Abstract

Background: To improve the training process and its results, we used a novel method of studies of medicine in a hybrid laboratory (HybridLab). The aim of the HybridLab training method is to develop standardized practical skills and to improve long-term memory. We created a peer-teaching model that included e-learning modules combined with online checklist-driven skills and decision flowcharts that started with simple steps and progressively worked towards complex simulation scenarios. The aim of this study was to evaluate students’ opinion about initial neonatal resuscitation (INR) training by applying the HybridLab method.

Methods: We analyzed how fifth-year medical students of the Lithuanian University of Health Sciences (LUHS) Medical Academy evaluated their initial neonatal resuscitation (INR) knowledge before and after the training cycle by using a standardized evaluation questionnaire (a 7-point Likert scale), and conducted a qualitative study using the in-depth unstructured interview technique.

Results: The mean evaluation of INR knowledge before the training cycle was 3.19±1.92 points, and after the cycle - 6.84±0.44 points. The overall score of the evaluation of the respondents’ knowledge increased by 3.77±1.9 points (p<0.001). In total, 34.6 % of the respondents presented positive evaluations of the HybridLab method, whereas 15.4 % of the respondents presented negative evaluations. Neutral opinions were presented by 19.7 % of the respondents, and 19.7 % of the students did not have an opinion.

Conclusions: The HybridLab training method may increase students’ satisfaction with the training process, may improve their self-confidence, and may ensure the quality of the acquisition of practical skills.

Keywords: HybridLab training method; hybrid learning; blended learning
Introduction

Teaching medical students correctly performed and long-lasting practical skills is a difficult task for the teacher. The main factors that determine the results of teaching are the presentation of the teaching material, the learning environment, and students' motivation and satisfaction with the learning process (Poon 2013). Hybrid learning (a combination of several teaching techniques– asynchronous or synchronous e-learning and face-to-face teaching) is increasingly broadly used for the teaching of medical students (Liu et al. 2016). A number of researchers have stated that this is an effective technique for training medical students in clinical skills (Liu et al. 2016; Rowe et al. 2012; Guzer & Caner 2014; Lopez-Perez et al. 2011). However, the teacher remains the main factor determining the success of teaching at a higher education institution. Even in hybrid learning, the teacher's competence, the design of the presented material, and the created learning environment determine the learning atmosphere, the students' motivation, and, of course, the learning outcomes (Lizzio et al. 2002). For a number of years, students have been learning clinical skills according to the "see one, do one, teach one" principle. However, a number of researchers think that such learning is not safe. Students have to learn practical skills in a safe environment, in the laboratories of the simulation of clinical situations, and only then can they apply the learned skills in the work with real patients. Imitations of clinical situations are an effective teaching technique, which is useful in learning or improving practical skills – especially in cases of urgent clinical situations (Aggarwal et al. 2010; Lee et al. 2012; Sigalet et al. 2013; Cicero et al. 2012). However, such learning require many resources.

The Lithuanian University of Health Sciences (LUHS) and the Crisis Research Center (CRC) created a learning methodology to overcome issues when teaching resources were limited and demands required a standardized practice for skills.

The aim of our study was to evaluate students' opinion about learning Initial Neonatal Resuscitation (INR) by applying the HybridLab method.

Methods

CRC created a peer-teaching model that included e-learning modules combined with online checklist driven skills and decision flowcharts that started with simple steps and progressively worked towards complex simulation scenarios. The methodology stressed success-based learning where peer-teachers used checklists to assist the learner down the correct pathway. Based on mastery-learning concepts, learners build automaticity in their skill responses, practicing until competent. Remote faculty provided additional feedback for both learners and peer-teachers after viewing video performances of skills. HybridLab training platform developed by Hybrid Labs, Kaunas, Lithuania was used to combine all the training, evaluation and course management activities.

The subjects of the study were 5th-year medical students of the Medical Academy of the Lithuanian University of Health Sciences (LUHS) who were studying the Obstetrics and Gynecology module of the Neonatology cycle in 2015. This study was approved by the decision of Lithuanian University of Health Sciences Biomedical Research Ethics Committee passed at Committee session on November 09, 2015 (protocol No. BE-MF-80). All subjects gave written consent to participate in the study after they were familiarized with its aim and methods.

During the Neonatology cycle, the students were taught the course and skills of initial neonatal resuscitation by applying the HybridLab teaching technique. The students learned the theoretical material at home, using electronic formats of the material: the most recent recommendations for neonatal resuscitation, videos of resuscitation...
procedures (mouth-to-mouth ventilation and chest compressions) and the sequence of actions, algorithms, and clinical situations. After the analysis of the theoretical material, the students remotely solved a 10-item test until the evaluation of their theoretical knowledge reached 100%. After that, the students in groups of 3 started learning practical skills in the HybridLab for 3 hours at the time of their choice (Fig. 1).

When learning practical skills, the students were using a neonate’s mannequin (Newborn Anne, Laerdal), algorithms of the course and the actions (mouth-to-mouth ventilation and chest compressions) of the initial neonatal resuscitation, and checklists for clinical situations (Fig. 2). Students’ training was filmed on video cameras installed in the laboratory. The students’ permission was obtained prior to the filming. The records of the simulations of clinical situations and the solution of the control situation were viewed and evaluated remotely by the teachers, using standardized evaluation sheets.

We analyzed how the students evaluated their INR knowledge prior to and after the training cycle. For this purpose, we used a standardized evaluation questionnaire consisting of 10 statements, which were evaluated using Likert’s 7-point scale (1 point meant “strongly disagree”, and 7 points – “strongly agree”). Three questions of the scale were about the students’ evaluation of their neonatal resuscitation skills (the first steps of resuscitation, mouth-to-mouth ventilation, and chest compressions), and 7 questions – about the students’ evaluation of their knowledge of the course of INR.

After the cycle, we conducted a qualitative study using an in-depth unstructured interview, where the respondents anonymously expressed their opinion about the HybridLab training technique.

Statistical analysis of the data was performed using software packages for storage and analysis of data SPSS 22.0 (Statistical Package for Social Science 22 for Windows). All parametric data were expressed as the mean ± SD (standard deviation) and 95% CI (confidence interval). To evaluate the changes in the score prior to and after the training, we used Paired Samples Statistics and Wilcoxon’s non-parametric test. The differences between the groups were considered to be statistically significant when the level of significance was p<0.05.

Results

Self-evaluation of knowledge prior to and after the training cycle

The study included 188 students (77% of all 5th-year students) (Fig. 3).

Before the training cycle, a total of 159 students (85%) evaluated their knowledge about INR. Of these, 30.8% of the students strongly disagreed, 13.6% - disagreed, and 13.0% - partially disagreed that they could perform INR, while 9% of the students did not have any opinion. Meanwhile, 19.1% of the students partially agreed, 11.9% – agreed, and 2.8% - strongly agreed that they could perform INR. The mean self-evaluation score of the students’ knowledge about INR before the training cycle was 3.19±1.92. This means that students partially disagreed that they had initial neonatal resuscitation skills (the first steps of resuscitation, mouth-to-mouth ventilation, and chest compressions) and knew the correct course of INR (Fig. 4).

After the training cycle, 120 students (64%) evaluated their knowledge about INR. Of these, 0.1% disagreed that they knew how to perform INR, and 0.3% of the students did not have any opinion. Meanwhile, 1.4% of the students partially agreed, 12.4% – agreed, and 85.8% - strongly agreed that they could perform INR. The mean self-evaluation score of the students’ knowledge about INR after the training cycle was 6.84±0.44. This means that
students agreed that they had initial neonatal resuscitation skills (the first steps of resuscitation, mouth-to-mouth ventilation, and chest compressions) and knew the correct course of INR (Fig. 5).

We analyzed how the students’ self-evaluation of their knowledge changed after the HybridLab training cycle. The results of the parametric paired test for dependent variables showed that after the HybridLab training cycle, the overall self-evaluation of the students’ knowledge increased by 3.77±1.9 points (p<0.001). The greatest mean change in the self-evaluation score was in the 5th statement, and the slightest – in the 2nd statement (Table 1).

Results of an in-depth unstructured interview about the HybridLab training cycle

The qualitative study included 151 students (80 %). The students’ responses fell into 6 categories: positive aspects, negative aspects, areas of improvement, unclear theoretical or practical questions, neutral experience, and no opinion. Multiple comparisons showed that the category of positive aspects was significantly greater (p<0.05) (Fig. 6).

A total of 37 (19.7 %) students did not present their opinion. The number of students with neutral experience or those who replied 'no comments' was also 37 (19.7 %). Six students (3.2 %) suggested applying the HybridLab technique in other subjects of neonatology. A small percentage of the students (7.4 %) did not present their opinion, but they asked questions related to the theory and the practical skills.

Positive evaluations of the HybridLab technique were submitted by 34.6 % of the students, and 15.4 % of the students presented negative evaluations. The opinions of those who presented positive or negative evaluations of the training cycle were distributed into 5 different subcategories (Table 2).

Discussion

The HybridLab training technique is a new hybrid method including the elements of self-evaluation, problem-based learning, and simulation training in a practical skill training laboratory without a direct contact with the teacher. The aim of the HybridLab training technique is to develop standardized practical skills and long-term memory. Such student training model was created with the aim of standardizing the teaching process, stimulating time management and teamwork skills, and learning from successes rather than from failures. In our study, we analyzed the students’ opinion about this training technique. The results of our study showed that learning initial neonatal resuscitation (INR) by applying the HybridLab technique stimulated the students’ satisfaction with the learning process, increased their self-confidence, and ensured the quality of practical skill acquisition. After the training cycle, the students strongly agreed that they learned how to perform INR.

The factors that play a significant role in students' satisfaction with the teaching process include interest in the topic and willingness to understand it. Students' satisfaction with the learning process is also influenced by good learning atmosphere (Hu et al. 2007), active learning with continuous feedback from the teacher, and learning together with colleagues. The application of various teaching techniques in the teaching process may increase students' satisfaction with the teaching process and improve learning efficiency, and may also help the students to improve the practical application of their theoretical knowledge (Lehmann et al. 2013; Gras et al 2012; Woltering et al. 2009; Lenchus et al. 2011). Over one-third of the participants of our study liked the HybridLab method. The main factors that determined the students’ satisfaction with this training technique were the following: 1) well-prepared and standardized teaching material (a pre-test, videos, algorithms, and real clinical situations); 2) team-based solutions of clinical situations, which facilitated the acquisition of theoretical knowledge and practical skills; 3) the teachers'
benevolence, attentiveness, and timely assistance even though this was not a face-to-face technique; 4) practical knowledge and skills useful in real life; 5) the training environment providing positive emotions. A study conducted in Belgium in 2012 analyzed students' opinion about the hybrid learning method. The researchers found that the main factors that affected the students' satisfaction were the following: 1) time efficiency of online collaboration and online tasks; 2) emotions in the online environment; 3) timeliness of feedback or responses online, support from the teacher; 4) peer interaction both online and offline, and 5) quality of online communication. Students reported that the flexibility of time and location and the possibility of learning from others were big advantages of hybrid learning and online collaboration (Zhang 2012). Ilic D. et al. analyzed the significance of a hybrid learning technique in teaching students the principles of evidence-based medicine. The researchers found that the application of such technique increased the students' self-confidence (Ilic et al. 2013). The results of a study conducted in the United Kingdom showed that the majority of the students liked the hybrid learning technique. The authors of the study stated that a well-prepared structure of hybrid learning, good academic contents, and interactive practical training classes increase the students' motivation for learning and may improve the learning outcomes (White & Sykes 2012). Good learning environment and microclimate, satisfaction with the learning process, understanding the usefulness of learning, functionality of the teaching method, and good academic content of the topic are related to students' satisfaction with the hybrid learning method (Wu & Liu 2013). In our study, the students named the overall positive subject-based and emotional experience as the main positive aspect of this technique.

A small part (15%) of the students did not like the HybridLab method. They preferred the participation of the teacher in the training process. They found the algorithms, the videos, and the clinical situations to be insufficiently clear. They also encountered technical issues viewing the video material, and they thought that too much time was allocated for this topic. The results of a study conducted by Zhang et al. showed that a part of the students disliked the hybrid learning technique because of the insufficient communication between the students and the teachers (Zhang 2012). With the help of the HybridLab method, we transformed the whole learning process into independent learning: the students studied the theoretical material at home, and upon entering the HybridLab, they solved the clinical situation without the teacher's assistance, only using algorithms and checklists of the clinical situations. The teachers only viewed the video records remotely and provided feedback to each student individually via e-mail. Mpotos N et al. found in their study that during independent learning of resuscitation skills with the use of video material, better results were achieved when applying voice feedback (Mpotos et al. 2013). Our study showed that students received sufficient teachers' attention and assistance during the learning process. Before the cycle, the students studied the theoretical material, viewed videos, analyzed the algorithm, and solved a pre-test. The aim of the pre-test was to help the students to acquire the main theoretical knowledge required during the training of practical skills. The pre-test was supposed to be taken multiple times until 100% score was achieved. Li Q et al. found that a pretest and feedback improved the acquisition of practical resuscitation skills during training (Li et al. 2011).

During the training of INR skills via the application of the HybridLab method, the students were learning in groups of three. Thus, the students could use all the training time for active learning – i.e. solving clinical situations and evaluating them. The results of a study performed in Canada by Tolsgaard et al. showed that clinical simulation-based training of practical skills in small groups was more effective and stimulated students’ self-confidence (Tolsgaard et al. 2015; Tolsgaard et al. 2013).

Standardization of the teaching material and the evaluation of the students' practical knowledge was another highly important factor in the HybridLab training process. The checklists and algorithms used during the practical skill training helped the students to perform the actions correctly and in the correct order at the first attempt. With the help of the HybridLab method and eliminating the teacher from direct contact with the students, we created a
unified learning environment and design of the presented material for all students, thus avoiding the influence of the teacher's competence on the quality of the study process.

**Study limitations**

Our sample size was relatively small, which prevents us from making broader conclusions. The students' self-evaluation of their knowledge prior to the training cycle might have been influenced by knowledge acquired during other cycles. While we applied the in-depth unstructured interview technique to avoid influencing the students' opinion about the HybridLab method, this choice might still have influenced the students' opinion and responses. This assumption is supported by the fact that about one-third of the students either did not answer the questions or stated that they did not have an opinion. Thus, further studies evaluating the students' opinion about the HybridLab method and its significance for the preservation of practical skills are required.

**Conclusions**

The results of our study showed that the application of the HybridLab technique in initial neonatal resuscitation training may ensure the quality of the acquired practical skills and increase the students' self-confidence and satisfaction with the learning process.

**Declaration of Interest**

The authors report no declarations of interest.

**Consent for publication**

Not applicable.

**Take Home Messages**

1. The main factors that determine the results of teaching are students' motivation and satisfaction with the learning process.

2. Standardization of the teaching material and the evaluation of the students' practical knowledge - highly important factor in the HybridLab training process.

**Notes On Contributors**

Ausrele Kudreviciene, MD, PhD, is a lector of the Department of Neonatology Faculty of Medicine Lithuanian University of Health Sciences.
Ruta Jolanta Nadisauskiene, MD, PhD, is a Professor and Head of the Department of Obstetrics and Gynecology Lithuanian University of Health Sciences, FRCOG.

Rasa Tameliene, MD, PhD, is an Associated Professor and Head of the Department of Neonatology Faculty of Medicine Lithuanian University of Health Sciences.

Jurgita Garcinskiene, MD, is an assistent of the Department of Neonatology Faculty of Medicine Lithuanian University of Health Sciences.

Irena Nedzelskiene is a Engineer programmer, Department of Dental and Oral Pathology, Lithuanian University of Health Sciences.

Algimantas Tamelis, MD, PhD, is a Professor and Head of the Department of Surgery Lithuanian University of Health Sciences.

Paulius Dobozinskas, MD, is an assistent of the Department of Emergency Medicine Lithuanian University of Health Sciences, and the Project Director of the Crisis Research Centre, Lithuania.

Dinas Vaitkaitis MD, PhD, is a Professor and Head of the Department of Emergency Medicine Lithuanian University of Health Sciences and the Director of the Crisis Research Centre, Lithuania.

**Acknowledgements**

The authors wish to thank all students who kindly participated in the study.

**Bibliography/References**

   
   [http://dx.doi.org/10.1136/qshc.2009.038562](http://dx.doi.org/10.1136/qshc.2009.038562)


   


http://dx.doi.org/10.1186/1472-6920-13-169


http://dx.doi.org/10.1186/1472-6920-13-23


http://dx.doi.org/10.1186/1472-6920-13-23


http://dx.doi.org/10.1186/1472-6920-13-23


http://dx.doi.org/10.1186/1472-6920-13-23


http://dx.doi.org/10.2196/jmir.4807


http://dx.doi.org/10.1080/03075070120099359


http://dx.doi.org/10.1016/j.compedu.2010.10.023


http://dx.doi.org/10.1097/MEJ.0b013e328358490a


http://dx.doi.org/10.3109/0142159X.2012.642831


http://dx.doi.org/10.1097/ACM.0b013e318294fd45


http://dx.doi.org/10.1007/s11606-013-2378-4


http://dx.doi.org/10.1111/medu.12624


http://dx.doi.org/10.1007/s10459-009-9154-6


http://dx.doi.org/10.4304/jltr.4.1.176-185


Appendices
Fig. 1. HybridLab 24/7 Simulation Technology with a Remote Instructor
Fig. 2. Learning of practical skills in the HybridLab
Fig. 3. The design of the study
Fig. 4. Self-evaluation of knowledge prior to the HybridLab training cycle
1. I know how to determine if neonatal resuscitation is required
2. I know when to call for help
3. I know when the first steps of resuscitation have to be performed
4. I know how to perform the first steps of resuscitation
5. I know the duration of the first steps of resuscitation
6. I know when to begin mouth to mouth ventilation
7. I know how to perform mouth to mouth ventilation
8. I know when to perform chest compressions
9. I know how to perform chest compressions
10. I know how to evaluate the improvement in neonatal condition during resuscitation

Fig. 5. Self-evaluation of knowledge after the HybridLab training cycle
Fig. 6. Response categories and frequencies of an in-depth unstructured interview about the HybridLab training cycle

\[ \chi^2 = 68.468, \ df = 5, \ p < 0.001 \text{ (chi-square goodness of fit test)} \]
Table 1. Changes in the scores of the students’ self-evaluation of their knowledge prior to and after the HybridLab training cycle

<table>
<thead>
<tr>
<th>Statement</th>
<th>Mean change in the evaluation score (95%CI)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I know how to determine if neonatal resuscitation is required.</td>
<td>3.75 [3.35 – 4.15]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>2. I know when to call for help.</td>
<td>3.21 [2.80 – 3.63]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>3. I know when the first steps of resuscitation have to be performed.</td>
<td>3.76 [3.38 – 4.14]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>4. I know how to perform the first steps of resuscitation.</td>
<td>3.67 [3.30 – 4.05]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>5. I know the duration of the first steps of resuscitation.</td>
<td>4.24 [3.86 – 4.62]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>6. I know when to begin mouth to mouth ventilation.</td>
<td>4.12 [3.74 – 4.50]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>7. I know how to perform mouth-to-mouth ventilation.</td>
<td>3.74 [3.34 – 4.14]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>8. I know when to perform chest compressions.</td>
<td>3.84 [3.46 – 4.22]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>9. I know how to perform chest compressions.</td>
<td>3.39 [2.97 – 3.81]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>10. I know how to evaluate the improvement in neonatal condition during resuscitation.</td>
<td>4.0 [3.64 – 4.36]</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
Table 2. Response categories and subcategories, their frequencies, and illustrating quotes

<table>
<thead>
<tr>
<th>Categories</th>
<th>Subcategories</th>
<th>Frequencies (n, %)</th>
<th>Illustrating quotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Positive aspects</td>
<td>Learning techniques</td>
<td>5 (7.7%)</td>
<td>An excellent training technique – a multitude of clinical situations are solved within a short period of time, which facilitates the assimilation of theoretical knowledge and practical skills. An excellent training technique – everything was understandable and clear. The learning process was very interesting and easy.</td>
</tr>
<tr>
<td></td>
<td>Learning material</td>
<td>15 (23%)</td>
<td>The algorithms and questions provided before the test help to remember the main points of this topic. Very clear and easily understandable algorithms and situations. Excellent learning material: useful algorithms and videos help to learn the correct performance of neonatal resuscitation actions. Very interesting and realistic situations help to memorize the sequence of the resuscitation actions.</td>
</tr>
<tr>
<td></td>
<td>Organization of learning</td>
<td>5 (7.7%)</td>
<td>Benevolent teachers, trying hard to help the students. I liked the fact that the teachers evaluated the training situations. I liked receiving the teacher’s evaluation when I started solving the training situation – I then realized what I should improve. Everything was well-organized – the training process was very smooth.</td>
</tr>
<tr>
<td></td>
<td>Learning outcomes</td>
<td>12 (18.6%)</td>
<td>The acquired knowledge will survive for a long time. This is very useful – this gives the opportunity to orient oneself in the situation and to do everything correctly.</td>
</tr>
<tr>
<td></td>
<td>Overall positive subject-related and emotional experience</td>
<td>28 (43%)</td>
<td>Everything is awesome.</td>
</tr>
<tr>
<td>2. Negative aspects</td>
<td>Learning techniques</td>
<td>10 (15.5%)</td>
<td>It would be nice to have live presentations of the resuscitation actions. Neonatal resuscitation is highly important, and thus it should not be learned independently.</td>
</tr>
<tr>
<td></td>
<td>Learning material</td>
<td>12 (14.1%)</td>
<td>The algorithms overlap, and eventually one does not know which actions and for how many times should be repeated.</td>
</tr>
<tr>
<td></td>
<td>Organization of learning</td>
<td>3 (4.5%)</td>
<td>The initial neonatal resuscitation is given too much time. Technical problems prevented me from viewing the video material.</td>
</tr>
<tr>
<td></td>
<td>Training aids</td>
<td>3 (4.5%)</td>
<td>Effective blows are difficult to ensure.</td>
</tr>
<tr>
<td></td>
<td>Evaluation of the control situation</td>
<td>1 (1.5%)</td>
<td>I had my evaluation score lowered because I commented on my actions, and thus the resuscitation took more time.</td>
</tr>
<tr>
<td>3. Areas of improvement</td>
<td></td>
<td></td>
<td>Other practical classes in Neonatology should also employ the HybridLab technique.</td>
</tr>
<tr>
<td>4. Unlikely theoretical or practical questions</td>
<td></td>
<td></td>
<td>Should blows and chest compressions be coordinated during neonatal resuscitation? Why is cardiac activity not checked with a stethoscope? Why do we have to evaluate if the chest is rising during mouth-to-mouth artificial respiration?</td>
</tr>
<tr>
<td>5. No opinion</td>
<td></td>
<td></td>
<td>No remarks or comments.</td>
</tr>
<tr>
<td>6. Neutral experience</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Declarations

The author has declared that there are no conflicts of interest.

This has been published under Creative Commons "CC BY 4.0" (https://creativecommons.org/licenses/by-sa/4.0/)

AMEE MedEdPublish: rapid, post-publication, peer-reviewed papers on healthcare professions’ education. For more information please visit www.mededpublish.org or contact mededpublish@dundee.ac.uk.