

# Improving Efficiency of Clinical Skills Training: A Randomized Trial

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**BACKGROUND:** The rising number of medical students and the impact this has on students' learning of clinical skills is a matter of concern. Cooperative learning in pairs, called dyad training, might help address this situation.

**OBJECTIVE:** The aim of this study was to evaluate the effect of dyad training on students' patient encounter skills.

**DESIGN:** Experimental, randomized, observer-blinded trial.

**PARTICIPANTS:** Forty-nine pre-clerkship medical students without prior clinical experience.

**INTERVENTION:** All students underwent a 4-h course on how to manage patient encounters. Subsequently, the students were randomized into a dyad practice group ( $n=24$ ) or a single practice group ( $n=25$ ). Both groups practiced for 4 h on four different case scenarios, using simulated patients. Students in the dyad group practiced together and took turns as the active participant, whereas students in the single group practiced alone.

**MAIN MEASURE:** Performance tests of patient encounter skills were conducted 2 weeks after the training by two blinded raters. Students had no clinical training during those weeks. A questionnaire-based evaluation surveyed students' confidence in their patient management skills.

**KEY RESULTS:** The dyad group scored significantly higher on the performance test, mean 40.7 % (SD 6.6), than the single group, mean 36.9 % (SD 5.8),  $P=0.04$ , effect size 0.61. Inter-rater reliability was 0.69. The dyad group expressed significantly higher confidence in managing future clinical patient encounters than the single group, mean 7.6 (SD 0.9) vs. mean 6.5 (SD 1.1), respectively,  $P<0.001$ , effect size 1.16.

**CONCLUSION:** Dyad training of pre-clerkship medical students' patient encounter skills is effective, efficient, and prompts higher confidence in managing future patient encounters compared to training alone. This training format may help maintain high-quality medical training in the face of an increasing number of students in medical schools.

**KEY WORDS:** clinical skills; medical students; co-operative learning; training efficiency.

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## BACKGROUND

The Association of American Medical Colleges recommends increase in U.S. medical school capacity to meet the expected needs in 2015 and beyond.<sup>1</sup> However, the rising number of medical students and the impact this has on student learning has been a subject of concern in recent literature.<sup>2-4</sup> In addition, methods for enhancing students' clinical skills are needed as there are fewer hours available for skill development and remediation upon graduation as a result of resident duty hours regulations.<sup>5</sup> This calls for efficient and effective training protocols that address issues of quality of care, cost, and clinical teacher resources. Clinical skills learning is, however, difficult to improve, despite several initiatives to reform training.<sup>6,7</sup>

The search for optimal training protocols involves research on collaborative learning. This concept is well-known from peer-learning formats such as problem-based learning or small group learning, which rely on interaction and reflection with peers.<sup>8,9</sup> Literature from non-medical areas suggest that training in pairs, which is known as dyad training, is an effective and efficient way to train complex motor skills.<sup>10-14</sup> These studies have shown that participants in dyad groups perform as well or better than participants who train alone, despite having half the amount of hands-on time. However, there is also evidence that dyad training may hinder learning tasks that depend heavily on declarative knowledge, such as learning how to operate a computer program.<sup>15</sup> Therefore, it is unknown whether the positive effects of dyad training translate to learning patient encounter skills, which are a mix of cognitive and motor skills.

The aim of this study was to evaluate the effect that dyad training has on the patient encounter skills of medical students. The study involved two key research questions: (1) "What is the effect of dyad training of pre-clerkship medical students compared to single training, assessed by a performance test of patient management skills 2 weeks after the training?" and (2) "What is the students' perception of the training format in terms of confidence in managing future clinical patient encounters?"

**METHODS**

**Study Design**

This was an experimental, randomized, observer-blinded study of the effect of dyad training (intervention) compared to single training (control) (Fig. 1). The study was conducted in accordance with the Consolidated Standards of Reporting Trials statement.<sup>16</sup>

**Setting and Participants**

The study was conducted at the Centre for Clinical Education, University of Copenhagen, Rigshospitalet, Denmark.

The medical program at our university consists of a 6-year traditional curriculum with basic science teaching during the first 3 pre-clerkship years and clinical sciences during the last 3 clerkship years. Students receive traditional didactic teaching in clinical medicine during the last 6 months of the pre-clerkship phase, leading up to their first clerkship. Before entering clinical clerkships, all students must complete a mandatory course in patient encounter skills.

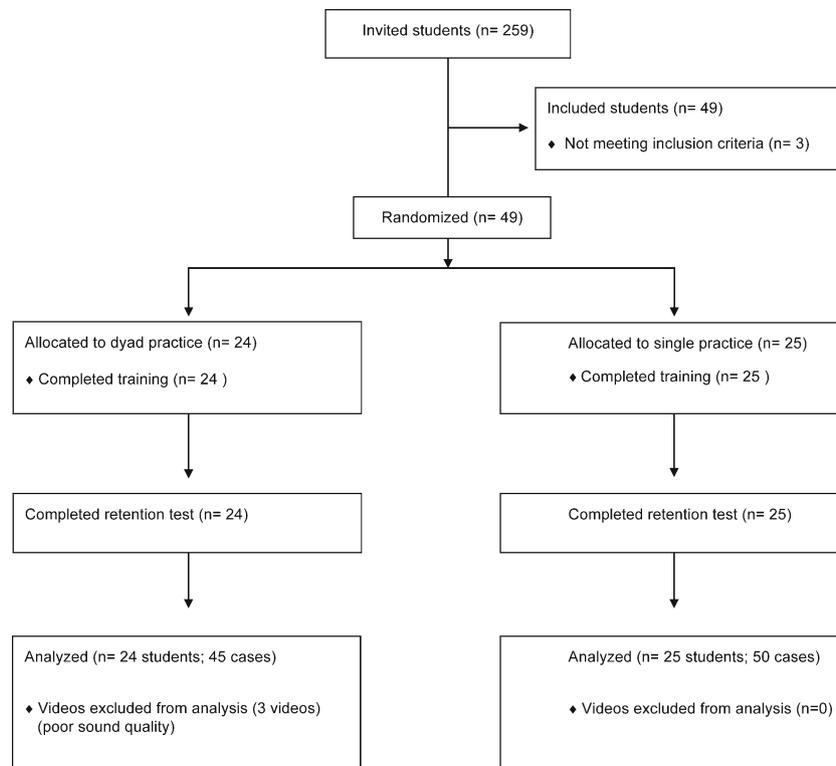
In January 2011, all end-of-third year (pre-clerkship) medical students from one cohort (259 students) at the University of Copenhagen in Denmark were invited by e-mail to participate. Participants were paid a small honorarium for their involvement

and were enlisted on a first-come, first-serve basis. The students invited were all about to begin their first core clerkship. The only exclusion criterion was prior clinical experience. Hence, none of the participating students in this study had any prior basic skills training.

Ethical approval, in the form of an exemption letter from the Regional Ethical Committee of the Capital Region, was obtained before conducting the study.

**Intervention**

All students enrolled in the study received a standard 4-h long practical course on how to manage patient encounters including teaching history taking and practicing physical examination skills in the skills lab. After completion of this course, students were randomized into either dyad-practice or single-practice protocols for a period of 4 h. This practicing took place on the next day. A computer-generated list of random numbers was used to allocate the students. Four different standardized cases related to the students' prior theoretical courses on clinical medicine (pneumonia, tonsillitis, deep venous thrombosis, and new-onset of diabetes) were constructed for the practice sessions and simulated patients were trained to portray the cases. The students were instructed to take the patients history and perform a physical examination using a maximum of 25 min per encounter.



**Figure 1. Flowchart of study setup.**

The students then had another 25 min to write a patient workup, including tentative and differential diagnoses, as well as management plans. The report was done using a post-encounter form that were structured according to the Reporter-Interpreter-Manager-Educator (RIME) framework (Table 1).<sup>17</sup> The students practicing in pairs were assigned to pairs according to a computer-generated list of random numbers. They were instructed to alternate between actively managing the patient encounter and observing their partner, to ensure equal amounts of hands-on time for all students working in pairs. They were told to manage the patient encounter predominantly alone during the history taking and physical examination. However, they were allowed to suggest, comment or discuss essential steps with each other during the history taking and physical examination. During the time allocated for writing patient workups, the dyads were instructed to continue to work in pairs, and they were allowed to discuss the patient encounter, differential diagnoses, management plan, and potential learning goals. All dyads were instructed to write their own patient workups and the time used for discussion was self-regulated. The students in the single group managed all four encounters alone, and thereby had double the hands-on time compared to the dyad group.

## Outcome and Follow-up

Two weeks after the practice sessions, the students were assessed individually on a performance test. No formal clinical training or teaching took place during the period between the training and practice and the performance test. All students were instructed to: “Manage each patient encounter using 25 min for history taking and physical examination and 25 min for writing patient workups”.

**Table 1. The Post-Encounter Card Completed After Each Patient Encounter by Students in the Randomized Study of the Effect of Practicing Patient Management Skills in Pairs (Dyad) or Alone (Single). The Encounter Card Was Structured According to the Reporter-Interpreter-Manager-Educator (RIME) Framework**

<b>Reporter</b>
Focused summary of previous patient history
Summary of current patient history
Summary of physical examination
<b>Interpretation</b>
Summary of current medical problem
Description of psychosocial and ethical considerations
Tentative diagnoses and differential diagnoses
<b>Manager</b>
Patient workup and management plan
Follow-up on patient workup and management plan (i.e. what happens if... or...)
Instructions to medical team and information to the patient and relatives
<b>Educator/learning</b>
Questions to supervisor or to the conference about this patient
Learning goals—one specific and one general

Two new cases were created for the performance test and portrayed by simulated patients (chronic obstructive pulmonary disease [COPD] in exacerbation and cytomegalovirus/Epstein-Barr virus [CMV/EBV] infection). All students were assessed individually and all encounters were videotaped. Again, the students had to take patient history as well as perform physical examination during the encounter, followed by writing workups using the RIME framework (Table 1). Each element was allocated 25 min. The videotapes and post-encounter cards were then rated individually by two physicians (AG and MBR), using a previously validated scoring form based on the RIME framework (Appendix A).<sup>18</sup> All students were briefed on the assessment format during the initial training, but none of them had previously been assessed using the RIME framework.

The raters were trained using video-recordings of patient encounters from a previous study and they were instructed to do a criterion-referenced scoring of performances according to the standards expected of medical graduates. The assessors were blind to the identity and allocation of the participants as they had not been in direct contact with any of the participating students before or during the conduction of the study. Instead, they received anonymized video-recordings with individual performances of each student after completing the performance tests and the randomization sequence was concealed from the assessors until all assessment scores were typed in and all statistical analysis completed. The assessors were instructed to report any violation of the blinding.

Finally, all students completed a questionnaire that asked them to rate their confidence in managing future clinical patient encounters on a nine-point Likert-scale with descriptive anchors (1 = very insecure, 9 = very confident).

## Statistical Analysis

Sample size calculation was based on a previous construct validation study demonstrating an average difference of 22.0 % (SD 11.0) between year-four and year-six students,<sup>18</sup> which was considered acceptable. Assuming a difference of 22 %, a power of 80 %, and a two-tailed  $\alpha$  of 5 %, 46 students were required to detect a difference. To compensate for potential dropouts, three more students were included.

All scores were calculated into a percentage of the maximum score. For comparison between the two groups mean total RIME scores were calculated as an average of the two raters' scores. The continuous variables were tested for skewness and kurtosis. Performance-scores and confidence ratings were analyzed for differences between the two groups using Independent-Samples *T*-test. Effect sizes of differences were calculated using Cohen's *D*. Inter-rater reliability was calculated using Intra-class Correlation Coefficients and potential differences were analyzed using Paired Samples *T*-test for each RIME element.

**RESULTS**

All 49 participants ( $N=49$ ) were included in the statistical analysis. Table 2 shows the baseline characteristics of the participants. Three out of 98 videos (3 %) were excluded from the analysis due to technical problems with the audio on the recordings.

Inter-rater reliability was 0.69, (95 % CI 0.50–0.81). Neither the assessors nor the primary investigator recorded any violations to the blinding of the allocation of participants. The Paired Samples *T*-test showed significant differences in ratings on the Reporter and Manager elements ( $p=0.007$  and  $0.003$ , respectively), with one of the raters scoring higher (MBR) than the other (AG) on both elements. The dyad group scored significantly higher on the performance test 2 weeks after the intervention, mean 40.7 % (SD 6.6), compared to the single group, mean 36.9 % (SD 5.8),  $P=0.04$ , effect size 0.61. Table 3 shows distribution of scores across the four RIME categories between the two groups.

The dyad group rated confidence with managing the patient encounter significantly higher than the single group; mean 7.6 (SD 0.9) in the dyad group vs. mean 6.5 (SD 1.1) in the single group,  $P<0.001$ , effect size 1.16.

**DISCUSSION**

This study indicates that dyad practice was more effective and efficient than single practice when training pre-clerkship medical students to manage patient encounters. Students in the dyad group were also more confident than those who practiced alone. These results are consistent with existing literature on dyad training from domains outside medicine,<sup>10–14</sup> and are supported by theoretical assumptions regarding how and why collaborative learning works in terms of increased confidence, shared memory, and cognitive partnership.<sup>8</sup> Literature from the field of motor skills learning, neuroscience, and psychology offers theoretical explanations of the observed benefits from dyad practice.

Motor-skills learning literature has suggested that the beneficial effects of dyad practice are largely due to

**Table 3. Results of Performance Test of Students in a Randomized Study of the Effect of Practicing Patient Management Skills in Pairs (Dyad) or Alone (Single)**

Element	Dyad group ( $n=24$ ) Means (SD)	Single group ( $n=25$ ) Means (SD)	P values; Cohen’s d effect size (95 % CI)
Reporter	64.3 (8.7)	60.4 (11.6)	$P=0.192$ ; $d=0.38$ (–0.19–0.94)
Interpreter	31.6 (7.5)	30.3 (7.6)	$P=0.535$ ; $d=0.18$ (–0.39–0.73)
Manager	28.8 (9.2)	23.9 (6.2)	$P=0.03$ ; $d=0.65$ (0.04–1.19)
Educator	20.8 (14.2)	15.0 (11.8)	$P=0.125$ ; $d=0.45$ (–0.13–1.00)
Total score	40.7 (6.6)	36.9 (5.8)	$P=0.04$ ; $d=0.61$ (0.03–1.18)

observation.<sup>14,19</sup> Recent research within the field of neuroscience has suggested mechanisms of learning by observation, with studies showing that the brain rehearses observed actions using the same neural circuits that are activated when actively executing actions. Thus, neurons in the frontal and parietal areas of the brain, called “mirror neurons,” are shown to respond to observation and execution of the same action.<sup>20–22</sup> Psychological research has suggested that collaboration helps reduce the risk of cognitive overload, due to united memory and shared information processing.<sup>23,24</sup> Finally, other effects such as the social aspects of dyad training<sup>19</sup> may be of importance to learning. This may be even greater significance if dyad training was applied to clinical settings, where many students may feel insecure in a new work-place.<sup>3</sup>

Several studies have shown deficiencies in clinical skills of students and residents,<sup>25–27</sup> and faculty must continue to observe and evaluate trainees’ clinical skills to improve quality of care and patient safety.<sup>28</sup> However, it is becoming increasingly difficult for clinical faculty to meet these expectations, as increases in class size are not always supported by additional resources.<sup>4</sup> Recent literature has therefore called upon effective and efficient models that are less dependent on clinician teachers and instead include other training facilities, such as simulation training in skills labs.<sup>4</sup> Our study indicates that dyad training in skills labs may contribute to reducing costs of training and allowing more students to be trained simultaneously without jeopardizing the quality of training. An important aspect of this study is therefore that training in dyads was *not* detrimental to subsequent standardized patient performance, although it allowed more efficient use of resources. Hence, the findings from this study suggest that dyad training—besides having desirable pedagogical qualities—also has the potential to impact how cost-effective and efficient basic clinical skills training is delivered.

**Table 2. Baseline Characteristics of Three End-of-Year Medical Students Randomized to Practicing Patient Management Skills in Pairs (Dyad) or Alone (Single)**

Characteristics	Dyad group ( $n=24$ )	Single group ( $n=25$ )
Men, <i>n</i>	6	8
Women, <i>n</i>	18	17
Mean age, <i>y</i> (range)	24.5 (22–36)	24.5 (21–32)
Prior clinical training, <i>y</i>	0	0

We consider the moderate increases in performance-scores obtained after a rather short intervention to be of relevance to practice. In support of this, the scores of the dyad group compare to the level of end-of-clerkship year-four students in a previous construct validity study.<sup>18</sup> In the construct validity study, end-of-year four students scored mean 47.9 as Reporters, 42.6 as Interpreters, 41.0 as Managers, and 32.4 as Educators. Thus, the students in the present study scored far higher as Reporters but lower as Interpreters, Managers, and Educators. However, the students in the present study had the advantage of having received training during the intervention in cases similar to the performance-test cases, which may explain the high Reporter scores in both groups. The RIME subgroup analysis of the performance test suggested that the dyad group may have stimulated each other to reflect more on management plans, giving rise to a higher score on this element. This may in turn have resulted in an increase in the quality of proposed learning goals although the difference in Educator scores was not statistically significant between the two groups. The scores on the Reporter and Interpreter elements were similar between the two groups, which may suggest that the beneficial effects of dyad training relate to more advanced aspects of performance. This correlates well to previous anticipations that a reduction in cognitive load of the most demanding tasks leads to improvements in learning for students working in pairs. However, a recent study showed that trainees “perceived that requesting frequent/inappropriate support threatened their credibility”,<sup>29</sup> and having more confident students may also have a downside if they fail to ask for supervision when appropriate.

The experimental nature of this randomized controlled study means that it does have certain limitations. This study only considers clinically naïve students, and the rather low overall performance scores indicate that further training in patient encounter skills is necessary. This is not surprising, as the students participating in this study had no prior basic clinical skills training. Thus, the findings of this study concern the initial phase of skills acquisition. Furthermore, we have only assessed the impact of dyad training on performance levels after 2 weeks, and further research is needed to explore the effects beyond this initial phase of skills acquisition. However, the experimental design of this study did not allow a follow-up study, as the students went into different clerkships after completing the performance test and thereby made standardization of patient management training impossible. Research is needed to assess whether the beneficial effects of dyad training also relate to more senior students and transfer into clinical clerkship learning. However, applying dyad training in the clinical setting may be a challenge regarding the time used per encounter. Learning in clerkships has been characterized as opportunistic<sup>30</sup> with an un-controlled mix of cases, which may also interfere with implementation of dyad training in a clinical setting. Nevertheless, dyad training may be a

valuable format to prepare pre-clerkship medical students in skills labs.

In conclusion, this study demonstrates that training clinical skills in pairs is more effective and efficient than training alone, and it has positive effects on students’ confidence in managing the patient encounter. This training format may help maintain high-quality medical training in the face of an increasing number of students in medical schools.

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**Conflict of Interest:** *The authors declare that they do not have a conflict of interest.*

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## APPENDIX A

**Table 4. The RIME-Structured Scoring Form Used by the Two Assessors T**

Assessment of the students' performance*	1	2	3	4	5
<b>Reporter</b>					
Relevant and sufficient history-taking					
Relevant and sufficient physical examination					
<b>Interpreter</b>					
Summary of the key medical problems					
Summary of psychosocial, organizational and ethical problems of importance to the medical problem					
Suggestions of diagnosis and differential diagnoses					
<b>Manager</b>					
Propose a diagnostic and treatment plan—in general aspects					
Indicate follow-up on the management plan (if...then...)					
Indicate key information and instructions to patient, personnel and others					
<b>Educator</b>					
Formulate questions or discussion topics to tutor/supervisor/conference about this specific case					
Formulate general learning goals relating to this case					

\*The criterion of the assessment was according to expectations of post-graduate year-1 residents. Hence, a score of five was given to the performance expected from year-1 residents, and the assessors were trained by assessing videos from a previous construct validity study<sup>18</sup> until consensus was reached on distribution of scores on performances of medical students at the end-of-year four, end-of-year-six, and PGY-1 residents (five videos in total). The consensus formation was achieved by discussing scores after each rating