Paramedic student anxiety levels towards concepts in pharmacology at a regional university in Australia

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Education

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Abstract

Introduction
Science-based subjects have a long history of inducing stress and anxiety among many health care students. While there has been substantial research conducted across many allied health courses, very little research has examined the impact of pharmacology stress in paramedic students. In this study we set out to explore the perceived anxiety levels to various topics in second-year university applied pharmacology.

Methods
Using a paper based questionnaire conducted at the start and end of the teaching semester in a second year applied pharmacology subject, students were asked to record their perceived levels of anxiety to concepts and scenarios in applied pharmacology. Students ranked areas of anxiety from highest to lowest and were able to respond with short answers.

Results
A total of 140 students completed the questionnaire. Calculating dosages and understanding the mechanism of action ranked high with 69% and 70% of students respectively scoring 4 or 5 out of 5. Other areas such as contraindications and side effects scored lower (28% and 24%, respectively) with indications scoring only 11%. By the end of the semester students still reported high anxiety levels towards calculating drug concentrations, remembering all medications and understanding pre-existing patient medications.

Conclusion
The results of this study indicate that students commence and leave with high levels of perceived anxiety towards various aspects of pharmacology. This outcome suggests that further pedagogical tools could be employed to assist students to lessen this anxiety to assist the students in better understanding the material to ensure confident graduates.

Keywords:
paramedic students, student anxiety, pharmacology, education

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Introduction

The acquisition of new knowledge and its comprehension at a university level is a complex neurological task that requires students to master numerous cognitive skills such as application, analysis, synthesis and evaluation (1,2). It has been widely known for decades that subject-specific anxiety can have a profound, negative impact on the acquisition and comprehension of new information (3–6). Specifically, students with pre-conceived notions, previous negative experiences and a lack of background education can dramatically affect the ability of students to process, encode, organise, store and retrieve information (7). Together these factors can have a negative contribution to a student's academic self-efficacy, which as behavioural theory supports the concept of a belief in ones own ability to understand and comprehend new material (8). It is therefore not surprising that subject specific anxiety can have a substantial impact on engagement, motivation, academic performance and even course attrition rates (9–11). Indeed, there is growing concern that student anxiety at a tertiary level is a major issue that needs to be addressed to ensure capable and confident graduates (12–14).

Science subjects have a long history of inducing anxiety within many student populations (15,16). For example, within nursing, various studies have highlighted that learning and comprehending science-based material (eg. pharmacology) causes significant anxiety that may even result in medication errors conducted in practice (17–19). However, at the present time there is limited evidence available on subject-specific anxiety during undergraduate paramedic training. Employed paramedics are not only expected to respond to emergency situations but provide a rapid diagnosis and apply appropriate treatments including the administration of medications. It is therefore critically important that students studying paramedicine have a solid foundation in pharmacology knowledge to adequately prepare them for professional practice (20).

Methods

Institutional context
At Charles Sturt University Bathurst campus (New South Wales), applied pharmacology is a second year paramedic subject delivered as weekly, 4 hour lectures combined with a compulsory 2 hour tutorial of groups of less then 30 students. Within this subject, tutorials are delivered exclusively via case studies presented as real-world simulations that include applied clinical skills such as assessment, medication preparation and administration. Assessment items for applied pharmacology include online quizzes, random pop tutorial quizzes and a final end of session exam. Prior to enrolling, students are required to have a sound knowledge of first year anatomy and physiology combined with second year pathophysiology, including some minor theoretical pharmacology.

Survey design
At the commencement of the semester, students were surveyed to investigate their levels of anxiety towards various concepts in pharmacology such as indications, contra-indications, side effects, mechanism and dosages. To avoid any potential conflict of interest an academic not related to the subject explained, distributed, collected, analysed and secured the surveys until the conclusion of the subject. Briefly, a short talk prior to the start of the tutorials was delivered to the students on the benefits of the study and emphasised that involvement was non-compulsory and entirely voluntary. A paper-based survey was then given to the students consisting of three main sections: the first section devoted to student demographics such as age, gender and previous pharmacology study; the second section asked students to rank how they felt about learning pharmacology concepts using a 5-point Likert-style scale in order from least (1) to most anxious (5); and the final section asked students to indicate their level of anxiety regarding particular applied pharmacology scenarios in professional practice again using the same Likert-style scale.

At the conclusion of the same semester, students were again surveyed to investigate if their beliefs and concerns had changed. An academic not related to the subject presented a short explanation of the survey and highlighted that participation was not compulsory and entirely voluntary. This second paper-based survey consisted of two main sections: the first section was the same questions from the first survey that asked students to indicate their level of anxiety regarding particular applied pharmacology scenarios in professional practice again using the same Likert-style scale. An additional component was included at the end of the survey to record qualitative data regarding what the students perceived to be easy or hard to learn about pharmacology and their beliefs regarding how the teaching of pharmacology could be improved.

Ethics

Ethics approved by the Charles Sturt University's Faculty of Science Minimal Risk Ethics in Human Research Committee. All information collected in this study was de-identified and kept in a secure location by a member of staff not related to the subject.

Data analysis

All data are presented as means ± SEM (standard error of the mean) and were compared statistically with a Mann-Whitney U unpaired t-test with statistical significance accepted at p<0.05. All statistical tests were done with Prism 6.0 (Graphpad).

Results

Student demographics

The present study comprised data from 140 internal students enrolled in applied pharmacology for paramedic students at [WHICH CAMPUS? See comment above] Charles Sturt University. Responses in the form of paper-based questionnaires were collected both at the commencement (n=140) and in the final week of the semester (n=119). Response rates were 100% of students present at both times. Student demographics indicated that the majority of students (78%) were aged 18–24 years, 18% 25–34 years and 4% 35–44 years, with only one student aged 45–54 years (Table 1). There was a slight majority of female students enrolled (56% vs. 44%).

	Percentage (n=140)
Age (in years):	
18-24	78%
25-34	18%
35-44	3%
45-54	1%
Gender:	
Male	44%
Female	56%

Table 1. Student demographics enrolled in applied pharmacology at the start of the semester (n=140)

Anxiety levels in applied pharmacology

To better understand the concerns our paramedic cohort faced with learning applied pharmacology, students were asked to rank from 1 to 5 (least to most anxious) various concepts in applied pharmacology such as drug mechanism, indications, contraindications, side effects and dosage. Similar to previous studies (21,22), students that scored 4 or 5 out of 5 were classified as 'highly anxious'. Overall we found students were highly anxious about learning dosages (70.0%; Table 2) and the mechanism of action for various medications (68.6%). However, other concepts appeared to provoke less anxiety such as learning contraindications (27.9%), side effects (23.6%) and indications (10.7%).

To further elucidate the areas in applied pharmacology where students were most concerned, we asked our cohort to rate from 1 to 5 (least to most anxious) various scenarios they would likely encounter working as paramedics. Over two-thirds of students rated scenarios 4 or 5 that centred on remembering all medications in paramedic practice (70.0%, mean of 3.9 ± 0.1; Table 3), calculating weight-based drip ratios (67.1%; mean of 3.8 ± 0.1), calculating dosages (66.4%; mean of 3.6 ± 0.1) and understanding the prescription medications already prescribed to patients (63.6%; mean of 3.8 ± 0.1). In the remaining scenarios student responses were generally similar. A small percentage of students reported feeling high anxiety towards administering a bolus dose intravenously (25%; mean of 2.7 ± 0.1), explaining how a medication works (22.1%; mean of 2.6 ± 0.1), determining the contraindications of medications (21.4%; mean of 2.7 ± 0.1), determining the right drug to administer (17.9%; mean of 2.8 ± 0.1), understanding a patient's signs and symptoms (17.1%) and explaining the side effects to patients (10.8%; mean of 2.3 ± 0.1).

	% scoring item as 4 or 5 (n=119)
Learning the dosages of a medication	70.0%
Learning the mechanism of action of a medication	68.6%
Learning the contraindications of a medication	27.9%
Learning the side effects of a medication	23.6%
Learning the indications of a medication	10.7%

Table 2. Ranked concepts in pharmacology that students are most anxious about (4 or 5 out of 5) at the start of the session (n=119)

Table 3: Answers to student questionnaires at the commencement of semester (n=140) and completed after studying applied pharmacology (n=119). Differences in responses analysed using a Mann-Whitney U test

| | Percentage (%) | | | | | Number of students (n) | Mean ± SEM | p value |
| | Least anxious | | | | Most anxious | | | |
	1	2	3	4	5			
I need to remember all the possible medications given in paramedic practice								
Before	1.4	7.9	20.7	40	30	140	3.9 ± 0.1	
After	1.7	12.6	21	37	27.7	119	3.8 ± 0.1	0.36
I need to calculate a weight-based drip rate of a medication infusion.								
Before	5	7.9	20	36.4	30.7	140	3.8 ± 0.1	
After	6.7	10.9	16	33.6	32.8	119	3.7 ± 0.1	0.93
I need to calculate the correct dose of a medication to give a patient.								
Before	5.7	9.3	18.6	44.3	22.1	140	3.6 ± 0.1	
After	7.5	20.2	28.6	35.3	8.4	119	3.1 ± 0.1	<0.001
I need to understand what prescription medications a patient takes before treating them.								
Before	2.1	10	24.3	35.7	27.9	140	3.8 ± 0.1	
After	3.1	4.2	22.8	48.8	21.1	119	3.8 ± 0.1	0.74
I need to determine the right drug to give a patient.								
Before	3.6	32.1	46.4	15	2.9	140	2.8 ± 0.1	
After	17.6	40.3	27.7	12.6	1.8	119	2.4 ± 0.1	<0.001
I need to understand a patient's signs and symptoms to know what drug to give.								
Before	6.4	37.9	38.6	15.7	1.4	140	2.7 ± 0.1	
After	14.3	40.3	35.3	10.1	0	119	2.4 ± 0.1	<0.05
I need to determine the contraindications of a given medication before I administer to a patient.								
Before	7.1	37.1	34.4	20	1.4	140	2.7 ± 0.1	
After	8.4	35.3	37	15.1	4.2	119	2.7 ± 0.1	0.92
I need to administer a bolus dose of a medication intravenously to a patient.								
Before	10.7	28.6	35.7	22.9	2.1	140	2.7 ± 0.1	
After	21	31.9	21.9	21	4.2	119	2.5 ± 0.1	0.08
I need to explain to a patient how the medication works and what it does.								
Before	13.6	32.9	31.4	19.3	2.8	140	2.6 ± 0.1	
After	20.2	39.5	25.2	14.3	0.8	119	2.4 ± 0.1	<0.05
I need to explain the side effects of a medication to a patient.								
Before	16.4	45.7	27.1	10.8	0	140	2.3 ± 0.1	
After	15.1	52.1	23.5	9.3	0	119	2.2 ± 0.1	0.61

When the same questionnaire was repeated at the end of the semester (after; Table 3), students showed minor, but not significant reductions in anxiety involving scenarios centred on remembering all medications (3.9 ± 0.1 vs. 3.8 ± 0.1; p=0.36), calculating weight-based drip rates (3.8 ± 0.1 vs. 3.7 ± 0.1; p=0.93) and understanding prescription medications that patients were already taking (3.8 ± 0.1 vss 3.8 ± 0.1; p=0.74). However, the scenario where students were asked to calculate the correct dose was significantly reduced from 3.6 ± 0.1 to 3.1 ± 0.1 (p<0.001). Furthermore, we found scenarios centred on determining the correct drug to administer patients was also reduced from 2.8 ± 0.1 to 2.4 ± 0.1 (p<0.001) and understanding a patient's signs and symptoms was also markedly reduced from 2.7 to 2.4 ± 0.1 (p<0.05). In addition, the concept of explaining how a medication works to a patient was reduced from 2.6 ± 0.1 to 2.4 ± 0.1 (p<0.05). The remaining scenarios however were largely unchanged. We found no difference between determining the contraindications of a given medication (2.7 ± 0.1 vs. 2.7 ± 0.1; p=0.92), needing to administering a bolus dose (2.7 ± 0.1 vs. 2.5 ± 0.1; p=0.08) and needing to explain the side effects of a medication (2.3 ± 0.1 vs. 2.2 ± 0.1; p=0.61).

Analysis on student comments
In the final stage of the second survey, students were asked to write responses to what they found easy to learn, what they found hard and their thoughts on what may improve their understanding of applied pharmacology. In agreement with our initial results, the vast majority of students commonly reported that knowing indications was by far the easiest. Specific comments included:

'Learning indications and when to give them'.
'Learning the basic concepts and reasons to give it to patients'.
'Indications. Know which drug to give is probably easiest'.

Interestingly, students additionally reported that using a range of scenarios facilitated their understanding of learning indications.

Students reported:

'When we undertook a breakdown in class using a variety of scenarios, I thought that made applying the drug correctly, easy'.
'Medications when given a scenario or real life story regarding its use'.
'I found scenarios helped towards my understanding of drugs better'.

Although our students initially reported some anxiety with learning the mechanism of action for various agents, there was a small subset of students who reported they found learning the mechanism easier. In addition, some of the student comments indicated that there was a link between learning previous pathophysiology and understanding applied pharmacology concepts. Specifically:

'I can remember the mechanism of action of the drug really well after I learn the pathophysiology behind the drug'.
'Mechanism of action was easier to understand with review of pathophysiology'.
'The MOA of medications was easier due to the BMS [biomedical sciences] studies'.

Next, analysis of what students found the most difficult to learn during the teaching semester showed there was an ongoing theme of memorisation centred around learning the mechanism of action, the number of pharmaceutical agents in paramedic practice and calculating dosages. Students' comments included:

'Rote learning of the drugs and all information that they carry with the indications, mechanism of action, contraindications, side effects, dosage, route, precautions and pharmacokinetics.'
'Multiple drugs and their interactions. It is massive memory recall'.
'Remembering and adhering to the contraindications of each drug'.
'The sheer number of drugs and how much detail in each'.

In the final question of the survey, students detailed anything that would have improved their studies. In agreement with our initial results, there was general consensus that spending more time learning the cellular mechanism of action for drugs would be greatly beneficial. Likewise, several students supported the value of case scenarios in paramedic practice towards understanding applied pharmacology.

Discussion

Subject-specific anxiety is a well-documented occurrence across multiple disciplines at a university level (15,23,24). It is unfortunate that this anxiety can potentially impair the acquisition of new knowledge, the recall of information and difficulty processing and consolidating new information in university subjects (3,7,25,26). While there has been significant research centered around the various causes of stress while studying at tertiary level (12,27–29) and the implementation of various techniques and strategies (30,31), it still remains a complex factor that can negatively affect student attrition rates and graduate confidence.

In the present study we set out to explore the anxiety levels of second year paramedic students at a regional university in Australia towards various concepts in pharmacology.

We found that topics such as indications and contraindications appeared to give students low levels of anxiety. This was perhaps unsurprising as these common themes indicated these two areas are closely aligned, easy to learn and required little time for memorisation or clinical application. This may also be due to these concepts generally being relatively straightforward and students tending to view them as absolutes. Students identified that they saw common linkages in indications and contraindications that enabled them to better relate these concepts to each other. As an example, there are several medications easily grouped as chest pain or acute coronary syndrome medications. Teaching students medications based on groups or classes of indication may continue to reinforce this positive finding. Our results also showed that using case studies and debrief sessions significantly reduced the anxiety around simple dosage calculations, indications and explaining to patients how the medication works. In agreement with previous studies, where case studies have been employed in health care education, students responded positively and showed increased understanding of the material (32–34).

However, our students identified rote learning all the medications used in paramedic practice as one of the most challenging aspects of their pharmacology education and this did not improve as the semester progressed. Unfortunately, memorisation stress is not restricted to paramedic students. Multiple studies have shown that memorising concepts is a common stressor among many university students (35,36). While learning and knowing all the drugs in paramedic practice is a crucial requirement to be qualified, there are various pedagogical techniques that could be employed to facilitate this learning such as mnemonics, (37), team-based learning (38) and concept mapping (39). More recently, it has also been shown that strategically placed review sessions are an effective tool for improving and promoting learning in pharmacology across several biomedical disciplines (40). It is reasonable to suggest that if additional pedagogical techniques are offered it may promote another way of learning this material and thus reducing anxiety.

It is without question that there is a critical need for the ongoing review and refinement of education based practices centering on applied pharmacology in health sciences. At present there is a significant incident rate of iatrogenic errors reported in various fields of health care (41–43). While there have been substantial efforts to reduce these errors with various education programs (44–46) and the development of new administration protocols (47) there is still room for improvement. The precise role of anxiety in the early phase of student learning remains a complex and poorly understood issue. Therefore, it is plausible that appropriate stress management during the learning phase of new information might facilitate student knowledge and compression.

Conclusion

To be effective health care workers paramedics must feel confident in their abilities to work in highly stressful and unpredictable scenarios. Laying the groundwork in applied pharmacology during their undergraduate training and strengthening this information with real-world simulations plays a crucial role in preparing paramedics for professional practice. The data from this study showed that paramedic students studying applied pharmacology may be more anxious about concepts such as mechanism or weight-based dosages and their anxiety levels about these topics did not change as the semester progressed. On the contrary, students found concepts such as indications or contraindications easier to learn and as such represented lower levels of anxiety. Targeting areas of anxiety such as mechanism and dosage are a potential way of designing pharmacology subjects to enhance student knowledge and comprehension. Reduced anxiety and greater understanding can then lead to lower attrition rates and enhanced performance in paramedic programs.

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Conflict of interest

The authors declare they have no competing interests. Each author of this paper has completed the ICMJE conflict of interest statement.

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