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Procedural and Interpretive Skills of Medical Students: Experiences and Attitudes of Fourth-Year Students

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Abstract

Background
Recent data do not exist regarding fourth-year medical students' performance of and attitudes toward procedural and interpretive skills, and how these differ from third-year students'.

Method
Cross-sectional survey conducted in February 2006 of 122 fourth-year students from seven U.S. medical schools, compared with their responses in summer 2005. Students estimated their cumulative performance of 22 skills and reported self-confidence and perceived importance using a five-point Likert-type scale.

Results
The response rate was 79% (96/122). A majority reported never having performed cardioversion, thoracentesis, cardiopulmonary resuscitation, blood culture, purified protein derivative placement, or paracentesis. One fifth of students had never performed peripheral intravenous catheter insertion, phlebotomy, or arterial blood sampling. Students reported increased cumulative performance of 17 skills, increased self-confidence in five skills, and decreased perceived importance in three skills (two-sided $P < .05$).

Conclusions
A majority of fourth-year medical students still have never performed important procedures, and a substantial minority have not performed basic procedures.

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At a time when outcome-oriented clinical skill education is receiving increased attention, medical educators need to know on which skills to focus their curricular efforts and resources. We have previously shown that deficiencies exist in students' performance of procedural skills. In 2005, we surveyed a subset of medical students from the class of 2006 at seven U.S. medical schools at the end of their third-year clerkships.[1] We asked about 22 distinct procedural and interpretive skills as derived from the Association of American Medical Colleges (AAMC) Medical School Objectives Project (MSOP) Report I[2] and a Clerkship Directors in Internal Medicine (CDIM) members survey.[3] We found that a majority of third-year students had never performed important procedures such as purified protein derivative (PPD) placement, blood culture, cardiopulmonary resuscitation (CPR), or lumbar puncture, and one quarter had never performed basic procedures such as peripheral intravenous (IV) catheter insertion and phlebotomy. Students felt it important to achieve competence in performance upon graduation for all skills surveyed, and they had the lowest self-confidence in those skills performed least frequently, if at all.

To help medical educators target skills for the improvement of instruction and development of curricula, we wished to investigate how these same students' experiences and attitudes changed in their fourth year. We hypothesized that students, during their fourth year through advanced clerkships, would perform more of some skills that they had rarely performed through their third year, but might still perform some skills infrequently. This important information would reveal procedures that graduating students are less likely prepared to perform as new interns. We sought to identify skills that students overall performed less frequently and had lower self-confidence in performance, because these skills would warrant emphasis by educators for increased student experience.

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Method

We developed a confidential, Internet-based survey and asked students to report their estimated performance frequency of 22 procedural and interpretive skills since the beginning of medical school. We asked students to use a five-point Likert-type scale to report their self-confidence in performing these skills in an unsupervised setting (1 = "not at all confident"; 5 = "very confident") and their perceived importance of being competent in skill performance as medical school graduates (1 = "not at all important"; 5 = "very important"). The skills included arterial blood sampling, phlebotomy, peripheral IV catheter insertion, blood culture performance, throat culture performance, nasogastric tube insertion, PPD placement, Papanicolaou (Pap) smear performance, lumbar puncture, paracentesis, thoracentesis, urinalysis, urethral (Foley) catheter insertion separately in males and

females, CPR, cardioversion, suturing a laceration, and interpretation of a chest X-ray, electrocardiogram, Gram stain, peripheral blood smear, and spirometry. Before starting the survey, students encountered a screen with definitions of each procedure; this information was developed via a consensus of the investigators and was also accessible as a pop-up screen during the survey. Regarding frequency of performance, we instructed students to exclude times when a skill was performed for the purpose of evaluation, during a written exam, or on a model or mannequin. To encourage participation in the survey, each responding student was eligible for a random drawing to receive one of four $100 gift cards.

In February 2006, we surveyed 122 students from the class of 2006, near the end of their fourth year. Students from the Warren Alpert Medical School of Brown University, the Medical College of Wisconsin, Texas A&M Health Science Center College of Medicine, the University of Miami Miller School of Medicine, the University of Massachusetts Medical School, the University of Pittsburgh School of Medicine, and the University of Virginia School of Medicine participated in the study. These schools were invited to participate because of their previous involvement in multiinstitutional medical education research. These students were part of the original sample of convenience of 171 students who had completed the internal medicine clerkship in each school's last clerkship block for academic year 2004–2005 and who had responded to our first survey. The students had given informed consent before participation, and they provided their first and last names and six-digit dates of birth so that we could compare their data in this follow-up survey. In February 2006, a coinvestigator or his representative at each institution e-mailed students the Internet link to the survey and asked for their participation. Reminder e-mails were sent at two and three weeks after the initial message. We obtained demographic information from each participant, including gender, age, prior career if applicable, whether or not a subinternship had been completed in

Table 1

Cumulative Performance, Self-Confidence, and Perceived Importance of Procedural and Interpretive Skills Through the Third (M3) and Fourth (M4) Years of Medical School

	Average frequency of performance through M4 [SD] and average increase from M3*			Percentage of students who have never performed skill		
Procedural or interpretive skill	M4	Average increase	*P* value	M3	M4	*P* value
Arterial blood sampling	5.1 [6.6]	1.9	**<.001**	33	19	**.001**
Phlebotomy	10.3 [14.0]	2.4	**.02**	24	20	.32
Peripheral intravenous catheter insertion	12.8 [18.7]	3.5	**.001**	30	23	.11
Blood culture	1.7 [14.8]	0.8	**.03**	73	65	.07
Throat culture	8.2 [10.0]	1.0	**.007**	12	7	.21
Nasogastric tube insertion	3.5 [6.5]	1.0	**.006**	37	30	.16
PPD placement	1.0 [2.0]	0.1	.12	72	65	.13
Pap smear performance	20.9 [16.5]	3.3	**.04**	2	2	1.000
Lumbar puncture	2.5 [8.1]	1.7	**<.001**	62	43	**<.001**
Paracentesis	0.9 [1.3]	0.3	**.002**	66	53	**.005**
Thoracentesis	0.3 [0.6]	0.1	.14	88	81	.11
Urinalysis	8.3 [14.0]	3.8	**.02**	30	25	.20
Urethral catheter insertion (male)	7.9 [8.0]	0.7	**.002**	10	6	.16
Urethral catheter insertion (female)	6.7 [7.6]	0.5	**.04**	17	13	.25
Cardiopulmonary resuscitation	1.0 [2.4]	0.3	.07	72	68	.51
Cardioversion	0.2 [0.5]	0.0	.23	92	85	.13
Suturing a laceration	8.7 [11.1]	0.6	**.005**	15	13	.53
Chest X-ray interpretation	49.0 [54.4]	12.8	**.001**	1	0	.32
Electrocardiogram interpretation	39.3 [50.4]	14.2	**.001**	1	0	.32
Gram stain interpretation	5.9 [9.7]	1.4	.21	41	39	.72
Peripheral blood smear interpretation	6.1 [12.1]	2.1	**.01**	38	31	.29
Spirometry interpretation	5.7 [7.8]	1.7	**.007**	42	28	**.02**

Two-sided *P* values less than .05 are **boldfaced**.

* The Wilcoxon matched-pairs signed-rank test was used to analyze the mean frequencies of skill performance between M3 and M4 years because the data were not normally distributed.

† Students reported self-confidence in performing a skill competently and unsupervised using a five-point Likert-type scale, with 1 = "not at all confident" and 5 = "very confident."

‡ Students reported perceived importance of being competent in a skill as a medical school graduate using a five-point Likert-type scale, with 1 = "not at all important" and 5 = "very important."

medicine, surgery, pediatrics, or "other" fields, and anticipated residency discipline. We collected data regarding these last two items to assess the generalizability of our sample.

Data were compared using paired *t* test, Wilcoxon matched-pairs signed-rank test (for data not normally distributed), and the McNemar test for two related samples, with two-sided *P* values reported for all tests. We chose to use data only from those students who responded to both surveys; consequently, data reporting the experience of third-year students from this analysis would not necessarily exactly match with the results of our previous study. The study was performed with the expedited approval of the institutional review board (IRB) of the University of Pittsburgh and the IRBs at the other participating institutions. All analyses were performed at the University of Pittsburgh using STATA 9 (Stata Corp., College Station, Texas). Funding for the study was provided by the Shadyside Hospital Foundation (Pittsburgh, Pennsylvania) and the Data Center at the Center for Research on Health Care at the University of Pittsburgh (Pittsburgh, Pennsylvania).

Results

The response rate was 79% (96/122). Individual schools' students comprised 13% to 22% of the total respondents.

Mean age was 28 years, and 56% were female. At least 97% of students completed clerkships in medicine, surgery, pediatrics, obstetrics–gynecology, psychiatry, and family medicine. The most common subinternships students reported completing were medicine (46%) and surgery (43%), with 19% of these students completing both, but 29% completing neither. Students also reported completing subinternships in pediatrics (19%) and "other" fields (21%). The most common prior health-care-related careers included paramedic (9%) and phlebotomist (4%). The most commonly anticipated residencies included internal medicine (15%), pediatrics (10%), obstetrics/gynecology (10%), anesthesiology (8%), family medicine (7%), and general surgery (7%).

Table 1
Continued

Self-confidence† [SD]			Perceived importance‡ [SD]		
M3	M4	*P* value	M3	M4	*P* value
2.9 [1.4]	3.1 [1.2]	**.009**	4.3 [0.8]	4.1 [0.9]	.12
3.4 [1.3]	3.6 [1.2]	.13	4.2 [1.0]	4.3 [0.9]	.69
3.0 [1.3]	3.3 [1.3]	**.03**	4.4 [1.0]	4.2 [0.9]	.25
2.3 [1.3]	2.5 [1.2]	.31	3.8 [1.1]	3.6 [1.2]	.16
4.2 [1.1]	4.3 [0.9]	.28	4.4 [0.9]	4.3 [0.9]	.29
2.9 [1.3]	3.3 [1.3]	**.002**	4.4 [0.9]	4.3 [0.9]	.35
3.1 [1.4]	3.2 [1.3]	.30	3.5 [1.3]	3.3 [1.3]	.05
4.2 [0.9]	4.3 [0.9]	.65	4.4 [0.9]	4.4 [1.0]	.74
1.8 [1.1]	2.3 [1.3]	**.001**	4.2 [0.9]	3.9 [1.0]	**.02**
2.0 [1.2]	2.1 [1.2]	.11	3.8 [1.0]	3.5 [1.1]	**.005**
1.4 [0.8]	1.7 [1.0]	**.03**	3.8 [1.0]	3.4 [1.1]	**.002**
3.7 [1.3]	3.7 [1.3]	.82	4.2 [1.1]	4.1 [1.0]	.60
4.2 [1.0]	4.3 [1.0]	.19	4.4 [0.9]	4.2 [1.1]	.10
4.1 [1.1]	4.2 [1.1]	.37	4.3 [0.9]	4.2 [1.0]	.13
2.7 [1.2]	3.3 [1.4]	<**.001**	4.8 [0.6]	4.7 [0.7]	.33
1.7 [1.0]	2.4 [1.3]	<**.001**	4.3 [1.1]	4.2 [1.1]	.67
3.3 [1.2]	3.5 [1.3]	.19	4.4 [0.9]	4.4 [0.8]	.92
3.7 [0.8]	3.8 [1.0]	.22	4.9 [0.4]	4.8 [0.4]	.72
3.5 [1.0]	3.5 [1.0]	.63	4.8 [0.4]	4.8 [0.4]	.60
2.8 [1.2]	2.7 [1.2]	.37	3.9 [1.2]	3.6 [1.1]	.06
2.4 [1.2]	2.6 [1.3]	.28?	3.8 [1.2]	3.6 [1.2]	.06
2.6 [1.3]	2.6 [1.2]	3.9 [1.2]	3.7 [1.2]	.07	

Table 1 shows the mean cumulative performance of procedural and interpretive skills through the fourth year and the average increase from the third year, the percentage of students each year who reported never having performed each skill, and the mean self-confidence and perceived importance in each year. Students had increased cumulative performance in 17 skills through their fourth year, but not in cardioversion, thoracentesis, CPR, PPD placement, or Gram stain interpretation. A majority of fourth-year students reported never having performed cardioversion, thoracentesis, CPR, blood culture, PPD placement, or paracentesis. Approximately one fifth of fourth-year students had not performed phlebotomy, arterial blood sampling, or peripheral IV catheter insertion. Compared with their third-year responses, a significantly smaller percentage of fourth-year students reported never having performed arterial blood sampling, spirometry interpretation, lumbar puncture, or paracentesis, though more than 40% still reported never having performed the last two skills.

Fourth-year students reported a mean self-confidence of less than 3.0 for eight skills. Compared with their third-year responses, students' self-confidence was significantly increased for seven skills: arterial blood sampling, peripheral IV catheter insertion, nasogastric tube insertion, lumbar puncture, thoracentesis, CPR, and cardioversion, even though a majority of students still

had never performed the last three skills. Fourth-year students' perceived importance of being competent in skill performance as medical school graduates was greater than 3.3 for all skills and greater than 4.0 for 14 skills. However, in comparing third- and fourth-year responses, students' perceived importance actually significantly decreased for lumbar puncture, paracentesis, and thoracentesis. For no skill did perceived importance significantly increase.

Discussion

It seems that most, but not all, fourth-year medical students are learning and performing most skills as recommended by CDIM members and the AAMC MSOP Report I. However, a majority of students still have never performed several important procedures, and about one fifth have not performed basic procedures, such as phlebotomy or peripheral IV catheter insertion. These results were found in a student sample that had a reasonable balance of students having completed medical and surgical subinternships and that had a relatively even distribution of anticipated residency disciplines.

The changes in students' experiences and attitudes are intriguing. Though students estimated having cumulatively performed a greater number of 17 procedures through their fourth year as compared with at the end of their third year, the average increase in number performed for each skill was less than 4 for 15 such skills. It seems that the fourth year may not add clinically significant procedural experience. Statistical and clinical significance are not necessarily the same. Do the performance frequencies indicate enough to achieve competency? One may argue that the number of a particular procedure performed to ensure competency varies from student to student, whereas others may feel that such a number is irrelevant if the student is unable to perform the procedure with reasonable frequency later during residency. Yet, even without performing procedures, students may have a false sense of confidence as they progress through medical school, as we showed that self-confidence actually increased for procedural skills that a majority of students did not perform, namely thoracentesis, CPR, and cardioversion. Our findings are consistent with another institution's study of fourth-year students during their medicine subinternship, revealing that few students performed basic procedures, and for lumbar puncture, self-confidence did not correlate with frequency of its performance.[4] Another worrisome finding was the decrease in perceived importance for lumbar puncture, paracentesis, and thoracentesis, three procedures seldom performed by students. The decrease could be explained by a student's thought that perhaps opportunities for performing such procedures will occur during residency, not medical school. It is possible that some students have fewer opportunities to do particular procedures because they are performed by support staff or because residents have first priority in performing them.

Our study had several limitations. The list of skills we evaluated is not comprehensive; for example, we did not ask about arthrocentesis or airway management. Students may have had recall bias in estimating the number of times they performed a particular procedure. The perceived importance of a procedure that a student had never performed may not be accurate, as a student would be guessing at future significance. Students may have misinterpreted the meaning of the skills listed or not have read the definitions of procedures that were provided at the beginning of the survey. We could have overestimated the average number of procedural and interpretive skills performed by all students at these medical schools, because the students in our study sample represented a highly self-selected group who responded to two sets of surveys, and they also may have had more opportunity for procedures as students in the last medicine clerkship block for the academic year, when residents were more experienced and could provide supervision. Finally, we surveyed students in February of their fourth year, making it possible, though unlikely, that they performed more procedures during their final two to three months of medical school after matching for residency.

However, our study had several strengths that should be noted. This was a multiinstitutional study combining both private and public medical schools, and, to the best of our knowledge, it is the first project to query students directly about the skills listed in the AAMC MSOP Report I and the CDIM members' survey and to follow students over time. In comparing experiences and attitudes, we resurveyed only those students who had responded to our previous survey and therefore were able to perform matched-pairs comparisons. We provided definitions of procedural and interpretive skills that were arrived at by consensus in order to minimize students' potential misunderstanding of a procedure's details or description.

In 2005, the AAMC Project on the Clinical Education of Medical Students published its Recommendations for Clinical Skills Curricula for Undergraduate Medical Education,[5] which encompass a wide range of procedural and interpretive skills and are meant to be used as a resource for improving the clinical skills education of medical students. Medical educators now must decide which procedural and interpretive skills should be taught and how best to do so. Though we have identified procedures that few students are performing, one question does arise: do all students need to learn and perform all skills? Though some educators may say that doing so during medical school is not required to become a competent physician, others may argue that such learning makes students more aware of the indications and contraindications of diagnostic tests and better prepared to understand the experiences of their patients. It is also important to recognize that medical school may be the last opportunity for students to experience a wide range of procedural and interpretive skills. Also, residency program directors may expect graduating students, who will be new interns, to be familiar with and even to have already performed procedures required for certification by their respective specialty board.

At a time when medical school class sizes are expanding and new schools are forming, medical educators are faced with teaching procedural and interpretive skills to a greater number of students, yet perhaps with little increase in resources. Though one reaction may be to expand teaching and develop new instructional curricula, we suggest that educators investigate barriers to medical student performance at their respective

institutions as the first step in developing clinical curricula. If students lack the clinical opportunities to perform skills, even the most detailed procedural skills curricula will not be effective. If opportunities are lacking, one solution may be to use medical simulation as a means to provide students with exposure to procedural skills. Alternatively, perhaps educators should change their expectations of students and, instead, permit them to have knowledge and understanding of procedures rarely performed by them, much like the certification policy of the American Board of Internal Medicine for procedures such as lumbar puncture in which graduating medicine residents need to know the indications and contraindications, proper technique, complications, and how to obtain informed consent, but do not necessarily need to have demonstrated competence in performance.[6]

Conclusions

Medical educators feel that students should learn and perform procedural and interpretive skills, but not all students are doing so. The fourth year of medical school cannot be relied on to provide students with clinically significant additional experience in procedures. Educators need to decide which specific skills their students should learn and perform, find out why students are not performing procedures at their respective institutions, and then design ways to increase exposure to and experience in procedural and interpretive skills.

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References

1 Wu EH, Elnicki DM, Alper EJ, et al. Procedural and interpretive skills of medical students: Experiences and attitudes of third-year students. Acad Med 2006;81(10 suppl):S48–S51.
2 Association of American Medical Colleges. Learning objectives for medical student education—Guidelines for medical schools: Report I of the Medical School Objectives Project. Acad Med. 1999;74:13–18.
3 Elnicki DM, Van Londen J, Hemmer PA, Fagan M, Wong R. U.S. and Canadian internal medicine clerkship directors' opinions about teaching procedural and interpretive skills to medical students. Acad Med. 2004;79:1108–1113.
4 Coberly L, Goldenhar LM. Ready or not, here they come: Acting interns' experience and perceived competency performing basic medical procedures. J Gen Intern Med. 2007; 22:491–494.
5 Association of American Medical Colleges. The AAMC Project on the Clinical Education of Medical Students: Recommendations for Clinical Skills Curricula for Undergraduate Medical Education. Available at: (https://services.aamc.org/Publications/showfile.cfm?file=version56.pdf&prd_id=141&prv_id=165&pdf_id=56). Accessed June 11, 2008.
6 American Board of Internal Medicine. Polices and Procedures for Certification, November 2007. Available at: (www.abim.org/certification/policies/imss/im.aspx#procedures). Accessed June 11, 2008.