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Dual-Instructor System Improves Outcomes in Laboratory Medicine Training

Running Title: Dual-instructor system

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ABSTRACT

Laboratory medicine is a rapidly growing specialty with an increasing demand for skilled employees. However, typical medical technologist training programs use a traditional teaching system, which often emphasizes theoretical knowledge at the expense of practical skills. We sought to determine whether more well-rounded students may be produced using a non-conventional teaching approach, namely a dual-instructor system, which appoints one teacher for theoretical instruction and one for practical instruction. Methods: Seventy-six students in the laboratory medicine training program at The First People's Hospital of Yancheng City (Yancheng, China), were randomly divided into two approximately equal groups. One group was placed into courses using a dual-instructor system, while the other was placed into the same courses (pathology, immunology, and microbiology) but with traditional instruction (one teacher with only theoretical, and not clinical/practical, experience). Students in each group were evaluated for classroom participation, experimental skills, and theoretical knowledge. In each course, students in the dual-instructor group scored higher on each test than those in traditional group (P<0.05). Thus, a dual-instructor method produces more well-rounded trainees by improving both experimental skills and deepening theoretical knowledge.
KEY WORDS Dual-instructor system; Laboratory medicine; Experiment teaching

INTRODUCTION

Laboratory medicine, also known as clinical pathology, is an important medical specialty handling the processing and analysis of clinical samples through various chemical, microbiological, and immunological techniques (1). This specialty plays an increasingly important role in the diagnosis of medical problems, as well as in the assessment of medical treatments. Indeed, laboratory results regarding prevention, diagnosis, and treatment of disease influence an estimated 70% of medical decisions (2). Further, the quality of clinical laboratory tests have a direct impact on these medical decisions (3). Central to assuring good quality is the talent of the technical team in the laboratory.

Medical technologists with comprehensive theoretical knowledge in laboratory medicine, and especially those skilled in experimental techniques and having good practical abilities, are crucial to providing accurate and timely test reports for clinical practice. The current trend in the field is to cultivate a group of talented graduates from laboratory medicine training programs who have comprehensive skills (4). However, experimental skills are very important in laboratory medicine and should be emphasized.

Traditionally, in China, laboratory medicine training is taught by intramural instructors, most of whom are recent graduates and therefore lack practical experience in clinical employment. This lack of practical experience produces a weakness during training: students develop strong theoretical knowledge but lack practical skills (5). In contrast, skilled professionals from the clinical laboratory are more experienced, and thus are able to supplement the lack of practical experience of intramural teachers (6,7).

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Some training programs, such as clinical nursing, have moved toward a two-instructor system (8), in which, working from the same foundation, one instructor supplies theoretical knowledge and the other imparts practical, hands-on knowledge. This type of teaching system has proven more effective in producing students with a solid understanding of both features of a discipline (8, 9). Here, we extended this teaching approach to a laboratory medicine training program. To improve the quality of experimental training in laboratory medicine, and thereby produce graduates with both theoretical knowledge and practical skills, we applied a dual-instructor system for three courses—pathological, immunological, and microbiological tests—and compared this system with traditional teaching methods.

METHODS

Participants

Seventy-six students from the Laboratory Medicine Techniques class (entered in 2010) in the Department of Laboratory Medicine, Yancheng Health Vocational and Technical College and The First People's Hospital of Yancheng City (Yancheng, China), were randomly assigned to one of two groups for the duration of three courses. Thirty-eight students were placed in the dual-instructor group; these included 8 males and 30 females, ages 19 to 23 years. The remaining 38 students were assigned to the traditional teaching group; these included 9 males and 29 females, ages 19 to 23 years. There were no statistical differences in gender distribution or age between groups. Ethical approval for this study was granted by the Human Research Ethics Committee of the Yancheng Health Vocational and Technical College (Yanwei Ethics Number 201011).

Teaching methods

Dual-instructor group. This group was taught by two teachers, one full-time teacher (on campus) and one part-time teacher from the hospital. Prior to class, the two teachers discussed the experimental content, such as operating procedures, precautions, etc., to coordinate their opinions. During class, the full-time teacher would lecture on experimental content first, then the part-time teacher would demonstrate. The two teachers would give onsite instructions to students according to problems encountered during experimental operations. The teacher from the hospital had good clinical experience and frequent patient contact.

Traditional teaching group. This group was taught by individual full-time teachers (two teachers used in total for the 3 courses). These "traditional" teachers did not have clinical experience or experience with patient contact and were solely trained as instructors in theory, thus they represented the typical instructional paradigm in traditional laboratory medicine training programs.

Course content

The main content of the three courses covered the following: 1) experimental techniques for pathological tests (e.g., paraffin embedding, immunohistochemistry, preparation of cell smears, *in situ* hybridization); 2) experimental techniques for immunological tests (e.g., enzyme-linked immunosorbent assay, isolation and identification of mononuclear cells, determination of antiseptic properties of white blood cells, measuring immune complexes with polyethylene glycol, detecting C3 and C4 complements with immune turbidimetry, detecting antinuclear antibody with immunofluorescence, dot-immunochromatographic assay); and 3) experimental methods for microbiological tests (e.g., aseptic technique, bacterial identification, media preparation, bacterial isolation and culture, biochemical tests of bacteria, drug sensitivity tests).

Student assessment

Class assessment marks were based on the following: scores for students' classroom discipline during experimental teaching (early departure or late arrivals penalized); specific responses to questions asked during experiments (each student must have answered 3 questions); and lab report scores. After completion of the learning plan, all students participated in a skills assessment test: students drew lots to select a specific test, and teachers graded according to students' specific operations. Grades on the specific test were considered as a reflection of general experimental skills. Scores for theory knowledge were obtained by a written final examination. All scores were expressed within a one hundred-point system.

Statistical methods

Data analysis was performed with SPSS19.0 statistical software. Measurements are expressed as mean ± standard deviation ($\overline{X}$ ± s). Independent single-sample t-test was used to compare scores of ordinary experiments, experimental techniques, and theory tests between the two groups. Tests were two-sided, with α level of 0.05 and p<0.05 considered statistically significant.

RESULTS

For all sections of the course—pathology, immunology, and microbiology—mean scores for classroom participation, experimental skills assessment, and theory testing were significantly higher for students in the dual-instructor group compared to those in the traditional teaching group (all *P*<0.05; Table 1).

Table 1. Grading outcomes for laboratory medicine courses compared between dual-instructor and traditional teaching methods.

		Teaching Group		**Statistics**	
Course Section	Test	Dual-instructor	Traditional	t	P
Pathology	Classroom scores	86.7 ± 6.5	82.8 ± 9.7	2.054	0.044
	Experimental skills assessment	85.0 ± 8.0	74.1 ± 9.4	5.451	0.001
	Theory testing	74.5 ± 8.7	69.8 ± 9.8	2.22	0.029
Immunology	Classroom scores	86.6 ± 8.0	81.4 ± 8.6	2.708	0.008
	Experimental skills assessment	85.9 ± 7.2	77.1 ± 9.8	4.461	0.001
	Theory testing	73.6 ± 11.4	67.5 ± 11.6	2.32	0.023
Microbiology	Classroom scores	85.7 ± 8.3	80.8 ± 9.0	2.439	0.015
	Experimental skills assessment	83.4 ± 10.4	75.1 ± 10.1	3.515	0.001
	Theory testing	74.8 ± 9.4	69.5 ± 10.0	2.401	0.019

DISCUSSION

Laboratory medicine technicians represent a core group of professionals in medical and health institutions who are critical to the diagnosis and treatment of medical problems. With rapid technological advancements and increasing demands for a wide variety of medical tests (4), laboratory medicine has evolved from a supporting role in clinical medicine to an independent discipline (1).

Skill development, knowledge, and continuing education of laboratory medicine professionals are fundamental to guaranteeing reliable and high-quality test results. Skilled personnel must possess both excellent professional skills and practical ability. To ensure that laboratory medicine graduates possess these qualities, practical teaching methods must be strengthened and reformed (6).

Some disciplines, such as clinical nursing (8), have instituted a "Dual Teacher System", in which two different types of teachers are involved in training students: one is responsible for conveying subject matter, education theory, and cultural knowledge; the other, a demonstration teacher, handles the practical, hands-on application of the subject matter, i.e., experimental operations (7). This approach improves students' experimental skills and strengthens the integration of theory and practice, as well as cultivating qualified future teachers and helping meet the objectives of the training program.

Here, we applied the dual-instructor teaching system to determine whether the approach improves practical skills of trainees in a laboratory medicine program. For the three training courses in which this system was used (pathology, immunology, and microbiology techniques), students' classroom scores, experimental skills, and theoretical knowledge scores all improved in comparison with scores for students receiving traditional instruction, suggesting that this dual-instructor system is effective in improving technical training.

We propose several possible reasons that the dual-instructor system improved classroom outcomes. A system in which one instructor is responsible for theoretical knowledge and another is responsible for practical knowledge, but both instructors begin with an agreed-upon foundation, may offer a more stable and standardized classroom structure, improving students' learning ability. Additionally, the teachers reinforce each other's skill sets, which may improve their teaching enthusiasm and ability, thereby enhancing teaching quality.

Conclusions

The use of a dual-instructor system in laboratory medicine training programs may help to produce graduates with a more desirable combination of theoretical and practical skills, promoting more effective and professional laboratories and indirectly improving patient care.

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