Science knowledge needed for nursing practice: A cross-sectional survey of Australian Registered Nurses

ABSTRACT

Background

Nursing practice is underpinned by science knowledge. While the literature is consistent in identifying limitations in respect of the teaching of science content to nurses, there is a lack of consensus regarding what should be taught and to what level of detail. No studies to date have systematically surveyed registered nurses (RNs) for their perspectives about the science knowledge that should underpin nursing practice.

Aim

To establish the relative importance RNs place on science content taught to nurses.

Method

Practicing RNs across Australia were invited to participate in the study. A cross-sectional survey was administered online. The survey asked participants to prioritize 179 science topics according to the relative importance they felt should be placed on each.

Findings

A total of 1,583 RNs completed the survey. Participants indicated strong support for inclusion of foundational science knowledge in undergraduate pre-registration nursing programs. The majority of topics (88%) were rated as a 'high priority' (a rating of 4 or 5), particularly anatomy, physiology and pathophysiology. No topic received a rating of less than 3 (of a possible 5).

Discussion

RNs expressed different views about the prioritization of science content areas for nursing practice, compared with views of academics who teach science to nursing students. Identification of the science content areas that RNs regard as high priority for nursing practice can be used to guide improvements in nursing curriculum development.

Conclusion

The results of this study demonstrate that practising RNs place high value on various science topics and the teaching of biological sciences generally. This study suggests the need for greater inclusion of key stakeholders, including practicing RNs, in the development of nursing curricula.

Summary of Relevance

- **Problem or Issue**

Although science is important in nursing education, no clear evidence identifies what topics should be taught in undergraduate nursing programs.

- **What is Already Known**

Despite its importance in facilitating RNs to recognise and respond to signs of clinical deterioration, nurses lack confidence in applying science knowledge to practice.

- **What this Paper Adds**

This paper provides evidence of what science should be taught in undergraduate nursing programs from analysing the responses of 1,583 Australian RNs who prioritised the importance of 179 science topics to nursing practice.

Introduction

Nursing is a profession that requires a diverse skill set that is applicable in a vast range of practice environments. Ensuring adequate preparation for the registered nurse (RN) role requires a solid foundation of theoretical knowledge and an understanding of how this knowledge is applied in practice. Providers of undergraduate nursing education must prepare graduates for the unique diversity of the role of the RN and the dynamic nature of the health care environments in which they will function. The biological sciences (or biosciences) represent a significant proportion of nursing curricula internationally. Uncertainty regarding what is and is not critical content in undergraduate nursing programs creates pressure for educators who strive to ensure to produce graduates ready for practice. This paper describes the findings of a nationwide survey of Australian RNs to identify what priority they believed should be given to science topics in undergraduate nursing programs. The relevance of these findings and implications for education providers and the broader profession are discussed.

Background

Biosciences, including anatomy, physiology, pathophysiology, microbiology, chemistry and physics are typically taught within nursing education programs (Logan & Angel, 2011). Clinically relevant knowledge of the biosciences is essential for RNs to recognise and respond to signs of clinical deterioration (Evans et al., 2013; Jones et al., 2013; Kelly et al., 2014; McVicar et al., 2013). Studies over the past decade have suggested that many nurses are not confident in applying their bioscience knowledge or discussing bioscience related issues with patients or other health professionals (Friedel & Treagust, 2005; McVicar et al., 2013). McVicar et al. (2010), for example, found that while surgical nurses generally recognised the significance of key signs and symptoms in the clinical environment, they had difficulties explaining physiological changes and their potential impact on patient outcomes. There is broad concern within the literature that the design and delivery of bioscience content in nursing curricula is not optimally targeted towards preparing new graduates for registered nursing practice (Davis, 2010; Friedel & Treagust, 2005). As a result, newly qualified nurses perceived a shortfall

in their bioscience knowledge when commencing in the professional role, a situation that was perpetuated by the lack of opportunity to address the deficit with experience (Davis, 2010).

Although there is agreement within the literature that bioscience is a vital component of preparatory nursing programs, there is no consensus on what content should be taught and in what level of detail (Davis, 2010; Logan et al., 2013). This situation is also reflective of the broader higher education contexts globally, as no studies outside of nursing were found within the literature that systematically identified what science topics should be taught in health professional degree programs.

The study reported in this paper was part of a larger two-phase project that had the overall aim of identifying the existence and extent of the theory-practice gap in relation to science in nursing. In the first phase of the project, academics who taught science in undergraduate nursing programs in Australian universities were asked to identify the priority that was given to various science topics in those programs (Blinded for review, 2014). This paper reports on the second phase, a national survey of RNs in practice that aimed to establish the relative importance they place on science content taught to nurses.

Methods

Design

The study employed a survey design using a questionnaire developed by Logan (2008) which was adapted for this study. Although the original survey was developed for use in the Australian context, minor modifications were made to formatting and terminology to enhance clarity. Face validity of the survey items was originally established during development of the academic survey in Phase 1. This process involved a review of the survey items by a panel of academics from the authors' institution and other universities from across the country. Slight modifications were made to some items, particularly the demographic questions, to ensure they were appropriate for the RN cohort. The survey was deemed to be valid for this second phase following additional testing by four final year nursing students. The

questionnaire was delivered via a subscription survey website (SurveyMonkey.com). Ten demographic questions collected data including age and residential postcode. The main body of the questionnaire comprised 179 items clustered into six categories:

- Normal anatomy of body systems (11 items);
- Basic concepts (6 items);
- Normal cellular histology (10 items);
- Physiology and pathophysiology of body systems (86 items);
- Microbiology (22 items);
- Chemistry (20 items) and;
- Physics (24 items).

Participants were asked to rate each item on a 5-point scale on priority from 1 (lowest priority) to 5 (highest priority). Participants were also given the opportunity to provide additional comments. Reflective of the broad content and consistent with the terminology of the original questionnaire, the term 'science' was retained in preference to 'bioscience'. This terminology was retained throughout data collection and in reporting of the results.

Data collection and analysis

Approval to conduct the study was obtained from the principal investigator's university Human Research Ethics Committee. A link to the survey was distributed via the various Chapters of the Australian Nursing and Midwifery Federation. Respondents' anonymity was assured in the information sheet attached to the survey and submission implied consent. The survey was open for completion from April to August 2014 to provide adequate time for RNs across various states and territories to participate.

Demographic data and responses to scale items were downloaded for analysis. Data were analysed via descriptive and inferential statistics using IBM- SPSS Version 22 (IBM Corp., Armonk, New York,

2011). The association between participants' demographic characteristics and their total ratings score on priority in teaching (i) Basic Science concepts (questions 11-13 inclusive: basic concepts, normal gross anatomy and normal cellular histology) and (ii) Other Science Topics (questions 14-27 inclusive: physiology, pathophysiology of body systems, genetics, microbiology, chemistry, physics) were tested. The ratings from each participant were summed into a total score to be examined. One-way ANOVA or t-test was used (as appropriate) to test for differences in the two dependent variables by age (decade), years of experience in nursing (quartiles <2 yrs; 3-5; 6-10; >10), whether a postgraduate qualification (certificate/diploma/degree) was held, and whether work setting was acute care. A p value < 0.05 was regarded as significant throughout. The results of these analyses are presented in the following sections of this paper.

Findings

Of the 1,865 returned surveys, 1,583 were found to be complete with ratings of science topics and were thus included in the analysis. RN participants resided in one of eight Australian states or territories, with the majority living in NSW (62.6%); Victoria (13.1%); Tasmania (9.4%); and Queensland (6.6%). Two-thirds of participants were aged over 40 years and the median age range was 40-49 years. Most (74%) had ≥5 years of nursing experience and the median duration of practice was 16 years with an average 11 years of experience in their current specialty. Half the RNs (51%) held a postgraduate qualification: a degree; a diploma; or a certificate. The demographic characteristics of the sample broadly concur with national workforce statistics for RNs in 2011, based on age, length of experience and principal areas of work (Health Workforce Australia, 2014).

The participants worked in a wide range of services across all patient age groups. Around 40% were employed in hospital-based care and others were employed in services such as community health; mental health; primary care; general medical practices; outpatient clinics; aged care; palliative care; the justice system; the education sector; and rural and remote health services. The demographic profile of

participants indicate that they had qualifications and experience that positioned them well to provide feedback regarding the value of teaching science in undergraduate nursing programs and their responses are explored below.

Priority of science topics

Participants indicated general support for the teaching of all the topics presented in the survey. Table 1 presents a summary of responses in seven main categories based on perceived priority of teaching science topics (high, moderate, or low priority). Responses are aggregated to indicate how 1,583 participants prioritized each category. When rated on a scale of 1 (lowest priority) to 5 (highest priority), over one-third (37%) of the 179 listed topics achieved a median rating of 5; half (51%) achieved a median of 4 with 11% receiving a median rating of 3. No item averaged less than a score of 3. While this confirms the general value of the surveyed science topics to RNs, there were variations between items. These could explain the priority that RNs perceive should be given to science topics in contemporary nursing curricula.

(Insert here) Table 1: Priority for teaching science topic areas†

The following sections relate to the more detailed item-by-item average responses presented in Table 2 to Table 7.

Science topics rated as 'High priority'

All 'basic concepts', 'anatomy' and 'histology' items' scores ranged up to the maximum of five points with mean scores of >4, indicating support for the 'highest priority' of the science items (see Table 2). Strong support for the teaching of anatomy was evident, with all 11 items being prioritized in this category as a 4 or 5 by >84% of participants. The anatomy of the 'Cardiovascular system', 'Neurological system', 'Respiratory system', 'Renal system', 'Gastrointestinal system' and 'Endocrine system' were

rated at the top end of the priority scale by ≥95% of RNs. Likewise, there was strong support for the teaching of Histology, with eight of ten items ranked at 4 or 5 by >84% of participants. Three items in Basic Concepts were similarly highly ranked by >84%.

Table 2: RNs- rating of priority attributed to Physiology, Anatomy & Histology science topics within a nursing pre-registration undergraduate degree program. †

There was a strong positive response in respect of priority that should be given to the teaching of items relating to physiology and pathophysiology (See Table 3). Three-quarters (77%) of a total of 86 items were ranked at mean 4 or above on the priority scale, with the remaining 20 being ranked at less than 4. The strongest response was for teaching the cardiovascular system and respiratory system. Blood pressure and BP measurement reached a mean of 4.74 and myocardial ischaemia and infarction had a mean of 4.71. The highest ranked topics in the respiratory system items were major infections/diseases (M = 4.65) and breathing mechanics (M = 4.63). However, teaching of the neurological system was also prioritized in this range with pain highly ranked (M = 4.73).

Table 3a: RNs' rating of priority attributed to normal Physiology and Pathophysiology of Body Systems science topics within a nursing pre-registration undergraduate degree program

Table 3b: RNs' rating of priority attributed to "Normal Physiology and Pathophysiology of Body" Systems science topics within a nursing pre-registration undergraduate degree program. †

Around half the microbiology items (12 of 22) and six of 20 chemistry items were ranked at mean priority 4 or above, with the remainder rated lower (see Table 4). In the physics domain, the only item that was seen as a high priority was sound – auscultation and stethoscope use (M = 4.19).

Table 4: RNs' rating of priority attributed to "Genetics and Microbiology" science topics within a nursing pre-registration undergraduate degree program. †

Science topics rated as 'Moderate priority'

Survey participants rated fewer science topics as deserving of moderate priority in teaching. In basic concepts, anatomy and histology, a total of only 4 items were rated as moderate priority. When clustered by body system, twenty of 86 items (23%) in physiology and pathophysiology were ranked "moderate priority" in teaching. Genetics featured most strongly as being worthy of moderate priority in teaching with all six genetics items ranking between M = 3.50 to 3.82. Six of the ten reproductive system items were rated as moderate priority. However, all ratings extended across the spectrum from lowest priority (1) to highest priority (5).

A large proportion (72%; 64 of 86) of microbiology, chemistry and physics topics were ranked lower, as moderate priority (see Table 7). In particular, RNs ranked the non-biological topics less of a priority than other topics with many chemistry and physics items included at this level.

Table 5:RNs' rating of priority attributed to chemistry and physics within a nursing pre-registration undergraduate degree program. †

Science topics rated as 'Low priority'

No science topics were ranked overall as a low priority, with no items having a mean <3.

Science topics not listed

Respondents were given the opportunity to add any topic they felt had been omitted from the survey. More than 260 participants made comments, with many containing more than one suggestion. Of the comments that were science related, most were already listed in the survey or embedded in the pathophysiology of relevant systems (e.g. 'Asthma'; 'ARDS'; 'diseases of the eyes'; 'diseases of the ears'; 'neurotransmitters'; 'immunization and immunity'). Many participants commented about the need

to integrate and apply science concepts to practice, with two individuals taking the opportunity to propose that nursing education return to the hospital environment. A number of participants indicated that pharmacology should have been included, a category that was excluded as it is considered a specialist area of science. Nutrition and breastfeeding – arguably specialist areas – were also identified by participants as topics absent from the survey. Numerous comments were made about broader nursing concepts (e.g. basic nursing skills; assessment; wound care; hygiene; sleep) as well as those that underpin evidence-based practice such as research and critical thinking. Ageing was also mentioned by a few participants, with some making specific reference to 'the science of the ageing body'. Several suggested topics fell into areas of nursing specialisation such as mental health, infection control and palliative care. Social and behavioural sciences were also listed, including numerous references to psychology and communication. Stress management, time management and self-care were surprising suggestions for inclusion in a science survey as were topics such as law, ethics, mathematics, empathy, technology, political science, occupational health and safety, even spelling and grammar.

Impact of nursing experience

Older and more experienced nurses held stronger views about the teaching of science topics. A one-way ANOVA with post-hoc tests revealed a significantly higher total rating of priority of teaching basic concepts from nurses who were aged 40-49 years (M (317) = 118.10), and 50 or older (M (589) = 118.71), compared with those <30 years of age (M (250) = 114.62,) (F (3, 1395) = 5.46, p = 0.001). Similarly, there were significantly higher ratings of priority of teaching basic concepts from those with >10 years experience (M (625) = 118.85) and 6-10 years of experience (M (389) = 117.75) compared with nurses with 1-2 years of practice experience (M (212) = 114.48) (F (3, 1387) = 6.16, p <0.001). Further, nurses who held a postgraduate qualification (M (719) = 118.33, SD 13.48) rated the priority of teaching basic concepts significantly higher than those with entry-level qualifications (M (682) = 116.80, SD 13.90, t (1399) = 2.08, p = 0.038).

Total ratings for science topics followed a similar pattern. Nurses aged 50 or older (M (390) = 629.76) held significantly stronger views on priority that should be given to teaching science topics compared with nurses under 30 years of age (M (210) = 600.88) (F (3, 1003) = 4.60, p = 0.003). Similarly, nurses with >10 years' experience (M (423) = 627.18) prioritized teaching of science topics significantly higher than nurses with 1-2 years of practice experience (M (175) = 604.12,) (F (3, 996) = 2.83, p = 0.037). The findings, however, were not impacted by postgraduate qualification or acute care work setting.

Discussion

The results of this study provide an interesting picture of the value that practising RNs place on foundational science knowledge. The majority of topics presented to RNs in this survey were rated as 'high priority', particularly those that relate to anatomy, physiology and pathophysiology. Topics considered to be worthy of moderate priority in teaching were primarily those that may be classified as peripheral biological science topics within the microbiology, chemistry and physics domains. Of interest is that no topics were determined to be deserving of 'low priority' in teaching. Earlier research has found that despite recognition of the importance of foundational preparation in the biological sciences, many nurses believe their own preparation was inadequate (Davis, 2010; McVicar et al., 2010). It is likely that this perception has strengthened a conviction to correct that deficit in future generations entering the profession, and this view is reflected in the survey data.

The findings discussed in this paper contrast with those from a study employing the same survey to identify the priority that is actually given to these topics by those who teach science to nursing students. In that study (Blinded for review, 2014) academics prioritized fewer topics as 'high priority' with most being included in the 'moderate priority' category. The results described in this paper represent an upward shift of most topics that academics gave moderate priority to in teaching, with few exceptions. Cell differentiation, ranked as 'moderate priority' by RNs, was a subject area deemed to be 'high priority' by academics. Conversely, topics such as chemical reactivity, principles and issues relating to radiotherapy

and nuclear medicine and work/power mechanics rated as 'moderate priority' by RNs, were identified by academics as having 'low priority' in teaching. These conflicting findings reflect a lack of consensus between academics and clinicians in respect of the most fundamental knowledge required for nursing practice.

It is expected that practising RNs would have the most valid perspective on the knowledge that is required in the clinical environment; certainly the statistically positive association of nursing experience with the prioritisation of science topics, albeit weak, reinforces this suggestion. Much of the critical thinking and clinical decision-making in which nurses engage on a daily basis is dependent on having a working knowledge of the biological sciences to ensure positive patient outcomes (McVicar et al., 2013). Away from the practice environment, those who teach science to nursing students may have a degree of disconnection from the clinical setting despite the fact that approximately half of these teachers are themselves, RNs (Blinded for review, 2014). Currently, nursing within the higher education environment is constrained by numerous social, technological and economic factors (Ralph et al., 2014). These factors contribute to the disparity between what is considered essential knowledge for nursing practice and what is actually delivered. While RNs in practice may feel frustrated at their own perceived limitations in science knowledge, they may not appreciate that issues such as contracting academic semesters and fiscal constraints reduce opportunities for inclusion of additional content, unless it is at the expense of other aspects of the curriculum (McVicar et al., 2013).

Of particular interest in the data obtained from this study are the open-ended responses relating to topics that had been missed in the survey. Only around 10% of RNs chose to indicate topics that they believed were missing, indicating that the survey was comprehensive. Topics that were identified as being absent were largely specialist areas, most of which are nursing specialisations, rather than science-related. This finding raises questions about the concept of 'science' as held by RNs. Nursing is considered by some as a science, an art, or both, with these concepts viewed as being on a continuum (Logan & Angel, 2011).

What was surprising to the researchers was that participants identified additional topic areas such as grammar and spelling, when all items in this survey were clearly science-related. It is possible that RNs in practice have limited opportunity to be heard on matters related to nursing education programs and that this survey was seen as a way for them to contribute to the conversation.

Responses may also have been influenced by the age, professional experience and educational attainment of participants as they were associated with how nurses prioritised basic concepts and science topics. The amount of professional experience has been previously associated with increased competence or safety in practice (Takase, 2012; Kendall-Gallagher & Blegen, 2009), while greater levels of education are known to reduce rates of patient mortality (Aiken et al. 2003; Aiken et al. 2014). Since patient outcomes are improved when nurses are more experienced and educated, the perspectives of the nurses in this study who strongly prioritized science topics in nursing education should not be dismissed. Although the relationship between science knowledge and the quality of nursing practice is not known, current clinical opinion on what should be taught to nursing students is empirically substantiated and often expected as part of curriculum design (Ralph Birks, Cross & Chapman, 2015)

The results of this study raise a number of important issues for nursing education and practice, and identify potential areas for future research. Questions are raised about the discrepancy between the relative importance placed on science topics by those who use this knowledge and those who teach it. Logic dictates that RNs in the contemporary practice environment are best placed to know what knowledge needed to underpin safe practice. These findings would suggest that it is critical to include RNs with contemporary knowledge of the clinical environment in curriculum development processes as their practise-based perspectives are vital in prioritising the type of science knowledge is needed to support nursing students in becoming safe and effective practitioners. While current accreditation standards in Australia dictate that stakeholder input is a requirement (Australian Nursing and Midwifery

Accreditation Council, 2012), the findings from this study suggest that such involvement needs to be expanded.

The limitations of this research largely relate to conscious decisions made in the study design. The exclusion of pharmacology has isolated that subject area from related concepts such as chemistry, as covered in this research. This study might also have benefited from comparative analyses of responses with work speciality, work history and qualifications, however these analyses may have been confounded by other variables and would therefore have not added value to the results. Furthermore, terminology used in the survey might also have been an issue. Respondents might not have made the distinction between histological and macro-cellular concepts such as anatomy, physiology, and pathophysiology.

Conclusion

This study has confirmed the value of foundational scientific knowledge for RNs employed in all clinical contexts. If the purpose of nursing education is to provide graduates with a platform on which they can develop further expertise in the provision of quality nursing care, the focus must be on the inclusion of relevant science content taught at appropriate depth. In this study, practising RNs have indicated the importance of particular science topics, in particular gross systems anatomy, physiology and pathophysiology. Thus the content and level of detail of biological science featured in preparatory nursing curricula should reflect these priorities. Better links between clinical practice and curriculum design need to be developed so that all stakeholders can have confidence in the relevance and appropriateness of learning experiences in the pre-registration nursing space.

Relevance to practice

This study offers valuable insights into how RNs prioritise foundational science knowledge that should be included in undergraduate nursing programs. Aligning the teaching of science in undergraduate nursing

programs with what clinicians use in practice may enhance the relevance of nursing knowledge at the point of care, potentially leading to better patient outcomes.

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