ORIGINAL ARTICLE

Comparison of three methods for teaching mechanical ventilation in an emergency setting to sixth-year medical students: a randomized trial

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SUMMARY

OBJECTIVE: *To determine if there are significant differences between the tutorial, simulation, or clinical-case-based discussion teaching methods regarding the transmission of medical knowledge on mechanical ventilation.*

METHODS: *A randomized, multicenter, open-label controlled trial was carried out using 3 teaching methods on mechanical ventilation: clinical-case-based discussion, simulation, and online tutorial. Voluntary students of the sixth year of medical school from 11 medical colleges answered a validated questionnaire on knowledge about mechanical ventilation for medical students before, immediately after, and 6 months after in-person training consisting of 20 multiple-choice questions, and 5 questions about the participants' demographic profile.*

RESULTS: *Immediately after the test there was no difference between the scores in the simulation and clinical case groups,[15,06 vs 14,63] whereas, after some time, there was a significant difference in retention between the case-based and simulation groups, with the score in the simulation group 1.46 [1.31; 1.64] times higher than the score of the case group (p-value < 0.001). In the multivariate analysis, an individual who had received more than 4 hours of information showed an increase of 20.0% [09.0%; 33.0%] in the score (p-value = 0.001).*

CONCLUSIONS: *Our results indicate that, in comparison with other forms of training, simulation in mechanical ventilation provides long-lasting knowledge in the medium term. Further studies are needed to improve the designing and evaluation of training that provides minimal mechanical ventilation skills.*

KEYWORDS: *Respiration, Artificial. Emergencies. Students, Medical. Teaching.*

INTRODUCTION

The increased number of patients on mechanical ventilation, most of whom are not in an ICU, requires, from general practitioners, special skills on the subject[1,2]. Moreover, the increase in costs and mortality is related to the increase in the time of mechanical ventilation and its complications[3]. However, despite evidence showing that evidence-based practices can decrease these, such practices have low compliance and are underused in clinical practice[4-7].

There is a large number of non-specialist physicians working in emergency and pre-hospital services attending patients who need to be intubated and kept

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on mechanical ventilation[8]. However, the teaching of these skills is very deficient[9,10]. There are few studies about teaching and assessment methods of these skills among resident physicians, and there are no studies in the literature for undergraduate medical students.

Our study compares simulation methods, case-based discussions, and online remote education methods on artificial ventilation, and uses a validated tool for assessing knowledge on mechanical ventilation among students in the last semester of medical graduation[11]. The objective is to determine if there are, among the teaching methods, significant differences regarding the transmission of medical knowledge on mechanical ventilation.

METHODS

A randomized, multicenter, open-label controlled trial was carried out using 3 teaching methods on mechanical ventilation: clinical case-based discussion, simulation, online tutorial. A simple randomization using an electronic method was applied for each group of 10 students for each teaching method, and one group remained as the control. All participants answered a validated questionnaire on knowledge about mechanical ventilation for medical students before, immediately after training, and 6 months after i[t12], consisting of 20 multiple-choice questions, and 5 questions about the participants' demographic profile. Figure I

The participants were voluntary students of the sixth year of medical school from 11 medical colleges, out of 53 invited, who accepted the researcher's invitation. All of them were in the second semester of the course and had already participated in training sessions on adult intensive care, emergency room, and anesthesiology. The training sessions were offered at the headquarters of the participating universities by the same researcher in all groups.

All training was based on the basic objectives of knowledge on mechanical ventilation, divided into 55 items developed by Goligher et al.[13]. Four clinical cases were used for the simulation, case-based discussion, and online tutorial scenarios. The "control" groups attended an 8-hour course that was not related to mechanical ventilation and answered the questionnaire as well.

A training session based on 4 clinical cases with a structured sequence of questions was created for each case. The schedule was divided into two methods: in the simulation, students handled the artificial ventilator and observed the effects of its changes with the simulator. In the discussion-based format, the same sequence was followed, but there was no "hands-on" practice, only the demonstration by the instructor; both methods were recorded and saved on DVDs to be presented to a random group as an online Tutorial.

Using the simulation taxonomy, Chiniara et al.[14] used a high-fidelity scenario, emergency room, respiratory system simulator, and instructor-based debriefing; the instructor evaluated the response of each handling action of the group of students and made comments simultaneously. (Annex 1) The case-based discussion[11] was based on fundamental principles of structured discussion, realism, relevance, need to trigger the learner's involvement, challenging problem, and instructional methods such as equipment, simulators, and theatricalization of scenarios. The same sequence of structured questions was used for each scenario, but students had no direct contact with the ventilator, everything was demonstrated by the instructor. The online modality recorded the case-based modality, suppressing the interaction of the students and the instructor, and providing DVDs to the participants. The artificial ventilator iX5 was used in all training groups, the technical name of which is pressure and volume ventilator (registered with the Brazilian Health Regulatory Agency – Anvisa under no. 10243240052; manufacturer: Intermed Equipamento Médico Hospitalar Ltda). The simulator used was the PneuView® 3 Advanced Simulation Software (Michigan Instruments, Grand Rapids, Michigan, USA).

A Quasipoisson Regression (Wedderburn, 1974; McCullagh and Nelder, 1989) was used to compare the score between groups over time, with an interaction between the variables group and time, with the necessary contrasts being calculated. The software used in the analyses was R (version 3.4.1).

RESULTS

Most students reported not having attended a mechanical ventilation course as part of their undergraduate program (294, 89.1%); most of them never participated effectively in the approach to mechanical ventilation in a patient (282, 75.2%); and reported that the participation of the physical therapist prevailed in the approach to mechanical ventilation in emergency settings (213, 70.5%). The Case and Simulation groups had the highest scores for overtime retention (Table 1).

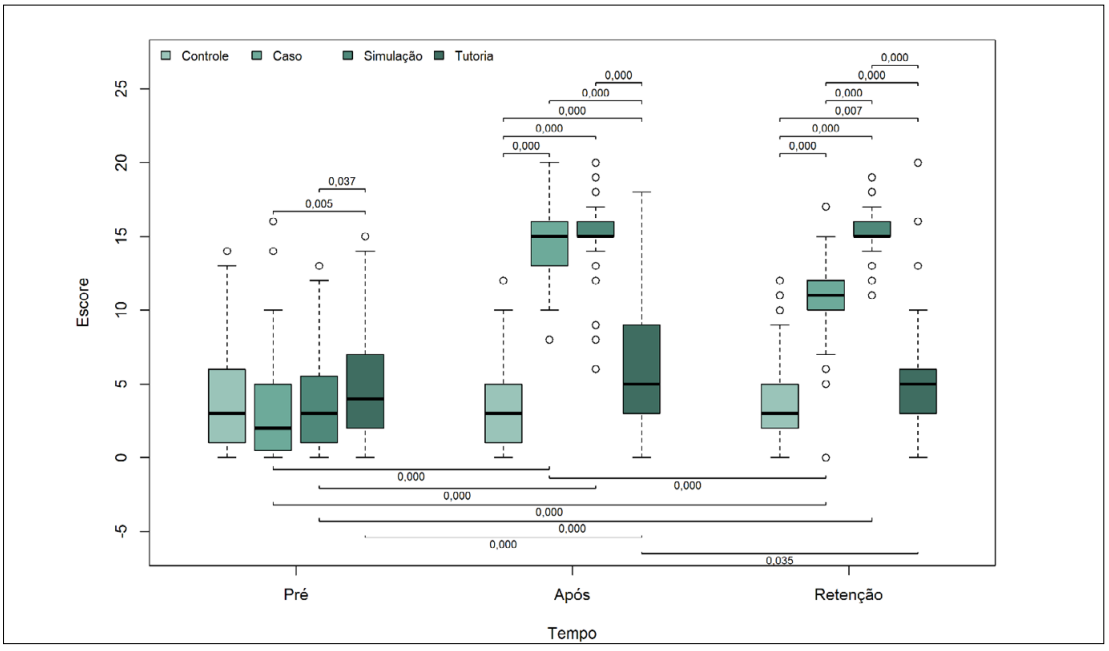
TABLE 1. DESCRIPTIVE ANALYSIS OF THE SCORE BY TIME AND GROUP

Group	Time	Average	SD	Min.	1st Q	2nd Q	3rd Q	Max.
Control	Pre-test	3.73	3.38	0.00	1.00	3.00	6.00	14.00
	Post-test	3.71	3.06	0.00	1.00	3.00	5.00	14.00
	Retention	3.83	3.08	0.00	1.00	4.00	6.00	16.00
Case	Pre-test	3.30	3.28	0.00	0.50	2.50	5.00	16.00
	Post-test	14.63	2.29	8.00	13.00	15.00	16.00	20.00
	Retention	10.96	1.89	5.00	10.00	11.00	12.00	16.00
Simulation	Pre-test	3.40	3.00	0.00	1.00	3.00	6.00	13.00
	Post-test	15.06	2.39	6.00	15.00	15.00	16.00	20.00
	Retention	14.60	2.82	3.00	14.00	15.00	16.00	20.00
Online tutorial	Pre-test	4.38	3.73	0.00	2.00	4.00	7.00	15.00
	Post-test	5.38	4.47	0.00	2.00	4.00	7.00	20.00
	Retention	4.68	3.96	0.00	2.00	4.00	6.00	20.00

TABLE 2. MULTIVARIATE ANALYSIS OF MECHANICAL VENTILATION CLASSES AND INFORMATION TIME

Variables		Initial model			Final model		
		Exp (β)	95% CI	P-value	Exp (β)	95% CI	P-value
Time = Pre	Group = Control	1.00	-	-	1.00	-	-
	Group = Case	0.87	[0.70; 1.07]	0.194	0.87	[0.71; 1.07]	0.198
	Group = Simulation	0.95	[0.77; 1.16]	0.601	0.95	[0.77; 1.16]	0.610
	Group = Tutorial	1.15	[0.93; 1.41]	0.190	1.15	[0.94; 1.41]	0.181
Time = Post-test	Group = Control	1.00	-	-	1.00	-	-
	Group = Case	3.58	[2.98; 4.30]	0.000	3.58	[2.98; 4.30]	0.000
	Group = Simulation	3.68	[3.08; 4.40]	0.000	3.67	[3.07; 4.38]	0.000
	Group = Tutorial	1.61	[1.33; 1.96]	0.000	1.60	[1.32; 1.94]	0.000
Time = Retention	Group = Control	1.00	-	-	1.00	-	-
	Group = Case	2.80	[2.36; 3.33]	0.000	2.81	[2.36; 3.33]	0.000
	Group = Simulation	4.08	[3.46; 4.82]	0.000	4.12	[3.49; 4.85]	0.000
	Group = Tutorial	1.29	[1.05; 1.58]	0.017	1.29	[1.05; 1.58]	0.016
Course = No		1.00	-	-	1.00	-	-
Course = Yes		1.26	[1.16; 1.38]	0.000	1.27	[1.17; 1.39]	0.000

FIGURE 1. COMPARISON BETWEEN GROUPS OVER TIME



Immediately after the training (POST-TEST), there was no difference between the scores in the simulation and clinical case groups, whereas over time (RETENTION) there was a significant difference between the case-based and simulation groups, with the score in the simulation group 1.46 [1.31; 1.64] times higher than the score of the case group (p-value < 0.001).

In the multivariate analysis (Table 2) when individuals who had not had classes of mechanical ventilation as part of their undergraduate program are compared to those who had, the latter shows an increase of 27.0% [17.0%; 39.0%] in the score (p-value = 0.001); and when compared to individuals who had 0 to 1 hour of training, individuals who had more than 4 hours of training show an increase of 20.0% [09.0%; 33.0%] in the score (p-value = 0.001).

DISCUSSION

Our study was the first multicenter study that evaluated the influence of different teaching methods on the knowledge about mechanical ventilation among medical students with a validated instrument. A teaching program standardized in simulation and case-based discussion achieved significant results in the acquisition and retention of knowledge in the short- and medium-term. Few studies have evaluated the teaching of mechanical ventilation; among them, most did not use validated assessment instruments[15,16], and among those using them, none approached medical students[17,18].

The common concept that simulation methods are associated with better results for medical students' knowledge and skill acquisition is controversial. Our study showed no significant difference in specific knowledge in terms of the method of discussion of clinical cases. Few studies have shown similar results[19,20]. In addition, the level of fidelity, in general, correlates with the success in the acquisition of knowledge; the more sophisticated the mannequin, the better the learning result. A recent study did not show this association, and the use of high-fidelity simulation led to a performance equal to or worse of knowledge improvement if compared to low-fidelity simulation, besides inducing undesirable effects, such as overconfidence[21].

Some studies have demonstrated the utility of using simulation in mechanical ventilation training. A study compared simulation training of mechanical ventilation for first-year residents to what the authors called "traditional bedside training" for third-year residents. Similar to our study, the simulation group (n = 40) scored significantly higher in the assessment of clinical skills than the traditional group (n = 27) (91.3% [95% CI 88.2% to 94.3 %] versus 80.9% [95% CI 76.8% to 85.0%], P = <0.001)[22]. Important limitations to the study are influences on the variation of patients at the bedside in the evaluation, and the lack of formal validation of the instrument, as well as the single center. Another study using a simulation of mechanical ventilation showed an improvement in knowledge and skills with an average of 40 to 67%, respectively. However, there are limitations to the study because of the use of an assessment instrument that has not been validated[23]. A randomized trial evaluated the mannequin-based simulation versus computer-based simulation. The mannequin-based group had a higher overall score and key action scores than the computer-based group (3.0 versus 2.0, and 82% versus 71%, respectively). The study was carried out in a single center with a non-validated instrument[24]. Only one study approached a tutorial form of teaching about ventilation, similarly to ours, and compared it to a method that added simulation training. Using a non-validated instrument and a small, non-randomized number of participants, the "hands-on" method achieved a higher assessment score than the tutorial alone (25% vs. 10%, p = 0.07)[25]. Our results using an online tutorial showed no difference in the acquisition of knowledge in relation to the control group.

CONCLUSIONS

Our results indicate that, in comparison with other forms of training, simulation of mechanical ventilation provides long-lasting knowledge in the medium term. Further studies are needed to improve the design and evaluation of training to provide minimal mechanical ventilation skills.

Author's Contributions

Fernando Tallo: project design, data collection and analysis, and drafting of the text.

Letícia Sandre Vendrame: data analysis and drafting of the text

Andre Luciano Baitello: data review and analysis

RESUMO

OBJETIVO: *Determinar se existem diferenças significativas entre os métodos de ensino tutorial, simulação ou discussão de casos clínicos relativos à transmissão de conhecimentos médicos sobre ventilação mecânica.*

MÉTODOS: *Um ensaio clínico randomizado, multicêntrico, aberto e controlado foi realizado usando três métodos de ensino em ventilação mecânica: discussão baseada em casos clínicos, simulação e tutorial on-line. Alunos voluntários do sexto ano de medicina de 11 faculdades responderam a um questionário validado abordando o conhecimento sobre ventilação mecânica para estudantes de medicina antes, imediatamente após e seis meses depois do treinamento presencial, composto por 20 questões de múltipla escolha e cinco questões sobre perfil demográfico dos participantes.*

RESULTADOS: *Imediatamente após o teste, não houve diferença entre as pontuações nos grupos de simulação e caso clínico [15,06 vs 14,63], ao passo que, após algum tempo, houve uma diferença significativa na retenção entre o baseado em caso e a simulação grupos, com a pontuação no grupo simulação 1,46 [1,31; 1,64] vez maior que a pontuação do grupo caso (p-valor <0,001). Na análise multivariada, um indivíduo que recebeu mais de quatro horas de informação apresentou aumento de 20,0% [09,0%; 33,0%] no escore (p-valor=0,001).*

CONCLUSÕES: *Nossos resultados indicam que, em comparação com outras formas de treinamento, a simulação em ventilação mecânica proporciona um conhecimento duradouro a médio prazo. Mais estudos são necessários para melhorar o desenho e a avaliação do treinamento que forneça habilidades mínimas de ventilação mecânica.*

PALAVRAS-CHAVE: *Respiração Artificial. Emergências. Estudantes de Medicina. Ensino.*

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