Physics in the Pre-pharmacy Curriculum

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This study presents the results of a survey of the 81 colleges of pharmacy affiliated with the American Association of Colleges of Pharmacy regarding requirements of physics in the pre-pharmacy curriculum. Responses included the number of semesters/quarters required, credit hours, group of students for whom the course is designed, mathematical basis, and length of time the physics requirement has been in place. Comments were made regarding strengths and weaknesses of the physics course at those colleges requiring physics, as well as reasons why physics is not required in the curriculum at the other colleges.

INTRODUCTION
Pharmacy majors take numerous science courses in the pre-pharmacy and the professional curriculum. In the pre-pharmacy curriculum, courses such as biology, anatomy, physiology, general chemistry, organic chemistry, calculus, and physics are typically required courses, along with courses in the liberal arts, social sciences, and other fields.

Because of a shift in emphasis toward teaching the clinical sciences, the inclusion of some courses in the basic sciences is often questioned. Arguments in support of physics remaining a requirement for entry into the professional program have been made recently(1), but the discussion is not new, as evidenced by a paper in 1967(2).

The American Association of Colleges of Pharmacy (AACP) in 1993 reported in a series of papers(3-5) that a pharmaceutical education provides “general education in the sciences” and “a foundation in the physical sciences.” A suggested curriculum outline includes physics in the study of basic physical and biological sciences and mathematics, although it is pointed out that an “item listed in the Core Curriculum does not necessarily mean that a course should be required to cover the indicated item.” In addition, the curriculum is to reflect a “broad, multidisciplinary science base” that is “not restricted by territorial and disciplinary boundaries.”

The American Council on Pharmaceutical Education (ACPE) has set guidelines(6) for pre-professional requirements and admissions criteria that include “basic sciences requisite to the curriculum for the professional program in pharmacy, illustrative which are general chemistry, organic chemistry, biological sciences, mathematics, computer technologies, and physical sciences.” Again, the shift appears to be away from the term “physics” to a more generic term “physical sciences.” How colleges of pharmacy interpret these guidelines or statements is left to the individual college.1

Faced with a changing curriculum at the St. Louis College of Pharmacy, which needed to be in place in time for our first “all PharmD” freshman class, the question arose as to whether physics should be in the curriculum or not. A quick survey on the Internet found that most of the colleges of pharmacy do require physics in their pre-professional curriculum, although the number of credit hours varied to some extent.

While this information was helpful to argue for continued inclusion of physics in the curriculum, it led to questions that needed to be explored in more detail. Thus, during late spring of 1999, a survey was sent to the deans of all the colleges of pharmacy in the U.S. and Puerto Rico, currently numbering 81, asking whether a course or sequence of courses in introductory physics is required to be taken by students in the pre-pharmacy curriculum.

This paper describes the results of the survey; data are reported along with comments made by a number of respondents. In the next section, the survey is described, followed by the numerical results of the colleges that require physics and comments by respondents from these colleges. Next, results of those colleges that do not require physics are described. The results with respect to the type of institution (public or private, with or without a graduate program) are presented in the next section, followed by a discussion of the results.

THE SURVEY
Questions from the two major sections of the survey are presented in Appendices A and B. The first section (Appendix A) asked if the pharmacy college required students to take physics in the pre-pharmacy curriculum, and if so, to give some details, such as number of semesters, credit hours, type of major for which the course is designed, and mathematics background required. Also, the first section asked for comments on strengths and weaknesses of the course.

The second section of the survey (Appendix B) was for colleges that do not require physics. Other questions were asked to determine if physics had been a required course in the

1At the St. Louis College of Pharmacy, students are required to take a one semester, four credit hour physics course. The course covers most major physics topics with applications to the human body or other medical systems. Examples include: classical mechanics and motion of the human body; fluid statics and dynamics related to pressure, blood flow, and intravenous fluids(7); thermodynamics related to body temperature, fever, and thermal conductivity of skin; wave properties including sound production and detection, sound intensity level and the use of earplugs; electrostatics related to membrane potential and action potential; optics of the eye; and nuclear decay, with biological effects of radiation and use of radiopharmaceuticals.

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past, and if so, when it was dropped from the curriculum. This section also included a question about whether physics is recommended as an elective. Finally, an open-ended question requested comments on why physics is not a required course.

The survey was sent to the deans of 81 colleges (or schools) of pharmacy affiliated with AACP. After five weeks, another copy of the survey was sent to those who had not responded. In all, there were 76 (93.8 percent) deans or their representatives who responded. The results of the survey are described in the next three sections.

RESULTS OF COLLEGES THAT REQUIRE PHYSICS

The results of the first six questions of the survey are shown in Table I. To the first question, “Does your pharmacy school/college require students to take a course or sequence of courses in introductory physics in the pre-pharmacy curriculum?” there were 59 colleges (77.6 percent of the 76 that responded) that answered “Yes.” Of these 59 colleges, 25 (42.4 percent) require one semester of physics, while 27 (45.8 percent) require two semesters; two colleges (3.4 percent) require only one quarter, two colleges (3.4 percent) require two quarters, and three colleges (5.1 percent) require three quarters of physics (Table I, Question 2). These last two categories roughly equate to two semesters, so that of the 59 colleges, 27 (45.8 percent) require one course in physics, and 32 (54.2 percent) require the equivalent of a full year of physics.

To Question 3 of the survey, Table I shows that the total number of credit hours to be earned range from three to 10 semester hours and four to 15 quarter hours. There are 20 colleges of the 59 colleges that responded (33.9 percent) that require four semester hours, 16 colleges (27.1 percent) that require eight semester hours, and eight colleges (13.6 percent) that require six semester hours.

Physics is normally taught as part of a pre-professional curriculum for pre-medical, pre-optometry, pre-dental, and architecture majors or as a course for engineering, chemistry, physics, and math majors. The survey reveals that most pre-pharmacy students take these courses, but at some schools a physics course has been designed specifically for pre-pharmacy students (Table I, Question 4). There were 41 colleges (77.4 percent of 53 colleges that answered this question) that indicated their students take physics for pre-professional majors, while eight (15.1 percent) indicated that their students take physics for engineering and science majors. Of those mentioned here, five colleges (9.4 percent) indicated that their students could take either course. Nine colleges (17.0 percent) indicated their students take a course for pre-pharmacy majors only.

The mathematical basis for physics is usually either algebra/trigonometry-based or calculus-based. There were 41 colleges (74.5 percent of 55 colleges that answered this question) that indicated that their students take the algebra/trigonometry course, while 22 colleges (40.0 percent) said their students take the calculus-based course. Eight (14.5 percent) of these colleges said their students could take either course (Table I, Question 5).

Question 6 was “How long has the physics course been in your curriculum?” Of the 55 colleges that require physics and answered this question, 43 (78.2 percent) have required the course for 10 years or more. There are 12 colleges (21.8 per-
cent) that have required physics for less than 10 years (Table I, Question 6). Five of these 12 colleges have been in existence for less than 10 years and have required physics for their entire time of operation. Four colleges have existed for only three years or less.

COMMENTS ON THE PHYSICS COURSES

There was a wide range of responses to the next two questions about strengths and weaknesses of the physics courses. Because of a variety of admissions policies, students often can take courses at any one of several campuses, so many of the responses indicated that any strengths or weaknesses depended on where students took the course.

Strengths of the courses included such descriptions as “rigorous,” “informative,” “demanding,” “very comprehensive,” “a good introductory course,” “an important sequence,” “an important opportunity to develop problem solving skills,” “provides sufficient knowledge base,” “course uses calculus ... weeds out students.” Other comments such as “feeds nicely into...,” “in a curriculum thread that includes...,” “prepares students well for...” went with various courses or content including “physical pharmacy,” “biopharmaceutics,” and “physico-chemical concepts.”

Descriptions of weaknesses of the courses included “depends on the college teaching the course,” “could be integrated better,” “curriculum thread not as well integrated as it could be,” “one semester course - major topics not covered,” “no control over course,” “many students are disgruntled with how physics is taught,” “difficult to comprehend.” Several colleges that require only one semester made comments such as “course does not address electricity, light, or modern physics,” “no nuclear (physics),” and “major topics are not covered.” Other comments on weaknesses addressed administrative concerns such as large sections, class closures, and requirements for transfer students.

From those colleges whose physics courses were designed for pharmacy majors, comments on strengths and weaknesses included the following: “course developed in consultation with pharmacy curriculum committee;” “worked with pharmacy department to design a course for our needs;” “joint effort by pharmacy and physics;” “biological topics emphasized;” “course content specifically oriented toward pharmacy;” “very good core of physics professors and excellent facilities;” “physics department was not supportive of change;” and “difficult to find qualified faculty to teach courses.”

Table II. Responses to the first three questions in Section II of the survey for those colleges that do not require physics in the pre-pharmacy curriculum

<table>
<thead>
<tr>
<th>1. Has your pharmacy school/college ever required students to take a course or sequence of courses in introductory physics in the pre-pharmacy curriculum? (Percentages are calculated based on 15 colleges that answered this question.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes: 9 (60.0%)</td>
</tr>
<tr>
<td>No: 6 (40.0%)</td>
</tr>
</tbody>
</table>

2. If your response is yes, when was the requirement dropped from your curriculum? (Percentages are calculated based on 9 colleges that answered “Yes” to Question 1 above.)

| Less than 3 years | 3 (33.3%) |
| At least 3 years, but less than 5 years | 0 (0.0%) |
| At least 5 years, but less than 10 years | 2 (22.2%) |
| At least 10 years | 4 (44.4%) |

3. Is a course or sequence of courses in introductory physics recommended as an elective to fill general science requirements? (Percentages are calculated based on 14 colleges that answered this question.)

| Yes: 4 (28.6%) |
| No: 10 (71.4%) |

RESULTS OF COLLEGES THAT DO NOT REQUIRE PHYSICS

To the question, “Does your pharmacy school/college require students to take a course or sequence of courses in introductory physics in the pre-pharmacy curriculum?” there were 17 colleges (22.3 percent of the 76 that responded) that answered “No” (Table I, Question 1). These respondents were directed to Section II, which had four questions listed. The results of the first three questions are shown in Table II.

To the next question about whether physics has ever been required, there were 15 colleges who responded. Of the 15 colleges, nine (60.0 percent) required physics at some time in the past and six (40.0 percent) never required physics (Table II, Question 1). Of the nine colleges that required physics in the past, three (33.3 percent) of them dropped this requirement less than three years ago, two (22.2 percent) dropped the requirement at least five years ago but less than ten years ago, and four (44.4 percent) dropped the requirement at least ten years ago (Table II, Question 2).

The colleges were asked if they recommended that physics be taken as an elective to fill general science requirements. Of the 14 colleges that responded to this question, only four (28.6 percent) answered “Yes,” while ten (71.4 percent) indicated that they do not recommend it (Table II, Question 3).

Section II of the survey also included a question asking why a sequence of courses in physics is not a required part of the curriculum. The following are some of the responses:

- “faculty did not feel physics was necessary”
- “it would make pre-pharmacy curriculum longer than two years”
- “the professional schedule of studies does not require physics”
- “physics was replaced with another course”
- “physics was not perceived as having relevant applicability to the ... curriculum”
- “no room ... we put in biostats as a pre-pharmacy requirement”
- “no relationship was seen between physics and the curricular outcomes or goals”
- “priority had to be given to other coursework”
- “switched from quarter system to semester system no room for physics”
- “physics was viewed as an impediment to the liberally educated pharmacist”
- “physics faculty (thought) suffering and humility were essential elements of physics appreciation”
Table III. Physics requirements at publicly supported or privately funded institutions

<table>
<thead>
<tr>
<th>TYPE OF INSTITUTION</th>
<th>∗Publicly supported institutions (n = 76)</th>
<th>∗Privately funded institutions (n = 76)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes: 43 (81.1%)</td>
<td>Yes: 16 (69.6%)</td>
</tr>
<tr>
<td>Is physics required?</td>
<td>No: 10 (18.9%)</td>
<td>No: 7 (30.4%)</td>
</tr>
</tbody>
</table>

Table IV. Physics requirements at colleges of pharmacy with or without a PhD program

<table>
<thead>
<tr>
<th>TYPE OF PHARMACY PROGRAM</th>
<th>∗One or more PhD programs (n = 76)</th>
<th>∗No PhD program (n = 76)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is physics required?</td>
<td>Yes: 46 (83.6%)</td>
<td>Yes: 13 (61.9%)</td>
</tr>
<tr>
<td></td>
<td>No: 9 (16.4%)</td>
<td>No: 8 (38.1%)</td>
</tr>
</tbody>
</table>

"students are required to take either quantitative chemistry or physics, most take physics"
"students with no high school physics or with grade below B are required to take one semester of physics in college"

DISCUSSION

While the survey focused on factual data regarding requirements for physics in the pre-pharmacy curriculum, several deans or representatives expanded on their responses to some of the questions. To the question of the total number of credit hours of physics required in the curriculum, several respondents indicated that their colleges have undergone or were planning changes in the number of hours required. One college increased its requirements from three semester hours to six in 1998; another required only high school physics in the past, but now requires four semester hours; another required physics many years ago, dropped it for several years, and then added it back into the curriculum in 1999. Two colleges recently decreased their requirements from six hours to four hours, and another was considering going to one semester from two semesters (currently eight hours).

It was evident that the inclusion of physics in the curriculum is an issue at several colleges of pharmacy. In addition to the changes at the colleges listed in the previous paragraph, comments by the respondents made this clear as well. One representative stated, “My personal preference for many years is that we not require physics, but I have not been able to convince a majority of the faculty.” Another said, “One four-hour course is considered too much for some, not enough for others. Thus your survey, I presume!” Another stated, “Do you really need physics? Is it a pre-requisite for anything in the professional program?” At one college where physics is not required, its representative stated with strong displeasure that physics was removed from their new PharmD program.

The comments from respondents at those colleges where the physics course is designed for pharmacy majors indicated that pharmacy faculty are generally supportive of physics in the curriculum. As stated previously, comments on the strengths of these courses included their emphasis on biological applications. Typically, physics courses for pre-professional majors do not emphasize biological applications, but, rather, they include a broad spectrum of applications of interest to many areas, even though these courses usually contain a majority of biological and pre-medical majors. Thus, as indicated by comments from respondents, physics courses for pharmacy majors only tend to meet their needs quite well.

Although most of these courses (for pharmacy majors only) were described as successful, several colleges reported variable support from physics faculty. One college reported that its faculty, including a pharmacetics professor with a PhD in physics, worked with an unsupportive physics department to design its course. Another college reported that a weakness of their physics course is that qualified faculty are difficult to find, presumably because of the biological and pharmacy emphasis. Another college, however, reported that the physics department has very good faculty for such a course. And yet another college has encouraged its physics faculty to attend workshops, tutorials, and conferences that include applications of physics to the human body and to the medical sciences.

CONCLUSION

The professional pharmacy curriculum focuses mostly on drug interactions, pharmacetics, drug products, and diagnosis and treatment of disease. However, the acquisition of knowledge and skills in the basic sciences, in problem solving, and in critical thinking remains an important component of both the professional curriculum and the pre-professional curriculum. In a day when the inclusion of physics in the pre-pharmacy cur-
riculum is debated, it is helpful to realize that a course in physics can help to develop these skills, as well as provide basic content for understanding processes important in the other sciences. Such a course can have a different look, e.g., for pre-professional majors, for engineering and science majors, or for pharmacy majors in particular, or it can have different levels of mathematical rigor.

As colleges of pharmacy consider changes to their existing curricula, perhaps they can use the results of this survey to determine what role a physics course will play in the development of their pharmacy students. For those colleges that currently have a physics requirement, this survey may help to confirm what they are doing or give cause for some needed changes. For those colleges that do not currently require a course in physics, they may wish to explore ways that a course could be included in their curriculum - particularly by working with physics faculty to develop a course targeted for pharmacy majors.

References

APPENDIX A. SURVEY QUESTIONS FOR COLLEGES OF PHARMACY THAT DO NOT REQUIRE PHYSICS IN THE PRE-PHARMACY CURRICULUM

Section I: Please indicate your response by checking the appropriate box(es).

1. Does your pharmacy school/college require students to take a course or sequence of courses in introductory physics in the pre-pharmacy curriculum?
   - yes
   - no - please skip to Section II.

2. How many semesters or quarters of physics are required?
   - 1 semester
   - 2 semesters
   - 3 semesters
   - 1 quarter
   - 2 quarters
   - U 3 quarters

3. What is the total number of credit hours to be earned in the physics course(s)?
   - 1
   - 2
   - 3
   - 4
   - 5
   - 6
   - 7
   - 8 Q 11
   - 9
   - 10
   - 12
   - 15 or more

4. For what group of students is (are) the physics course(s) designed?
   - pharmacy majors only
   - pre-professional majors (pre-pharmacy, pre-medicine, pre-dental, pre-optometry, etc.)
   - engineering and science majors

5. What mathematical basis is used in the physics course(s)?
   - algebra/trigonometry (no calculus)
   - calculus, with algebra/trigonometry

6. How long has (have) the physics course(s) been in your curriculum?
   - less than 3 years
   - at least 3 years, but less than 5 years
   - at least 5 years, but less than 10 years
   - at least 10 years

7. Please comment on any strengths of the physics course(s) taught in your curriculum.

8. Please comment on any weaknesses of the physics course(s) taught in your curriculum.

APPENDIX B. SURVEY QUESTIONS FOR COLLEGES OF PHARMACY THAT DO NOT REQUIRE PHYSICS IN THE PRE-PHARMACY CURRICULUM

Section II: For those who answered “no” to the first question in Section I, please answer the following questions.

1. Has your pharmacy school/college ever required students to take a course or sequence of courses in introductory physics in the pre-pharmacy curriculum?
   - yes
   - no

2. If your response is yes, when was the requirement dropped from your curriculum?
   - U less than 3 years ago
   - at least 3 years ago, but less than 5 years ago
   - at least 5 years ago, but less than 10 years ago
   - at least 10 years ago

3. Is a course or sequence of courses in introductory physics recommended as an elective to fill general science requirements?
   - yes
   - no

4. Please comment on why a course or sequence of courses in introductory physics is not a required part of your curriculum.