding of pharmacological principles. Nurses must be able to access an ever expanding information base on available drugs, understand the criteria for selecting drugs and make informed and reasoned choices that are appropriate for their patients. To be a discerning and safe administrator of drugs is an expected competency of a nurse graduate. An integrated curriculum approach where pharmacology is embedded in the curriculum and is part of the assessment portfolio enhances students’ ability to see the relevance of pharmacology to their professional practice.

References