

ORIGINAL RESEARCH

Using the Delphi process to attain expert consensus on bioscience concepts, topics, and skills in undergraduate nursing curricula

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ABSTRACT

Although many nurse scholars agree that biosciences are lacking in nursing curricula, it is difficult to determine exactly which bioscience concepts, topics, and skills are most important and relevant for undergraduate nursing students. The aim of this study was to gain expert consensus on pharmacologic and microbiologic concepts, topics, and skills necessary to prepare nurse graduates who are able to practice in a safe and professional manner. Five experienced clinical nurse educators familiar with undergraduate nursing programs and knowledgeable about undergraduate nursing students were invited to participate as expert panelists in a three-round electronic Delphi process. Two panelists were external to the university, and three were internal. The opinions of the expert panelists converged on the necessity of 20 pharmacological concepts and/or lecture topics, 18 microbiological concepts and/or lecture topics, seven pharmacological and 16 microbiological procedural skills. Top ranking pharmacology lecture topics included applied pharmacology as well as disease and symptom management (cardiovascular disease, respiratory disease, and diabetes most prominent). Top ranking microbiology lecture topics included hepatitis A, B, and C, as well as tuberculosis and nosocomial infections. The results of this study are relevant to Schools of Nursing who wish to offer core bioscience courses in order to improve curriculum quality and meet the needs of industry partners and accreditation bodies.

Key Words: Delphi process, Undergraduate, Nursing, Curriculum, Bioscience, Pharmacology, Microbiology

1. INTRODUCTION

In 1950, a broad knowledge of biosciences was considered to be “particularly desirable” for student nurses.^[1] By the 1970s, however, many nursing schools began eschewing core bioscience nursing courses in favour of course work that emphasized holism, sociology, and behavioural sciences.^[2,3] By the 1990s, despite multiple nursing scholars questioning the lack of biosciences in the nursing curricula, most nursing schools no longer offered biosciences as core courses.^[4-6]

Over the last decade, nurse researchers have examined out-

comes of reduced biosciences in nursing curricula and have published some alarming results. Nurses who have completed surveys and questionnaires post graduation have indicated that although they feel well prepared in interpersonal skills, they do not feel adequately trained to teach patients and families about biomedical components of healthcare.^[7-9] Davis reported that only 7.1% of nurses felt that their microbiology training was adequate for entry level nursing practice (n = 42).^[7] Researchers who surveyed nurses who chose to work in developing countries post graduation (n = 54) reported that these nurses felt particularly unprepared for

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difficult clinical situations: 74.1% felt that they did not have enough pharmacology training and 53.7% felt that they did not have enough microbiology training to provide effective nursing care.^[9]

Researchers who have explored the perceptions of experienced nurses about new graduates' knowledge and skills have come to similar conclusions. For example, Manias and Bullock (2002) completed six focus groups with experienced nurses about their perceptions of new graduates (defined as nurses practicing within one year following graduation). The experienced nurses reported that the new graduates had "enormous deficits" (p. 783).^[10]

Although most nurse scholars agree that biosciences are lacking in nursing curricula, scholars have not been able to agree on how bioscience content should be delivered.^[11,12] Lim and Honey argued that pharmacology content should be integrated because learning does not occur in isolation.^[13] On the other hand, Dilles, Vander Stichele, Van Bortel, and El-seviers suggested that a major challenge for a completely integrated program is in determining where, when, and how much integration actually occurs.^[14] Shields, Purcell, and Watson also argued against integration and suggested that the quality of nursing programs is declining and that students are passing clinical courses without a thorough knowledge of the sciences that support clinical decision-making.^[15] Meechan *et al.* investigated a middle-ground approach. They compared outcomes of two groups of nursing students; a control group who participated in the usual integrated program (n = 60) and an intervention group who received an additional 12 hours of pharmacology lectures along with simulation exercises (n = 60).^[12] Both groups completed a 69-item pharmacology assessment tool based on a vignette, and a 42-item pharmacokinetics on-line test. Students rated their knowledge and confidence levels using four-point likert scales. Meechan *et al.* found statistically significant differences between the control and intervention groups in test scores, and concluded that the inclusion of some focused pharmacology lectures may be more effective than integration alone.^[12]

2. METHOD

In our nursing school, bioscience content (specifically pharmacology and microbiology) has historically been threaded throughout various nursing courses in the undergraduate program. In an effort to improve the quality of the curriculum, and meet the needs of industry partners and accreditation bodies, two mandatory bioscience core courses will be introduced: a pharmacology lecture course in the second year, and microbiology lecture course in the third year of our four-year Bachelor of Science in Nursing program. There is a dearth of information in the literature regarding specific bioscience content that should be included in core bioscience courses.

The aim of this study was to gain expert consensus on pharmacologic and microbiologic concepts, topics, and skills necessary to prepare nurse graduates who are able to practice in a safe and professional manner. After the study received approval from the Behavioural Research Ethics Board at our university, we employed purposive sampling^[16] to recruit a panel of five experienced clinical nurse educators who were familiar with undergraduate nursing programs and knowledgeable about undergraduate nursing students. Based on our knowledge of nursing and the purpose of the study, we chose to invite nurse educators who had more than 25 years of nursing experience in a variety of clinical areas, who held Masters degrees, and who had at least 5 years of teaching experience teaching in both undergraduate theory and clinical practice courses. Nurse educators currently teaching in the second or third year of our program were not eligible to participate. Experts who agreed to join the panel received an electronic information letter, consent form, and demographic questionnaire (see Table 1). Two panelists were external to our university, and three were internal.

2.1 The Delphi process

During a Delphi process, researchers seek to gain consensus of a panel of experts via a series of online questionnaires. This technique is ideal for researchers who wish to elicit knowledge from experts who have busy schedules, are located in varied locations, and cannot attend meetings.^[17] A Delphi process resembles a nominal group process but the participants never meet face to face. An additional advantage of a Delphi process, therefore, is that a single influential participant will not be able to exert pressure and change the responses of the group members, which can occur during a face-to-face nominal group process.^[18] A potential pitfall of the technique is underestimation of the demands on the panel while participating in the Delphi process, and failure to compensate the participants for their time and effort.^[17] In this study, we had three rounds of questionnaires and at the end of the Delphi process we provided an honorarium for each panelist in the form of a \$100.00 gift card, as an acknowledgement for time and effort.

2.2 Data collection

In the first round of the Delphi process, we followed a pragmatic approach and offered a preliminary list of 53 concepts and topics for the panelists to consider. Theoretically, in round one of a Delphi process, panelists generate their own set of responses without utilizing or relying on any previous work for assistance, but researchers also support providing pre-existing information to panelists during round one to enhance efficiency, especially if the number of possible concepts and topics is extensive.^[19]

Table 1. Characteristics of the panel of experts

Characteristics		Percent
Years worked as a Registered Nurse	More than 30 years	100%
	General medicine	40%
Areas of clinical expertise (check all that apply)	General surgery	60%
	Renal	20%
	Oncology	20%
	Palliative care	20%
	Emergency	20%
	Critical care/Coronary care	20%
	Orthopedics	20%
	Pediatric/neonatal	20%
	Women's health	0%
	Case room/post partum	20%
	Psychiatry	0%
	Residential care	0%
	OR/PAR	0%
	Other	20%
Completed level of education	Master's Degree	100%
Teaching roles in undergraduate nursing programs (Check all that apply)	Preceptor	40%
	Clinical instructor	60%
	Classroom instructor or lecturer	60%
	Laboratory instructor	40%
	Other	20%
Years of experience teaching undergraduate nursing students	6 to 10 years	33%
	11 to 15 years	33%
	16 to 20 years	33%
Undergraduate nursing subjects currently teaching (Check all that apply)	Pathophysiology	0%
	Relational practice	0%
	Psychiatry	0%
	General medicine	20%
	General surgery	40%
	Palliative care	0%
	Oncology	0%
	Pediatric/neonatal	0%
	Women's health	0%
	Residential care	0%
	Pharmacology	0%
	Microbiology	0%
	Research	0%
	Other	20%
Undergraduate nursing subjects taught in previous years (Check all that apply)	Pathophysiology	20%
	Relational practice	0%
	Psychiatry	0%
	General medicine	60%
	General surgery	60%
	Palliative care	40%
	Oncology	20%
	Pediatric/neonatal	20%
	Women's health	0%
	Residential care	0%
Pharmacology	40%	
Microbiology	0%	
Research	0%	
Other	20%	

The preliminary list was informed by: a) our review of pharmacology and microbiology syllabi currently offered in undergraduate courses in other disciplines, b) our review of microbiology courses offered to nurses and other health professionals online, and c) suggestions and opinions of previous researchers gleaned from our review of the literature focused on pharmacology and microbiology in undergraduate nursing curricula. Panelists were asked to rate microbiology and pharmacology items within each concept or topic on a Likert scale (1 = strongly disagree to 5 = strongly agree) based on the item's relevance. The concepts and topics covered in round one included, but were not limited to: systems pharmacology (cardiovascular, gastrointestinal, respiratory *etc.*), pharmacokinetics (absorption, distribution, metabolism, and excretion *etc.*), microbial diversity, modes of transmission of microbes, and manifestations of illnesses caused by microbes.

Round one also contained four open-ended and unlimited text questions designed to elicit the panelists' opinions of the pharmacologic or microbiological knowledge and/or related skills that they felt were missing in the questionnaire, and an unlimited text item for anything else they might like to add.

In round two, we gathered the unlimited text answers from round one and the expert panelists were asked to rate additional items on a Likert scale (1 = strongly disagree to 5 = strongly agree) based on the item's relevance.

We retained all topics and concepts from round one and two that contained items that reached a consensus threshold of 70% ($\pm 5\%$) and we set aside topics and concepts with items that did not reach a consensus threshold of 70% ($\pm 5\%$) to use during the third round. An a priori consensus threshold of 70% ($\pm 5\%$) was selected because of the small number of panelists. Previous researchers have considered this threshold to be acceptable for small panels.^[18,20]

In the third round, topics and concepts containing items on which agreement had not been settled were highlighted. Feedback to each expert panelist included the percentages of agreement on each item. Panelists were encouraged to reconsider their stance on those items where consensus was not reached and to re-rate those items. Panelists were informed that any topics or concepts with items that failed to reach a consensus threshold of 70% ($\pm 5\%$) would be discarded. Finally, panelists were asked to rank topics and concepts from round one and two that contained items that had reached a consensus threshold of 70% ($\pm 5\%$).

All questionnaires were created on the Vovici site (our university services' information technology, social media, and

collaboration site). Vovici/Verint is a Canadian-hosted survey solution complying with our province's Freedom of Information and Protection of Privacy Act. All data is stored and backed up in Canada.

3. RESULTS

Panelists who responded to the four open-ended and unlimited text questions in round one noted that common causes of medication errors, high risk medications that require double checking, the procedures to follow when reporting a medication error, and knowledge of procedures contained in an adult septic workup were topics that were all missing in round one, as well the skill of discussing medication compliance with patients.

In round two, we created a questionnaire based on topics or concepts missing from round one. Panelists rated additional items based on the item's relevance.

In round three, panelists were asked to re-consider their stance on any items where consensus was not reached. Topics or concepts with items that failed to reach a consensus threshold of 70% ($\pm 5\%$) were discarded. Topics or concepts with items that did not reach a consensus threshold of 70% ($\pm 5\%$) included transcription of medications, agents used in bio-terrorism, the role of the nurse in bioterrorism emergency preparedness, and knowledge of all side effects of medications (versus knowledge of lethal and most common side effects). Panelists also continued to be unable to reach consensus ($< 70\%$ consensus) about whether undergraduate nursing students need to know about toxoplasmosis, round worms, pubic lice, rabies, west-nile virus, disease spread by ticks such as lyme disease or rocky mountain spotted fever, hantavirus, or the various pathogens responsible for acute diarrhea in developing countries.

The pharmacologic and microbiologic concepts, lecture topics, and skills for undergraduate nursing students deemed important and relevant by the panel of experts based on a consensus threshold of 70% ($\pm 5\%$) are listed in Table 2 and Table 3.

While the opinions of the expert panelists converged on the necessity of 20 pharmacological concepts and lecture topics, 18 microbiological concepts and lecture topics, seven pharmacological, and 16 microbiological procedural skills, it would be unreasonable to expect a lecturer to include 18 or 20 concepts and topics in a typical three-credit undergraduate pharmacology or microbiology course. A typical three-credit course consists of three hours of theory per week in a lecture format for 13 weeks.

Table 2. Pharmacological and microbiological concepts and topics

<p>Pharmacological Concepts and Topics</p> <ul style="list-style-type: none"> • Historical aspects of pharmacology and natural health products • Emergency preparedness related to bio-terrorism • The differences between: chemical names, trade or brand names, and generic names, pharmacological classification and therapeutic classification, over the counter and prescription drugs • Definitions of: pharmacokinetics, pharmacodynamics, potency, efficacy, acute toxicity and chronic toxicity, loading doses and maintenance doses • General knowledge of trade names, generic names and chemical names • Most common medical abbreviations in the context of prescriptions (e.g. BID, QID, PO, PRN) • All different routes of drug administration • The phases of pharmacokinetics: absorption, distribution, metabolism, and excretion • The relationship between drug plasma concentration and therapeutic response, plasma half-life and duration of drug action, cellular receptors and types of drug-receptor interactions (agonist, antagonist) • The value of the nursing process in drug administration • How to evaluate effectiveness of medications • Recording and reporting side effects and adverse effects of medications • The most common causes of medication errors, the reporting process for medication errors, and that the procedure to report medication errors is a method to enhance patient safety (not a punitive measure). • How drugs are regulated: the approval process for prescription drugs, controlled drug schedules, how natural health products are regulated • Specifics of pharmacotherapy during pregnancy and lactation, and in older adults • Cultural, genetic, gender, and psychosocial influences on pharmacotherapy • Client education (safety, adherence, side effects, adverse effects <i>etc.</i>) • Common complementary and alternative therapies, as well as safety and actions of common natural health products • Prototype drugs: chemical names, generic names, trade names, drug classification (pharmacological and therapeutic) pharmacokinetics, pharmacodynamics, contraindications, drug interactions, common side effects, common adverse effects, special considerations such as age, gender, pregnancy, lactation <i>etc.</i>), why prototype drug is ordered for a particular patient, how it is administered, dosage ranges, nursing implications • Leading agents for: addiction disorders, anxiety and insomnia, seizure disorders, autonomic nervous system disorders, emotional and mood disorders, lipid disorders, angina, acute myocardial infarction, stroke, heart failure, hypertension, dysrhythmias, coagulation disorders, pain control, muscle spasms and muscular spasticity, bone and joint disorders, shock, hematopoietic disorders, pulmonary diseases, immune system modulation, inflammation, fever, allergies, bacterial infections, fungal infections, viral infections, peptic ulcers, gastrointestinal disorders, nutritional disorders, pituitary, thyroid, and adrenal disorders, diabetes mellitus, disorders of the female and male reproductive systems, renal disorders, diuretic therapy, fluid, electrolyte and acid-base disorders, skin disorders, eye and ear disorders <p>Microbiological Concepts and Topics</p> <ul style="list-style-type: none"> • The four criteria that establish a causative relationship between a microbe and a disease (Koch's Postulates) • Universal precautions • How agents of infection are transmitted: airborne, droplet, direct contact, indirect contact, vector-based • Knowledge of nosocomial infections: who is most susceptible, what are the most common nosocomial infections, where are these bacteria commonly found in the hospital environment • Knowledge of factors related to antibiotic resistance: the practices that have led to the development and spread of antibiotic resistance, the practices that can help slow the spread of resistance • What MRSA is, and methods to prevent cross infection with MRSA • Knowledge of immune responses to antigens: what a primary immune response is, what a secondary immune response is, what an antibody titre is • Basic understanding of control of microbial growth: using chemicals, using heat, and using cold • Knowledge of infectious diarrhea: how to assess a patient with diarrhea, consequences of watery diarrhea, what oral re-hydration therapy is, use of antimicrobials to treat diarrhea, common ways to prevent the spread of infectious diarrhea, various pathogens that are responsible for acute diarrhea in developing countries • Mode of transmission, manifestations, treatment, complications, and prevention of spread for the following diseases: clostridium difficile, typhoid fever, hepatitis A, tetanus, influenza, mumps, rubella, haemophilus influenza type B, streptococcus pneumonia, toxoplasmosis, candida albicans, HIV, hepatitis B, hepatitis C, staphylococcus, helicobacter pylori, streptococcus • Screening, mode of transmission, risk factors, manifestations, complications, treatment, and prevention of spread specific to Mycobacterium tuberculosis • Basic understanding of infections spread by sexual contact (mode of transmission, manifestations, treatment, complications, and prevention of spread): chlamydia, gonorrhoea, syphilis, genital herpes, genital warts, pubic lice • Basic understanding of infections spread by the following: mice (hantavirus), ticks (encephalitis, Lyme disease, rocky mountain spotted fever), insect (malaria, west Nile virus), animal bite (rabies) • Knowledge of vaccines and vaccinations: the difference between active versus passive immunization, what is an attenuated vaccine, common risks to immune-compromised individuals, what is an inactivated vaccine, what is a subunit vaccine, what is a toxoid vaccine, the six targeted diseases for immunization, vaccine preparation, storage of vaccine, contraindications for vaccines • Basic knowledge of transmission of diseases: body fluids to which universal precautions apply, body fluids which have little or no incidence of transmission, the various portals of microbial entry and exit, the populations that are immunologically disadvantaged • Basic knowledge of procedures that are included in a diagnostic adult patient sepsis work-up. • Understand what a gram stain is, and why this is important to know • Understand what an acid fast stain is, and why this is important to know • Understand the difference between gram positive and gram negative bacteria

Table 3. Pharmacological and microbiological skills

<p>Pharmacological Procedural Skills</p> <ul style="list-style-type: none"> • The ten rights and three checks of drug administration • Administration of oral, parenteral, aerosol, and rectal medications • Calculating drug dosages • The specific high risk medications that require double checking before administration • Measuring liquid medications using various measuring devices (various syringes, medication cups) • Mixing parenteral medications • Breaking an ampule • Principles of documentation including but not limited to documenting effectiveness of medications, adverse event documentation, medication error documentation, and reconciling medication administration records <p>Microbiological Procedural Skills</p> <ul style="list-style-type: none"> • Standard hand washing procedures and use of alcohol based hand rubs • Standard aseptic technique • Principles of vaccine administration • Collection of urine for culture and sensitivity (midstream and from indwelling catheter) • Airborne precautions (personal protective equipment), droplet precautions (personal protective equipment), contact precautions (personal protective equipment) • Mantoux testing • Cleaning of spillages of blood and body fluids • Swab for MRSA and VRE • Swab wound bed (culture and sensitivity) • Collect specimen of stool for: culture and sensitivity, occult blood, ova and parasites • Monitoring indwelling tubes for signs of microbial growth • Routine maintenance of indwelling tubes to prevent microbial growth • Choosing aerobic blood culture bottles versus anaerobic culture bottles • Draw blood cultures from a central line • Perform nose swab, ear swab, throat swab • Collect sputum specimen
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Therefore during round three, the panelists were asked to pick 12 lecture topics/concepts absolutely necessary for inclusion in a core pharmacology lecture course by selecting 12 topics/concepts in order of importance from a drop-down menu. Topics/concepts on the drop-down menu contained items that consistently reached a consensus threshold of 70% ($\pm 5\%$). Finally, panelists were requested to narrow their choices even more by selecting only six lecture topics/concepts in order of importance from the same drop-down menu. These procedures were repeated for microbiology topics. To analyze the responses, each topic/concept selected was assigned a point value based on the number of ranks and the order in which the topic/concept was selected. Topics/concepts not selected were assigned zero points. Top ranked pharmacology lecture topics are shown in Figure 1. Narrowed choices for pharmacology lecture topics are shown in Figure 2. Top ranked microbiology lecture topics are shown in Figure 3. Narrowed choices for microbiology lecture topics are shown in Figure 4.

Pharmacological lecture topics deemed important and relevant, but not ranked in the top 12 by panelists (therefore

received zero points) included: insomnia, autonomic nervous system disorders, lipid disorders, psychosis, degenerative diseases of the nervous system, muscular spasms and muscular spasticity, hematopoietic disorders, immune system modulation, fever, allergies, fungal infections, nutritional disorders, pituitary, thyroid, and adrenal disorders, disorders of the male and female reproductive system, skin disorders, and finally eye and ear disorders. Microbiological lecture topics deemed important and relevant, but not ranked in the top 12 by panelists (therefore received zero points) included: typhoid fever, Hantavirus, Rocky Mountain spotted fever, malaria, and rabies.

4. DISCUSSION

Nurse scholars have argued that it is often difficult to accurately determine if essential theoretical and clinical principles of pharmacology and microbiology have been adequately addressed in integrative undergraduate program designs and teaching methods. The introduction of core pharmacology and microbiology lecture courses therefore represents a fundamental shift in our undergraduate nursing curriculum, with an ultimate goal of enhanced outcome-oriented indicators

that reflect improved educational standards and higher levels of professional knowledge and skills. The panel concurred that undergraduate students should be well versed not only in applied pharmacology and the mechanics of medication administration practices, but also in common diseases with

an emphasis on pharmacological symptom management (especially cardiovascular disease, respiratory diseases, and diabetes). Top ranking microbiology lecture topics included hepatitis A, B, and C, as well as tuberculosis, and nosocomial infections.

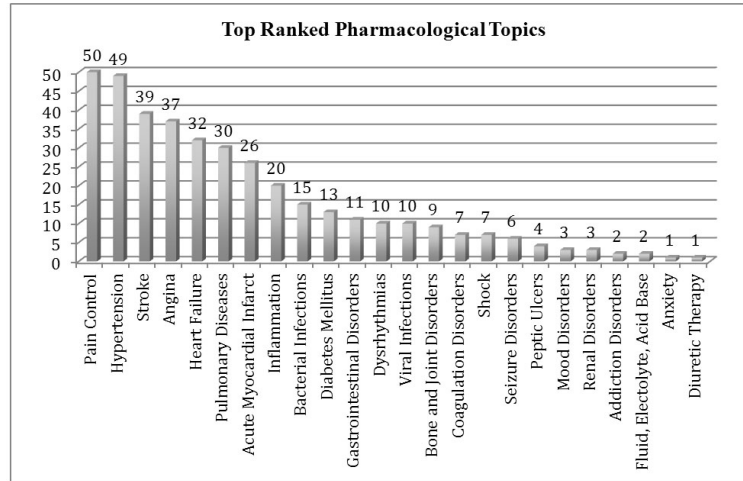


Figure 1. Panelists rank their top 12 topics in order of importance for inclusion in a core pharmacology lecture course for undergraduate nursing students

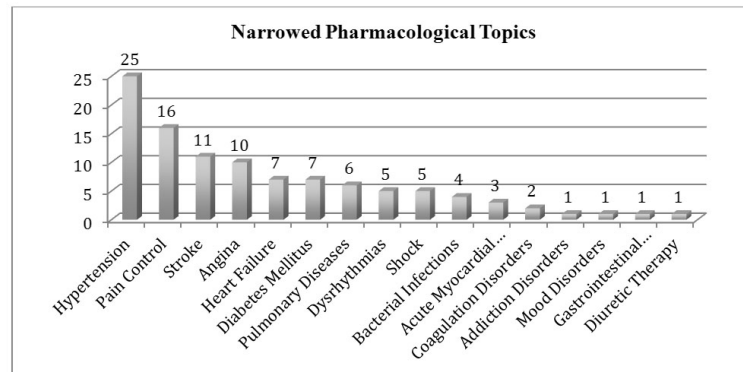


Figure 2. Panelists narrow their choices by selecting only six topics for inclusion in a core pharmacology lecture course for undergraduate nursing students, in order of importance

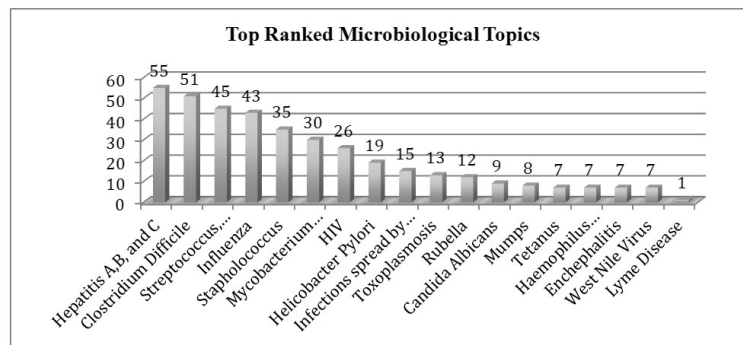


Figure 3. Panelists rank their top 12 topics in order of importance for inclusion in a core microbiology lecture course for undergraduate nursing students

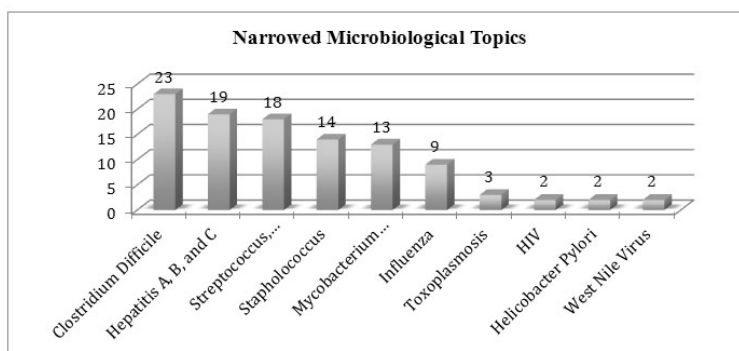


Figure 4. Panelists narrow their choices by selecting only six topics for inclusion in a core microbiology lecture course for undergraduate nursing students, in order of importance

All of the five clinical nurse educators (recruited both internally and externally) had more than 30 years of experience in nursing, were familiar with undergraduate nursing programs, and were knowledgeable about the microbiologic concepts, topics, and skills necessary to prepare nurse graduates who are able to practice in a safe and professional manner. One of the limitations of this study was the small number of panelists. Despite the small number, we believe that their opinions are likely to resonate with other nurse educators. Although all of the panelists had clinical expertise in medical and surgical nursing and most new graduates begin working on a medical

or surgical unit, none of the panelists had clinical expertise in psychiatry, so this is another limitation. In future research, we plan to use the results of this study to develop evaluation tools designed test the outcomes of implementing core pharmacology and microbiology courses in our undergraduate program. We plan to measure undergraduate nursing students' knowledge, skills, and perceptions of confidence in pharmacology and microbiology, pre and post curriculum changes.

CONFLICTS OF INTEREST DISCLOSURE

The authors declare that there is no conflict of interest.

REFERENCES

- [1] Wheeler MF. Review of microbiology by Florence C. Kelly and K. Eileen Hite. *The American Journal of Nursing*. 1950; 50(5): 45. Available from: http://journals.lww.com/ajnonline/Citation/1950/05000/Microbiology_.72.aspx <http://dx.doi.org/10.2307/3467872>
- [2] Chapman CM. The use of sociological theories and models of nursing. *Journal of Advanced Nursing*. 1976; 1: 111-127. <http://dx.doi.org/10.1111/j.1365-2648.1976.tb00434.x>
- [3] Cox CA. Who cares? Nursing and sociology: the development of a symbiotic relationship? *Journal of Advanced Nursing*. 1979; 4: 237-252. PMID:256570 <http://dx.doi.org/10.1111/j.1365-2648.1979.tb03006.x>
- [4] Clarke M. Nursing and biological sciences. *Journal of Advanced Nursing*. 1955; 22: 405-406. <http://dx.doi.org/10.1046/j.1365-2648.1995.22030405.x>
- [5] Trnobrnski PH. Biological sciences and the nursing curriculum: a challenges for educationalists. *Journal of Advanced Nursing*. 1993; 18: 493-499. <http://dx.doi.org/10.1046/j.1365-2648.1993.18030493.x>
- [6] Williamson GR. Teaching sociology to nurses: exploring the debate. *Journal of Clinical Nursing*. 1999; 8: 269-274. <http://dx.doi.org/10.1046/j.1365-2702.1999.00230.x>
- [7] Davis GM. What is provided and what the registered nurse needs – biosciences learning through the pre-registration curriculum. *Nurse Education Today*. 2010; 30: 707-712. PMID:20129721 <http://dx.doi.org/10.1016/j.nedt.2010.01.008>
- [8] Jordan S, Philpin S, Davies S, *et al.* The biological sciences in mental health nursing: stakeholders' perspectives. *Journal of Advanced Nursing*. 2000; 32(4): 881-891. <http://dx.doi.org/10.1046/j.1365-2648.2000.01552.x>
- [9] Kyriacos U, Jordan S, van den Heever J. The biological sciences in nursing: a developing country perspective. *Journal of Advanced Nursing*. 2005; 52(1): 91-103. PMID:16149985 <http://dx.doi.org/10.1111/j.1365-2648.2005.03555.x>
- [10] Manias E, Bullock S. The educational preparation of undergraduate nursing students in pharmacology: clinical nurses' perceptions and experiences of graduate nurses' medication knowledge. *International Journal of Nursing Studies*. 2002; 39: 773-784. [http://dx.doi.org/10.1016/S0020-7489\(02\)00008-1](http://dx.doi.org/10.1016/S0020-7489(02)00008-1)
- [11] Manias E. Pharmacology content in undergraduate nursing programs: Is there enough to support nurses in providing safe and effective care? *International Journal of Nursing Studies*. 2008; 46: 1-3. PMID:18656874 <http://dx.doi.org/10.1016/j.ijnurstu.2008.06.002>
- [12] Meechan R, Mason V, Catling J. The impact of an integrated pharmacology and medicines management curriculum for undergraduate adult nursing students on the acquisition of applied drug/pharmacology knowledge. *Nurse Education Today*. 2011; 31: 383-389. PMID:20833455 <http://dx.doi.org/10.1016/j.nedt.2010.07.011>

- [13] Lim AG, Honey M. Integrated undergraduate nursing curriculum for pharmacology. *Nurse Education in Practice*. 2006; 6: 163-168. PMID:19040872 <http://dx.doi.org/10.1016/j.nepr.2005.11.005>
- [14] Dilles T, Vander Stichele RR, van Bortel L, *et al.* Nursing students' pharmacological knowledge and calculation skills. Ready for practice? *Nurse Education Today*. 2011; 31: 499-505. PMID:20837376 <http://dx.doi.org/10.1016/j.nedt.2010.08.009>
- [15] Shields L, Purcell C, Watson R. It's not cricket: The ashes of nursing education. *Nurse Education Today*. 2011; 31: 314-316. PMID:21220181 <http://dx.doi.org/10.1016/j.nedt.2010.12.015>
- [16] Strauss A, Corbin J. *Basics of qualitative research: Techniques and procedures of developing grounded theory* (2nd ed.). Thousand Oaks, CA: Sage; 1998.
- [17] Waltz CF, Strickland OL, Lenz ER. *Measurement in nursing and health research* (4th ed.). Philadelphia: Springer Publishing Company. 2005.
- [18] Graham B, Regehr G, Wright JG. Delphi as a method to establish consensus for diagnostic criteria. *Journal of Clinical Epidemiology*. 2003; 56: 1150-1156. [http://dx.doi.org/10.1016/S0895-4356\(03\)00211-7](http://dx.doi.org/10.1016/S0895-4356(03)00211-7)
- [19] Keeney S, Hasson F, McKenna H. A critical review of the Delphi technique as a research methodology for nursing. *International Journal of Nursing Studies*. 2001; 38(2): 195-200. [http://dx.doi.org/10.1016/S0020-7489\(00\)00044-4](http://dx.doi.org/10.1016/S0020-7489(00)00044-4)
- [20] Naidoo P, Joubert RWE. Consensus on hypotonia via Delphi process. *Indian Journal of Pediatrics*. 2013; 80(8): 641-650. PMID:23681830 <http://dx.doi.org/10.1007/s12098-013-1018-7>