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MODERN EDUCATIONAL TECHNOLOGIES AS A MEANS OF INCREASING THE QUALITY OF MEDICAL STUDENTS' KNOWLEDGE ABOUT NOSOCOMIAL INFECTIONS

Elmira Kultanova[1], Anar Turmukhambetova[1], Yasminur Turdybekova[1], Karina Nukeshtayeva[1]

NCJSC «Karaganda Medical University», Karaganda city, the Republic of Kazakhstan.

Abstract

Inroduction: Multimedia learning occurs when the learner constructs a mental representation from the words and pictures that have been presented to him. The purpose of this study was to test the applicability of the proposed principles of multimedia learning to presentations to 2nd and 5th year medical students.

Methods: This study is a randomized trial conducted to compare the effect of educational interventions in raising medical students' awareness of infection control. The presentation and training video were developed by the researcher using WHO and CDC guidelines, as well as the results of their research.

Results: 180 students of the 2nd and 5th years of study of Karaganda Medical University were selected for the study. The basic test to determine the level of proficiency in activities aimed at preventing nosocomial infections showed satisfactory results. The introduction of the educational intervention showed an improvement in the overall mean score from 11.89 (2.6) points to 14.56 (2.23) points. The study groups showed statistically significant improvements in knowledge after educational intervention regardless of its type

Conclusion: Our study showed the effectiveness of the use of multimedia technologies in terms of raising students' awareness of the burden and standards of prevention of nosocomial infections among medical students. The introduction of the animated content we created made it possible to draw the attention of students to the burden of nosocomial infections and to motivate them to study the epidemiology of nosocomial infections and preventive measures.

Keywords: *multimedia learning, nosocomial infections, medical education.*

Резюме

СОВРЕМЕННЫЕ ОБРАЗОВАТЕЛЬНЫЕ ТЕХНОЛОГИИ КАК СРЕДСТВО ПОВЫШЕНИЯ КАЧЕСТВА ЗНАНИЙ СТУДЕНТОВ-МЕДИКОВ О ВНУТРИБОЛЬНИЧНЫХ ИНФЕКЦИЯХ

Эльмира Б. Култанова[1], Анар А. Турмухамбетова[1], Ясминур Г. Турдыбекова[1], Карина Е. Нукештаева[1]

НАО «Медицинский университет Караганда», г. Караганда, Республика Казахстан.

Введение: Мультимедийное обучение – это образовательный процесс, когда учащийся конструирует мысленное представление из слов и картинок, которые были ему представлены.

Целью данного исследования было проверить применимость предложенных принципов мультимедийного обучения к презентациям для студентов-медиков 2-го и 5-го курсов.

Методы: Это исследование представляет собой рандомизированное исследование, проведенное для сравнения влияния образовательных мероприятий на повышение осведомленности студентов-медиков об инфекционном контроле. Презентация и обучающее видео были разработаны исследователем с использованием рекомендаций ВОЗ и CDC, а также результатов их исследований.

Результаты: для исследования были отобраны 180 студентов 2 и 5 курсов Карагандинского медицинского университета. Базовый тест на определение уровня владения деятельностью по профилактике внутрибольничных инфекций показал удовлетворительные результаты. Внедрение образовательного вмешательства показало улучшение общего среднего балла с 11,89 (2,6) балла до 14,56 (2,23) балла. В исследуемых группах выявлено статистически значимое улучшение знаний после образовательного вмешательства вне зависимости от его вида.

Вывод: Наше исследование показало эффективность использования мультимедийных технологий в плане повышения информированности студентов о бремени и стандартах профилактики внутрибольничных инфекций среди студентов-медиков. Внедрение созданного нами анимационного контента позволило привлечь внимание студентов к бремени внутрибольничных инфекций и мотивировать их на изучение эпидемиологии внутрибольничных инфекций и мер профилактики.

Ключевые слова: *мультимедийное обучение, внутрибольничные инфекции, медицинское образование.*

Түйіндеме

ЗАМАНАУИ БІЛІМДІЛІК ТЕХНОЛОГИЯСЫ АУРУХАНА ІШІЛІК ИНФЕКЦИЯ ТУРАЛЫ МЕДИК-СТУДЕНТТЕРДІҢ БІЛІМ ДЕҢГЕЙІН ЖОҒАРЫЛАТУ ӘДІСІ РЕТІНДЕ

Эльмира Б. Култанова[1], Анар А. Турмухамбетова[1], Ясминур Г. Турдыбекова[1], Карина Е. Нукештаева[1]

"Қарағанды медицина университеті" КЕАҚ, Қарағанды қ., Қазақстан Республикасы.

Кіріспе: Мультимедиялық оқыту – бұл оқушы өзіне берілген сөздер мен суреттерден ойша бейнені құрастыратын білім беру процесі. Бұл зерттеудің мақсаты 2 және 5 курс медицина студенттеріне арналған презентацияларға мультимедиялық оқытудың ұсынылған принциптерін қолдану мүмкіндігін тексеру болды.

Әдістері: Бұл зерттеу медициналық студенттердің инфекциялық бақылау туралы хабардарлығын арттыруға білім беру шараларының әсерін салыстыру үшін жүргізілген рандомизацияланған сынақ болып табылады. Презентация мен нұсқаулық бейнені зерттеуші ДДҰ мен CDC ұсыныстарын және олардың зерттеу нәтижелерін пайдалана отырып әзірледі.

Нәтижелері: Зерттеуге Қарағанды медицина университетінің 2 және 5 курстарының 180 студенті таңдалды. Ауруханаішілік инфекциялардың алдын алу бойынша біліктілік деңгейін анықтауға арналған базалық тест қанағаттанарлық нәтиже көрсетті. Білім беру интервенциясын енгізу жалпы орташа баллдың 11,89 (2,6) баллдан 14,56 (2,23) баллға дейін жақсарғанын көрсетті. Зерттеу топтарында білімнің статистикалық маңызды жақсаруы білім беру араласудан кейін оның түріне қарамастан анықталды.

Қорытынды: Біздің зерттеуіміз медицина факультетінің студенттері арасында ауруханаішілік инфекциялардың алдын алудың ауыртпалығы мен стандарттары туралы студенттердің хабардарлығын арттыруда мультимедиялық технологияларды қолданудың тиімділігін көрсетті. Біз жасаған анимациялық контентті енгізу студенттердің назарын ауруханаішілік инфекциялардың ауыртпалығына аударуға және оларды ауруханаішілік инфекциялардың эпидемиологиясын және алдын алу шараларын зерттеуге ынталандыруға мүмкіндік берді.

Негізгі сөздер: *мультимедиялық білім беру, ауруханаішілік инфекциялар, медициналық білім.*

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Introduction

Multimedia learning occurs when the learner constructs a mental representation from the words and pictures that have been presented to him. For the purposes of the research program, multimedia learning messages are presentations of material using words and images that are intended to facilitate learning [1]. Images can be static graphics such as photographs, pictures, maps, charts, figures and tables, or dynamic graphics such as videos or animations [2].

The use of modern information technologies in the educational process improves the quality of student learning, helps future doctors and nurses to be better prepared for clinical practice and facilitates the work of teachers [3]. Lectures are made more informative by displaying images, video, animation and sound [4].

In previous studies, various educational strategies have been used to achieve the assimilation of the material and the quality of the curricula [5]. The most common educational interventions were lectures, video lectures, posters, questionnaires, and bulletins, as well as practical demonstrations and self-study modules with pre-tests and post-tests. The use of multimedia technologies in the field of medical education is gaining momentum every year. One example is the joint curriculum developed by the Stanford University School of Medicine and Khan Academy using videos. It should be noted that video-learning has shown many potential advantages over traditional lectures. Thanks to multimedia technologies, the assimilation and memorization of the material is achieved up to 40-50%, in contrast to traditional lectures and video presentations (from 10 to 30%). Despite the skills, knowledge and physical presence of the lecturer, the well-structured construction of the video shows effective assimilation of the material. A well-designed video allows the student to view and absorb the material based on their own learning needs. [6].

A study by Dongsong Zhang et al showed that students achieve high test scores when using video content in e-learning. A number of other studies have also shown that the overall learning outcome of e-learning with instructional video is either equal to or better than traditional learning [7].

The use of video teaching could improve the current curriculum in medical universities. According to Akgul Ahmet's systematic review, multimedia technologies have proven to be a predominantly effective method in surgical education [8]. The use of which before surgery can reduce the duration of training and improve patient safety. The introduction of the INVEST curriculum into daily practice has shown that video, combined with traditional education, significantly improved skills development at an early stage of training for laparoscopic cholecystectomy.

Teacher development curricula should introduce teachers to the principles of multimedia learning and the theory of cognitive load in order to increase their awareness of these principles and discourage overuse of the standard template. Emphasis on understanding the cognitive process of multimedia learning, rather than simply following certain design rules, is key. This process is especially relevant in medical education, since a significant part of medical education takes place through various multimedia formats such as didactic lectures, small group sessions and web modules, among other applications [9].

Nosocomial infections cause 5,000 deaths each year and are one of the most dangerous occupational hazards [10]. Many studies note the important role of an effective surveillance system in controlling the spread of nosocomial infections which in turn can be achieved by increasing literacy, knowledge and awareness of nosocomial infections among medical students [11,12].

Aim of this study was to test the applicability of the proposed principles of multimedia learning to presentations to 2nd and 5th year medical students. Specifically, this study was designed to address the following research question: Does an animated lecture result in increased learning for medical students? We hypothesized that animated lectures would result in increased knowledge transfer in medical students compared to teaching delivered using traditional design.

Materials and Methods

The third stage of the study was devoted to assessing the impact of multimedia technologies on the level of students' awareness. This phase of the study is a randomized trial conducted to compare the effect of educational interventions in raising medical students' awareness of infection control. The object of the study was students of the Russian department of the 2nd and 5th years of study of the Faculty of General Medicine and Dentistry, specialty "General Medicine" of the Medical University of Karaganda (180 people).

The students were divided into 3 groups: the first group of students attended a video lecture, the second group - a traditional lecture (PowerPoint presentation) and the third - a video and a traditional lecture. The presentation and training video were developed by the researcher (certificate of state registration of rights to the object of copyright No. 2701 dated August 23, 2018) using WHO and CDC guidelines, as well as the results of their research [13,14].

The PowerPoint presentation and the instructional video contained identical educational content. The video lecture was created in flat design format using Adobe CC 2018 products (Adobe System Incorporated, California, USA). The characters and details of the video were self-produced in Adobe Photoshop CC and Adobe Illustrator CC. Character animation and short video creation was done using Adobe Character Animator CC and Adobe After Effects CC. The voice content was audited using Adobe Audition CC. The duration of the video is 3 minutes, the voice acting language is Russian. The main character of the training video is shown in the screenshot in Figure 1. The slides used in the traditional lecture were prepared using Microsoft Office software (Microsoft PowerPoint version 16).

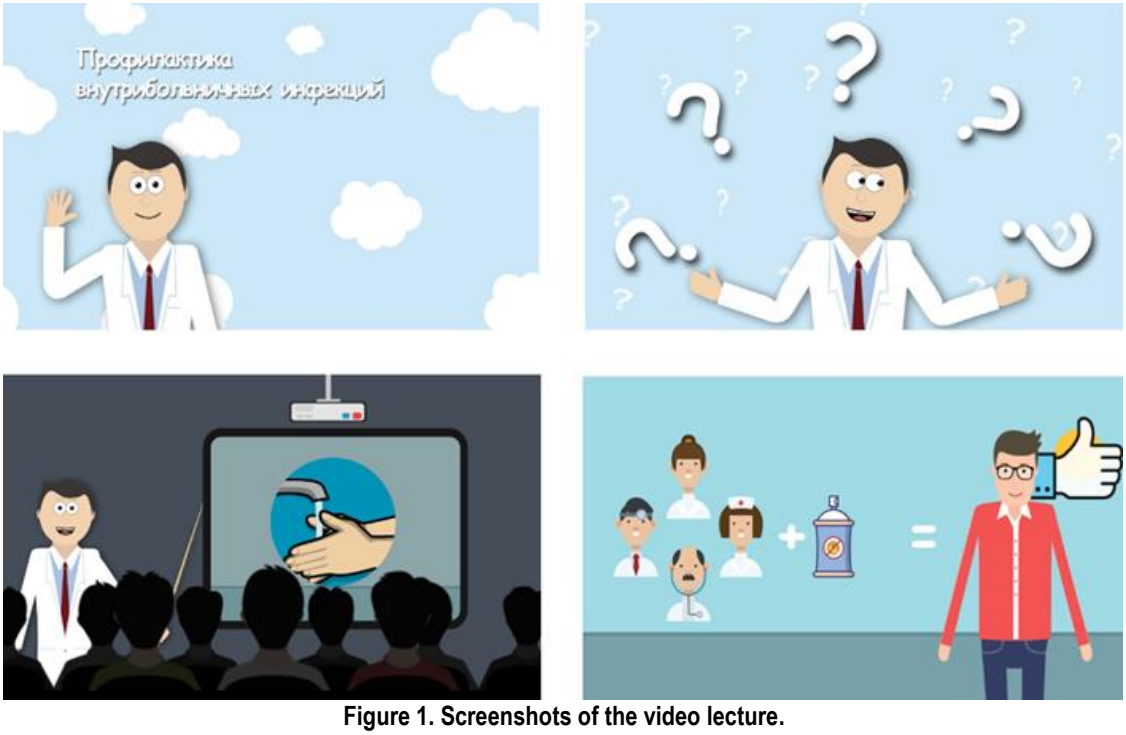

Figure 1. Screenshots of the video lecture.

As part of the described randomized study, a survey of students was conducted. As an assessment of the level of awareness in the field of prevention of nosocomial infections, we used a standardized questionnaire developed by M. Tavolacci et al. [15]. Questions about the prevalence and mortality of nosocomial infections in France were excluded from the questionnaire. The questionnaire included 25 questions divided into 4 main parts: respondent characteristics, nosocomial infections, standard precautions, and hand hygiene. The characteristics of the respondents included data on age, gender and course of study.

Students were asked to take a preliminary test to assess the basic level of knowledge in the field of nosocomial infections before the lecture and video. For the anonymity of the participants, the questionnaires were assigned an identification number. After passing the educational events, the participants underwent repeated testing in order to assess their assimilation of the material. For each correct answer, 1 point was assigned (the maximum score is 22). Paired t-test, independent t-test, and chi-square test were used for data analysis. A p value <0.05 was considered a significance level.

Statistical analysis of the data was performed using IBM SPSS Statistics version 25 and R. (citation: R Core Team (2017)). R: language and environment for statistical computing. R Foundation for Statistics Computing, Vienna, Austria. URL https: // www .R-project.org /.)

Ethical aspects of the study. The study was approved by the Ethical Committee of Karaganda Medical University.

Each questionnaire was accompanied by a cover letter explaining the purpose of the study and asking for participation. A written informed consent form was obtained from each participant. Confidentiality and anonymity of respondents was maintained by encrypting names with codes. The study was conducted in accordance with the Declaration of Helsinki.

Results

180 students of Karaganda Medical University were selected for the study in April 2018. The study involved students of the 2nd and 5th years of study at the Faculty of General Medicine, studying in Russian. The participants were randomly distributed into 3 groups as follows: the first group listened to a video lecture, the second to a traditional lecture, and the third group listened to a traditional and video lecture (combined). Each group evenly included 60 students: 30 students of the 2nd year of study and 30 students of the 5th year of study. Participants were asked to be tested to determine the level of awareness of the preventive measures of nosocomial infections before and after the educational intervention. Only one 5th year student showed reluctance to participate in the post-test. The final analysis included 179 respondents, whose distribution was as follows: group 1 - 60 people, group 2 - 59 people, group 3 - 60 people.

Participants ranged in age from 18 to 25 years old, with a mean age (SD) of 20.99 (1.77); 62.6% were female students. The distribution by sex and age is presented in Table 17. No significant differences in gender were found in the study groups.

Table 1.

Distribution by gender and age characteristics in the studied groups.

Gender	Group 1	Group 2	Group 3	P-value
Мужчины	21 (35.0%)	27 (45.8%)	19 (31.7%)	0.253
Женщины	39 (65.0%)	32 (54.2%)	41 (68.3%)	
Возраст	20.7 (1.8)	20.8 (1.7)	21.5 (1.7)	0.017

The basic test to determine the level of proficiency in activities aimed at preventing nosocomial infections showed satisfactory results. The introduction of the educational intervention showed an improvement in the overall mean score (SD) from 11.89 (2.6) points to 14.56 (2.23) points. The study groups showed statistically significant improvements in knowledge after educational intervention, regardless of its type (Table 2). Thus, in the group using video-lecture-based learning, there was an improvement in the average awareness score from 11.65 (2.16) to 14.5 (2.47) points. A similar situation is observed in the remaining two groups.

Table 2.

Comparative characteristics of the average awareness score depending on the type of educational intervention.

Lecture type	Beforeū (SD)	After ū (SD)	p-value
Total	11.89 (2.32)	14.56 (2.23)	<0.001
Video-based lecture	11.65 (2.16)	14.50 (2.47)	<0.001
Traditional lecture	11.47 (2.14)	13.81 (1.92)	<0.001
Combined lecture	12.53 (2.51)	15.37 (2.12)	<0.001
	<0.001	<0.001	

Table 3 shows the percentage of correct answers for each question. In the study groups, there was an improvement in the level of students' awareness after the educational intervention.

In groups where video-training was applied, there was a significant increase in the proportion of correct answers in questions of risk factors, prevention standards and hand hygiene. Nine items of the questionnaire showed that video-learning is an effective teaching tool. So, for example, in paragraph 1, an increase in the proportion of correct answers from 20% to 71.7%, p<0.001, was noted. When using the video, the proportion of correct answers in paragraph 3 increased not only in the first group (from 51.7% to 86.7%, p<0.001), but also in the group where traditional and video lectures were used (from 63.3% to 90.0%, p< 0.001). Traditional lectures also showed marked improvements in age-risk factors, aspects of preventive measures and hand hygiene. With the combined use of both methods of educational intervention, the six items of the questionnaire on risk factors and prevention standards showed an improvement in the level of students' awareness. The share of correct answers in item 4 increased from 8.3% to 60.0%, p<0.001.

The main share of students has an idea about the use of medical gloves in certain cases, as a means of protection and prevention of nosocomial infections. Despite this, students showed low awareness of the use of gloves in any medical manipulations and procedures. The application of teaching methods showed an increase in the proportion of correct answers (points 11-14).

Students are quite well acquainted with personal protective equipment in case of contact with biological fluid (96.7% of students gave the correct answer on the preliminary test). However, with options that exclude one of the items of personal protective equipment, students have doubts and give an incorrect answer. When explaining this issue with video and traditional lectures, an increase in the proportion of correct answers is noted (points 15-18).

As our survey showed, students do not have the information and methods of using alcohol-based products for hygienic handwashing (points 19-22). Only in the question about traditional handwashing, correct answers were given in the group after listening to the traditional lecture (from 5.1% to 33.9%, p<0.001).

Table 3.

Proportion of correct answers stratified by educational intervention groups before and after.

Questions	Pre-test n (%)	Post-test n (%)	p-value
1	2	3	4
Block 1. Risk factors for nosocomial infections:			
Is the environment (air, water, inert surfaces) the main source of bacteria responsible for nosocomial infection?			
Video-based lecture	12 (20.0%)	43 (71.7%)	<0.001
Traditional lecture	21 (35.6%)	38 (64.4%)	<0.001
Combined lecture	26 (43.3%)	42 (70.0%)	<0.001
Do you agree with the statement that advanced or very young age increases the risk of nosocomial infections?			
Video-based lecture	32 (53.3%)	33 (55%)	1.000
Traditional lecture	26 (44.1%)	39 (66.1%)	<0.001
Combined lecture	28 (46.7%)	31 (51.7%)	0.250
Do invasive procedures increase the risk of nosocomial infection?			
Video-based lecture	31 (51.7%)	52 (86.7%)	<0.001
Traditional lecture	41 (69.5%)	42 (71.2%)	1.000
Combined lecture	38 (63.3%)	54 (90.0%)	<0.001
Block 2. Prevention standards			
Do the prevention standards include recommendations ONLY for protecting patients?			
Video-based lecture	8 (13.3%)	52 (86.7%)	<0.001
Traditional lecture	13 (22.0%)	41 (69.6%)	<0.001
Combined lecture	5 (8.3%)	36 (60.0%)	<0.001
Do prevention standards include recommendations for protecting patients and healthcare workers?			
Video-based lecture	48 (80.0%)	54 (90.0%)	0.031
Traditional lecture	28 (47.5%)	41 (69.5%)	<0.001
Combined lecture	39 (65.0%)	49 (81.7%)	0.002
Are nosocomial infection prevention measures applied to all patients?			
Video-based lecture	56 (93.3%)	56 (93.3%)	1.000
Traditional lecture	38 (64.4%)	50 (84.7%)	<0.001
Combined lecture	48 (80.0%)	59 (98.3%)	0.001
Nosocomial infection prevention measures apply ONLY to healthcare workers who come into contact with body fluids			
Video-based lecture	51 (85.0%)	53 (88.3%)	0.500
Traditional lecture	35 (59.3%)	43 (72.9%)	0.008
Combined lecture	44 (73.3%)	56 (93.3%)	<0.001
Block 3. Hand hygiene			
Hand hygiene should be performed BEFORE or AFTER patient contact			
Video-based lecture	2 (3.3%)	21 (35.0%)	<0.001
Traditional lecture	12 (20.3%)	27 (45.8%)	0.001
Combined lecture	27 (45.0%)	26 (43.3%)	1.000
Hand hygiene should be done BETWEEN patient contacts			
Video-based lecture	41 (68.3%)	44 (73.3%)	0.250
Traditional lecture	43 (72.9%)	55 (93.2%)	0.004
Combined lecture	43 (71.7%)	54 (90.0%)	0.001
Hand hygiene should be done AFTER gloves are removed.			
Video-based lecture	49 (81.7%)	51 (85.0%)	0.500
Traditional lecture	53 (89.8%)	56 (94.9%)	0.250
Combined lecture	52 (86.7%)	57 (95.0%)	0.063

Table 3. Continued.

1	2	3	4
The standards for the prevention of nosocomial infections recommend the use of gloves:			
for all procedures			
Video-based lecture	14 (23.3%)	47 (78.3%)	<0.001
Traditional lecture	21 (35.6%)	47 (79.7%)	<0.001
Combined lecture	7 (11.7%)	52 (86.7%)	<0.001
if there is a risk of contact with biological fluid			
Video-based lecture	52 (86.7%)	57 (95.0%)	0.063
Traditional lecture	54 (91.5%)	56 (94.9%)	0.727
Combined lecture	49 (81.7%)	53 (8830%)	0.125
if there is a risk of cutting the skin:			
Video-based lecture	54 (90.0%)	59 (98.3%)	0.063
Traditional lecture	47 (79.7%)	55 (93.2%)	0.077
Combined lecture	58 (96.7%)	60 (100.0%)	
when healthcare workers have skin lesions			
Video-based lecture	55 (91.7%)	55 (91.7%)	1.000
Traditional lecture	50 (84.7%)	44 (74.6%)	0.263
Combined lecture	56 (93.3%)	58 (96.7%)	0.500
If there is a risk of contact with biological fluid, medical workers are required to use:			
mask, goggles and medical gown			
Video-based lecture	58 (96.7%)	58 (96.7%)	1.000
Traditional lecture	54 (91.5%)	54 (91.5%)	1.000
Combined lecture	41 (68.3%)	53 (88.3%)	0.016
mask and goggles			
Video-based lecture	14 (23.3%)	33 (55.0%)	<0.001
Traditional lecture	7 (11.0%)	27 (45.8%)	<0.001
Combined lecture	38 (63.3%)	45 (75.0%)	<0.001
goggles and medical gown			
Video-based lecture	16 (26.7%)	33 (55.0%)	<0.001
Traditional lecture	9 (15.3%)	21 (35.6%)	<0.001
Combined lecture	46 (60.0%)	48 (80.0%)	<0.001
medical gown and mask			
Video-based lecture	6 (10.0%)	26 (43.3%)	<0.001
Traditional lecture	8 (13.6%)	8 (13.6%)	1.000
Combined lecture	34 (56.7%)	39 (65.0%)	0.063
What are the indications for the use of alcohol-based hand rubs (on untreated hands)?			
instead of traditional hand washing (30s)			
Video-based lecture	34 (56.7%)	45 (75.0%)	1.000
Traditional lecture	42 (71.2%)	39 (66.1%)	0.0375
Combined lecture	33 (55.0%)	41 (68.3%)	0.008
instead of antiseptic hand washing (1.5 min):			
Video-based lecture	36 (60.0%)	31 (51.7%)	0.063
Traditional lecture	49 (83.1%)	40 (67.8%)	0.004
Combined lecture	10 (66.7%)	15 (68.3%)	0.063
instead of surgical hand washing (3min):			
Video-based lecture	32 (53.3%)	33 (55.0%)	1.000
Traditional lecture	45 (76.3%)	46 (78.0%)	1.000
Combined lecture	40 (41.7%)	25 (41.7%)	1.000
Traditional handwashing should be done before handwashing with alcohol-based products:			
Video-based lecture	9 (15.0%)	11 (18.3%)	0.500
Traditional lecture	3 (5.1%)	20 (33.9%)	<0.001
Combined lecture	25 (41.7%)	25 (41.7%)	1.000

Discussion

Our study showed the effectiveness of the use of multimedia technologies in terms of raising students' awareness of the burden and standards of prevention of nosocomial infections among medical students. The introduction of the animated content we created made it possible to draw the attention of students to the burden of nosocomial infections and to motivate them to study the epidemiology of nosocomial infections and preventive measures.

Despite the effectiveness of the use of multimedia technologies in education, some studies report mixed

results of its application [16–19]. It should be noted that H.H. Chuang and M.H. Rosenbusch stressed the importance of pedagogy for an effective video learning experience [20]. The authors noted that the use of only videos without a pedagogical approach does not make sense.

Based on the results of previous studies, it can be assumed that additional training based on multimedia technologies has a beneficial effect on the duration of training, the acquisition of surgical skills and trainee satisfaction. As an improvement and addition to our video, we recommend the introduction of scenes and processes that will improve the skills of students in the field of hand hygiene.

The development of curricula and the use of educational technologies should be guided using multimedia technology in medical education. Teachers can use existing videos or create their own. Such a strategy, the inclusion of interactive elements, can contribute to the active participation of students in learning. However, a balance in the use of multimedia technologies should be considered to avoid cognitive overload.

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Контактная информация:

Култанова Эльмира Берикбаевна, докторант Ph.D по специальности «Общественное здравоохранение» НАО «Медицинский университет Караганда», г. Караганда, Республика Казахстан.

Почтовый адрес: Республика Казахстан, 100008. г. Караганда, ул. Гоголя 40

Телефон: +77007777356,

e-mail: Kultanova@qmu.kz