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Students' Retention of Biophysical Agents Curriculum from First to Third Year of Study

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Abstract

Purpose: Biophysical agents (BPA) are widely used in physical therapy clinical practice and is a content area included in entry level physical therapist education programs. Retention of this content is critical for clinical practice. The purpose of this study was to measure to what extent 3rd year physical therapist students (PTS) were able to recall knowledge of BPA content after a 2 -year gap by repeating an examination that was given during the first year. Specifically, 1) Is there a significant difference in retention of BPA content/material between the 1st and 3rd year of curriculum, and 2) Does exposure/use of BPA during a clinical education experience (CEE) affect retention of material? Methods: A sample of convenience of 22 current 3rd year PTS who completed a BPA course during their 1st year participated. The comprehensive written examination for the BPA course served as the test instrument to determine knowledge retention. The PTS re-took this exam in their 3rd year of study, after completing their 2nd CEE. The PTS also completed a questionnaire soliciting information about demographics and degree of exposure to BPA during their CEE. A paired t-test was used to compare 1st year and 3rd year total test scores. The PTS were divided based on BPA exposure during their CEE, and test scores were compared using an independent samples t-test. Results: There was a significant decrease in test score from 1st to 3rd year (first year was 89.5% (range: 97.0% - 80.0%) while the 3rd year was 52.1% (range: 39.0% – 67.0%). There was no significant difference (p=0.561) in mean test scores on the 3rd year test for PTS with BPA exposure during CEEs (52.6%) vs those that did not (50.4%). Conclusions: Like other health professions, there was a decrement in knowledge retention. Results indicate a significant loss of retention of BPA knowledge when provided a 2-year gap, which was unaffected by exposure to BPA during CEEs. Exploring methods to improve knowledge retention in BPA curriculum may be needed. Future research should investigate retention with other methods of instruction including those that incorporate more active learning methods.

Keywords: biophysical agents, students, retention, modalities

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ABSTRACT

Purpose: Biophysical agents (BPA) are widely used in physical therapy clinical practice and is a content area included in entry level physical therapist education programs. Retention of this content is critical for clinical practice. The purpose of this study was to measure to what extent 3rd year physical therapist students (PTS) were able to recall knowledge of BPA content after a 2 -year gap by repeating an examination that was given during the first year. Specifically, 1) Is there a significant difference in retention of BPA content/material between the1st and 3rd year of curriculum, and 2) Does exposure/use of BPA during a clinical education experience (CEE) affect retention of material? **Methods:** A sample of convenience of 22 current 3rd year PTS who completed a BPA course during their 1st year participated. The comprehensive written examination for the BPA course served as the test instrument to determine knowledge retention. The PTS re-took this exam in their 3rd year of study, after completing their 2nd CEE. The PTS also completed a questionnaire soliciting information about demographics and degree of exposure to BPA during their CEE. A paired t-test was used to compare 1st year and 3rd year total test scores. The PTS were divided based on BPA exposure during their CEE, and test scores were compared using an independent samples t-test. **Results:** There was a significant decrease in test score from 1st to 3rd year (first year was 89.5% (range: 97.0% - 80.0%) while the 3rd year was 52.1% (range: 39.0% – 67.0%). There was no significant difference (p=0.561) in mean test scores on the 3rd year test for PTS with BPA exposure during CEEs (52.6%) vs those that did not (50.4%). **Conclusions:** Like other health professions, there was a decrement in knowledge retention. Results indicate a significant loss of retention of BPA knowledge when provided a 2-year gap, which was unaffected by exposure to BPA during CEEs. Exploring methods to improve knowledge retention in BPA curriculum may be needed. Future research should investigate retention with other methods of instruction including those that incorporate more active learning methods.

Keywords: biophysical agents, students, retention, modalities

Note:
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INTRODUCTION

Biophysical agents (BPA) are a group of interventions that administer thermal, electromagnetic, mechanical and light energy in order to produce a specific therapeutic effect.[1] Several of these BPA can be applied by, and added to, a patient care plan by health care practitioners such as athletic trainers, nurses, occupational therapists, physical therapists, physicians, and physician assistants. In physical therapy clinical practice BPA are commonly used.[2–8] As such, this is a content area included in entry-level physical therapist education programs.[9] Most entry-level physical therapist education programs provide this content within the first year of the didactic curriculum.[10] For effective practice, physical therapist students (PTS) are responsible for learning the safe, appropriate, and effective application of BPA. In addition, this content is represented on the national physical therapist licensing examination (NPTE).[11] Thus, retention of this information is important for best practice in physical therapy.

Prior research on knowledge retention in health care professions (medicine, nursing, physical therapy) has focused on retention and recall of cognitive knowledge of basic sciences such as anatomy and physiology. This research has shown that students exhibit declines in knowledge over time (i.e. one to three years and beyond).[12–18] In addition, amongst the declines in knowledge retention, variation was seen depending on content asked to be recalled, which year the students were currently enrolled in, and the student's discipline of study.[13,14,16,19]

Active learning strategies, team-based learning, computer assisted technology, problem-based learning, high fidelity simulation, and reinforcing and revisiting content throughout the curriculum may help with didactic knowledge retention.[20,21] In a study by Gilligan et al, pharmacology students were assessed on their ability to retain knowledge on drug interactions following a one-year gap. Students were allocated to two groups, one that presented case-based vignettes to other health care professionals during their final clinical experience and one that did not. Although knowledge retention declined after one year for both groups those who taught the information to others through the vignettes achieved better retention.[22]

Other research has explored active learning strategies effect on retention of psychomotor skills. For example, in the field of nursing, computer-assisted learning was found to be as effective or superior to more traditional means of instruction (such as live demonstration and textbook instruction) for retaining the psychomotor skills as associated with proper handwashing techniques for nursing students and as in performing musculoskeletal tests for physical therapist students.[23,24] In addition, in nursing the use of high fidelity simulation resulted in more effective knowledge retention and confidence in the psychomotor skills needed for advanced cardiac life support and knowledge retention for identifying cardiac arrhythmias when compared to textbook instruction.[25,26]

In the field of physical therapy, CEEs offer the most realistic experiential learning opportunities since they occur with actual patients in real time under the supervision of a licensed physical therapist. The experiential learning theory, which defines learning as "the process whereby knowledge is created through the transformation of experience" is the theoretical framework that underlies this method of learning.[27] Benefits of experiential learning have been well documented, and include solidifying content and providing a realistic context for learning.[28] Experiential learning allows students the opportunity to practice skills, obtain feedback and engage in active learning in a non-judgmental environment. Experiential learning has been associated with increased student confidence and satisfaction and promoting increased engagement, which can ultimately impact retention.[28] For example, medical students report that engagement in clinical experiences positively affected their perception of retention of human anatomy.[29]

Prior work in the field of physical therapy education identified a decrease of retention of knowledge in anatomy.[17,18] It is not currently known to what degree PTS retain material related to interventional coursework that will be used when constructing a plan of care that includes BPA. In addition, although many educational programs use traditional laboratory and lecture based formats to teach BPA content in the classroom, it is not known if experiential learning (i.e. CEE) enhances the retention of BPA knowledge.[10]

The purposes of this study were to 1) Determine third year PTS' (in a three-year curriculum) ability to retain BPA knowledge obtained during year one of the curriculum, 2) Determine if experiential learning of BPA during clinical experiences affect retention, and 3) Explore PTS' perceptions about their ability to retain BPA curricular content. Based on the experiential learning theory, our hypothesis was that all students would have a decrement in retention, and those students who had the experiential learning of BPA through their most recent CEE would show evidence of better knowledge retention of BPA material than those students that did not have experiential learning of this material.

METHODS

Test Instrument

To determine knowledge retention, the same comprehensive written examination for the BPA course administered in year one (1st year exam- defined as initial test) was administered a second time for this study (3rd year exam- defined as retest). This comprehensive examination included 44 multiple choice questions (each with four to five possible choices for response), three short answer questions (designed to be answered in one sentence each), and a bonus question, which was a written one-word answer to a question about the instructor's personal experience related to BPA which was discussed in class. The initial test was administered for two years prior to use with this cohort, and following each administration of the exam, revisions were made to specific test questions based upon examination metrics (i.e., point biserial values) and student feedback (clarity of question wording).

Subject Recruitment

A sample of convenience of 50 third-year PTS who successfully completed the BPA course in the fall semester of their first year and who were in good academic standing were invited to participate. A statement inviting eligible participants to partake in the study was read by a faculty member not associated with the project or the BPA course. Potential participants were informed that participation was voluntary and a decision to not participate would not impact their standing in the program. Potential participants were informed that they would be required to complete an online questionnaire and provide approximately 2 hours of time during which they would complete an examination (retest) pertaining to BPA. Twenty-two PTS contacted the primary investigator via email and agreed to participate. Participants were asked not to review BPA material prior to the retest. Informed consent was obtained, and the online questionnaire was completed prior to the retest. This study was approved by Stony Brook University's Human Subjects Committee Institutional Review Board.

Protocol

Participants were provided a three-digit code to enter on both the retest and the online questionnaire. The online questionnaire was distributed via email (Qualtrics©, Provo UT). The questionnaire solicited information about participant demographics, CEE, degree of exposure to specific BPA, and one question about their perceived importance of BPA inclusion in an entry-level physical therapist education program. Participants were provided with 2 hours (same amount provided during 1st year exam) to complete the retest and record their multiple-choice responses on a Scantron (Eagan, MN) form and their short answers on the retest packet. When completed, participants handed in their retest to the proctor and were asked one open-ended question, "Tell me your thoughts after taking this examination today." Responses were typed into a word document by the proctor using quotation marks, but without any identifying information. Participants were informed that upon request individual results would be provided.

Data Analysis

Participant responses to the multiple-choice questions and the bonus question were evaluated and scored with 2 points assigned for a correct response and 0 points for an incorrect response (for the bonus question, only 1 point was assigned for a correct response) using the ParScore Scantron software (version 5.5). Short answer questions (12 points) were scored and points earned were entered into a spreadsheet. Total retest scores were calculated by summing the score from the Scantron, the short answer responses and the bonus question. The highest score attainable was a 101. A paired t-test was used to compare total test score on the initial test to total test score on the retest. Independent group t-tests were used to determine if participants who scored in the top 50% on the initial test continued to score higher on the retest. An additional independent group t-test was used to determine if exposure to BPA while engaged in experiential learning during their most recent CEE affected retest scores. All comparisons were assessed at the $p<0.05$ level.

Responses to the open-ended question asked following the retest were downloaded into ATLAS.ti 8.0 software for content analysis.[30] Line by line open coding was done by a researcher with qualitative research experience. Frequencies of these open codes was recorded. This was followed by focused coding. Networks were created to link focused codes and to identify categories within the data. Peer review was done to confirm the qualitative findings and agreement regarding categories and subcategories was reached.

RESULTS

Quantitative results

Questionnaire data were downloaded to excel spreadsheets directly from Qualtrics and reported as frequencies and percentages. Demographic information about the sample is included in Table 1. The sample of 22 PTS included 36.4% (n=8) males and 63.6% (n=14) females. The majority of PTS (77.2%, n=17) had exposure to BPA while partaking in CEE II, which concluded about six weeks prior to the retest. The top four BPA with the majority of PTS experiencing direct application of during CEE II included hot

packs (94.2%, n=16), cold packs (94.2%, n=16), TENS (88.2%, n=15), and ultrasound (76.5%, n=13). No PTS had exposure to diathermy or spray and stretch.

Table 1. Student Demographics (n=22)

Demographic	Count	%
What is your sex?		
Male	8	36.4%
Female	14	63.6%
Have you taken any coursework that included BPAs prior to coursework in this DPT program?		
Yes	0	0.0%
No	22	100%
What setting were you in for CEE I?		
Acute care	8	36.4%
Acute Rehabilitation	1	4.5%
Skilled Nursing Facility/Long Term Care	12	54.6%
Outpatient	1	4.5%
Did you have any exposure to BPAs while you were a student for CEE I?		
Yes	11	50.0%
No	11	50.0%
What setting were you in for CEE II?		
Acute Care	1	4.5%
Outpatient General	15	68.2%
Outpatient Neuro	1	4.5%
School Based Pediatrics	2	9.1%
Skilled Nursing Facility/Long Term Care	1	4.5%
Other (please write)	2	9.1%
Did you have any exposure to BPAs while you were a student for CEE II?		
Yes	17	77.3%
No	5	22.7%
Do you currently work or volunteer as an aide in a setting in which you are exposed to BPAs?		
Yes	3	13.6%
No	19	86.4%
How many hours a week do you work/volunteer in this setting? (n=3)		
0-10 hours per week	2	66.7.%
10.5-20 hours per week	1	33.3%
The BPA course which I completed in my first year of study is _____ in the DPT curriculum (select one)		
Very important	2	9.1%
Important	18	81.8%
Unimportant	2	9.1%

Individual PTS total scores can be seen in Figure 1. Overall, there was a significant decrease in mean total test score from initial test to the retest (p=0.00). The mean score on the initial test was 89.5%±4.8% (range: 80.0% - 97.0%) and on the retest was 52.1%±7.4% (range: 39% – 67%). Additionally, as expected, PTS with exam scores in the top 50% (n=11) on the initial test had a mean score of 93.3%±2.5% that was significantly higher (p=0.00) than the mean score of 85.7%±3.4% from PTS with exam scores in the bottom 50% (n=11) (Figure 2) However, when these same groups were compared using scores from the retest, there was no significant difference in mean scores (p=0.72). The top 50% of PTS from the initial test had mean retest score of 52.7%±7.2% and the bottom 50% of PTS from the initial test had a mean retest score of 51.5%±7.8% (see Figure 2). Further, regardless of score on the initial test, there was no significant difference (p=0.56) in retest scores for PTS that had BPA exposure on their most recent CEE (retest score = 52.6%±7.4%) as compared to those that did not have BPA exposure on their most recent CEE (retest score = 50.4%±7.8%). Lastly, a total of 95.5% (n=21 out of 22) PTS answered the bonus question correctly on the retest.

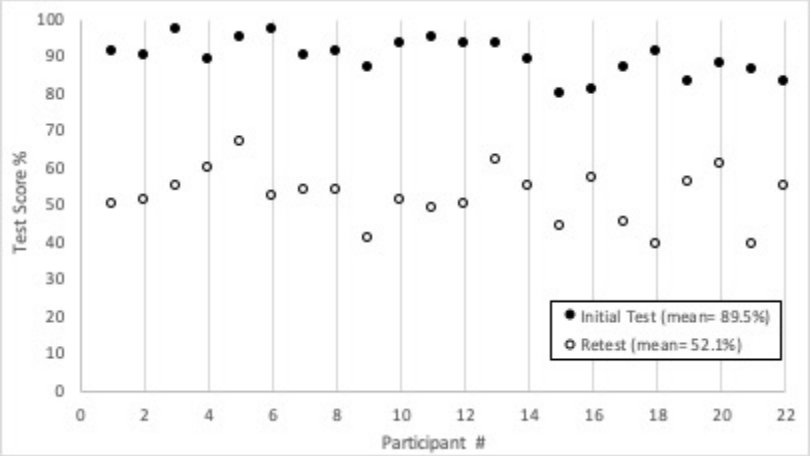

Figure 1. Individual Physical Therapy Student Total Scores

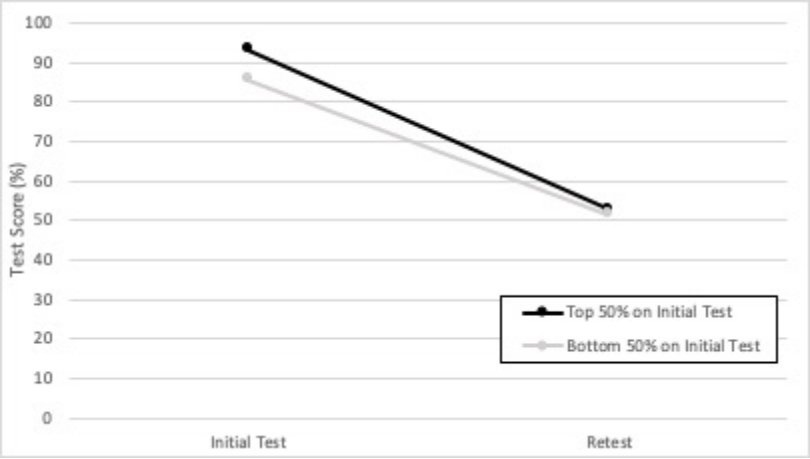

Figure 1. Comparison of Top 50% and Bottom 50% Initial and Retest

Qualitative Results

Immediately following the completion of the retest, PTS responded to the statement, "Tell me your thoughts after taking this examination." Two major categories emerged from this data: 1) A need to study, and 2) Impact of clinical experience. Each category was further supported by two subcategories each. The category, *a need to study*, had two subcategories which further illustrated student perceptions about this need. First, PTS described things (such as words), in the retest seeming familiar, but that studying further was needed to fill in the gaps. Second, PTS expressed that the retest made them realize they did not remember BPA content as much as they would have liked, or as much as they thought they should. Exemplars of these categories included the following:

> *"I felt like I remembered some of the words... Seeing it, but it was hard to know the right answer… Words came back to me but not the right choice"*
>
> *I felt like the test jogged my memory…. A lot of words were coming back to me ... some questions made me change my answer…*

The category, *impact of clinical experience*, also had two subcategories. First, clinical experience helped students recall information. This was in the form of picturing patients, practicing application of BPA, or reviewing with their clinical instructors or on their own in preparation for clinical application. Second, their perceptions of BPA changed because of their clinical practice, with references to the importance of BPA, and the differences between classroom instruction and clinical BPA application. Quotes reflecting these categories included the following:

"I felt like I forgot a lot of things... Things that I saw in the clinic, things that had more logical reasoning behind it I remembered, but things that were more memorization were harder..."

"I felt unprepared. And... um... a little bit almost confused at the detail that we learned in school vs how it is in clinic. There wasn't any detail in clinic—you figure out how to place the electrodes vs. here I was trying to dig back into the science as to why we use modalities and it was a little tough"

DISCUSSION

Similar to other health professions, results of this study suggest that when PTS are provided a 2-year gap from completion of BPA coursework there is a significant decrement in knowledge retention. This finding supported the first part of our hypothesis. Interestingly, retention was not affected by previous knowledge obtained at the conclusion of the coursework as measured by the initial test scores. Further, although it was hypothesized that exposure to BPA during CEEs would enhance knowledge retention the results from this study do not support that claim.

Clinical experience, while being an important factor as indicated in PTS responses after taking the retest, did not impact retention of knowledge as indicated by retest scores. However, qualitative data suggests that students perceived clinical experience as making a difference in what they were able to recall and remember. This is consistent with students in other health care professions who indicate clinical application of knowledge is perceived as important in retention.[29]

A simulation or laboratory examination, which would be a more interactive assessment that would include psychomotor skills and reciprocal student/instructor feedback and questioning, may produce different results. It is possible that environmental cues (i.e. programming a device or going through motions of actual application of the BPA), similar to what occurs during a clinical scenario, may better stimulate recall of information compared to a paper-based examination. Although some examination questions were case based, PTS were only able to go through these cases in their minds—not through actual application with a patient, equipment, sequencing tasks, talking things through, realizing possible mistakes or missteps and correcting them in the moment, or otherwise simulated scenarios.

Results of this study also raise the question, is some level of BPA knowledge decline acceptable? All PTS partaking in this study successfully completed two CEEs prior to the retest, and most PTS had some direct exposure to specific BPA during these experiences. Decreased retention as demonstrated in this study did not impact successful performance in the clinic for these students.

Findings from this study suggest that there is a reduction in retention of BPA material and may require that instructors of BPA in all health professions reexamine methods of instructional delivery and potentially develop and/or add other methods. For example, teaching PTS how to access information they do not remember, is critical. It is important for instructors to emphasize the importance of reading instruction manuals to find information related to contraindications and parameter selection. Referring to, and using evidence-based practice throughout the curriculum and encouraging PTS to remain current in their examination of the literature to help guide clinical decisions about appropriate use of BPA with specific patient populations is another possible strategy. Threading BPA content within other coursework, such as orthopedics and neurology, may also be appropriate as adjuncts to other interventions taught in these types of classes. Finally, encouraging PTS to create resources such as tables, mind maps, or video demonstrations to be used as active strategies to help aid in their learning during the BPA course. These student-created tools can also serve as references for later review (when recall of information is challenging) including when they are engaged in other coursework as well as during the clinical portions of their curriculum and when they begin autonomous practice.

The bonus question in this study was an open-ended question related to a humorous personal story regarding BPA that the instructor of the course told the PTS at the midterm point. All but one student answered the bonus question correctly on the retest, which suggests that PTS found this story meaningful enough to recall it two years later. This finding correlates with the Instructional Humor Processing Theory (IHPT).[31] This theory postulates that appropriate sources of humor enhance processing and retention of material and therefore, promote learning. The use of storytelling/narratives has also been shown to positively impact retention.[32] Instructors of BPA coursework might consider using appropriate humor through storytelling in the classroom to reinforce important concepts related to BPA content. This can include areas specifically related to safe and/or appropriate application of BPA.

Students in this study were taught using traditional lecture/laboratory-based teaching methods. Research suggests that in DPT programs, BPA instructors are adding more active learning strategies and online components to their courses.[10] One study investigating student outcomes in a BPA course based on two different methods of delivery (hybrid vs. traditional classroom

instruction) found no significant differences in student learning or retention among the two groups as measured by pre and post-test scores.[33] Further research may be needed in this area, examining more in-depth the types of learning strategies and teaching methods that are used in hybrid type courses. Students in this study had an 8-week CEE prior to taking the retest. Future research could investigate if longer CEEs with BPA exposure have an impact on retention.

Limitations

Results from this study are from one academic institution and from a small sample of PTS. As such, caution must be taken when generalizing this data. A larger sample, along with physical therapist assistant students, are both areas for future exploration. Additionally, PTS feedback regarding the retest was obtained from responses to one open-ended question following the retest, which limited the exploration of other perceptions PTS may have had.

CONCLUSIONS/RECOMMENDATIONS

There is a loss of knowledge retention of BPA material following a 2-year gap when measured using traditional testing methods. Exploring methods to improve knowledge retention in BPA curriculum may be needed. Future research should investigate retention with other methods of instruction, including those that incorporate more active learning methods. Experiential learning within the classroom environment, along with appropriate use of humor and storytelling, may be appropriate strategies to use to enhance student learning. In addition, measurements of retention of material should include assessments that capture psychomotor skills relevant to clinical practice and use of BPA, although not explored in this study, could better simulate the clinical environment in which students will be applying their knowledge of BPA.

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