The EYESI Simulator for Training Ophthalmology Residents

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Abstract: *Purpose*: To assess various aspects of integrating a virtual reality (VR) simulator in training ophthalmology residents. *Methods*: Both quantitative and qualitative approaches were employed in this study and some aspects of the VR EYESI simulator as a health technology and training method were assessed. Data was collected by a multiple-choice questionnaire that was filled by 19 novice residents and 4 fellowship candidates who were training at the ophthalmology department of Shahid Beheshti Medical University. In addition, six deep interviews were performed with the stakeholders and instructors of simulator training program at Labbafinejad Medical Center, Iran. Main outcome measurements were face and content validity as a score out of 100. *Results*: The ophthalmology residents gave a mean and standard deviation score of 71.36± 14.98 for face validity and 70.00± 18.95 for content validity and the fellowship candidates gave face and content score validity of 50.00±22.36 and 71.58%±22.66%, respectively. Residency instructors and authorities believed that the VR EYESI simulator reduces the time and improves the quality of training. They also stated that residents who were trained with the simulator were adequately prepared for entering the operating theatre and showed better eye-hand coordination and harmonization. All stakeholders strongly believed that simulation is a necessary method of education. *Conclusion*: The EYESI simulator is a virtual reality medium that enjoys acceptable face and content validity. It is also an effective method of training since it decreased the time and improved the quality of training.

Keywords: Residency Training, Phacoemulsification, Virtual System.

INTRODUCTION

Training of surgeons through apprenticeship was founded more than a century ago [1]. During training, ophthalmology residents face a variety of clinical conditions and gradually acquire required clinical experience through integrating theoretical knowledge, practical skills and clinical judgment. However, various factors such as reduction of number of open surgeries, advances in computer assisted surgical technologies and increasing patient expectations have changed the traditional methods of training [2].

Using virtual simulators is one of the new methods employed in training medical residents. Although the application of simulators for training enjoys a long precedence, for instance complex flight simulators which have been used in training pilots over half a century, their use in medical training is a relatively new phenomenon [3].

The simulator encompasses a broader concept. According to Krummel, a simulator is a means or an exercise that enables the participant experience a phenomenon occurring in real conditions under controlled ones [4]. Based on this definition, simulators fall into three groups, tissues and organs procured from artificial and inanimate materials, animate tissue or animal model, and virtual reality and computer-based simulators.

Considering the lack of adequate experience in modern training technologies, and the importance of evaluation as the main part of any educational program, this study has been carried out to analyze the implementation of a simulator-based training program in a main academic and referral eye hospital in Iran.

METHODS

This study was conducted as a part of a Health Technology Assessment (HTA) to analyze the effectiveness and efficacy of EYESI simulator (Cataract Training Modules, VRmagic Company, Mannheim, Germany) on training and its technical and organizational aspects. The research has been carried out at Labbafinejad Medical Centre which is an academic and tertiary eye hospital in Tehran.

The study was approved by the Ethics Committee of Shahid Beheshti University of Medical Sciences and was conducted by Ophthalmic Research Center, which is an independent organization from the training and managerial department of the hospital and accordingly the researchers had no conflict of interest.

The members of ophthalmology department of Shahid Beheshti University of Medical Sciences were considered as the main stakeholders of simulator-based training modules. Over 60 university faculties,

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residents and fellowship candidates, administrators and planners of residency programs worked in this department. Among them, all year 2 and 3 ophthalmology residents (21 persons), and all anterior-segment fellowship candidates (4 persons) entered the study. In addition, 6 university faculties who were in charge of residency training programs also entered the study.

Different checklists were used to collect data from various target groups. MEDLINE, Scopus and Cochran online resources were searched to find similar questionnaires. For residency and fellowship candidates, self-administered and multiple-choice questionnaires were developed by an expert panel. Face and content validity of the EYESI simulator was assessed by the questions presented in Table **1** to **4** from trainees' perspective. Technical characteristics of the simulator were determined as the face validity (Tables **1**, **2**) and the efficacy and practical aspects were considered as content validity (Tables **3** and **4**) of the simulator. All questions had 3 predefined Likert scale response options, week, intermediate and good. Ordinal scores of 0, 10, and 20 were applied to above scales respectively to calculate the total score of each item. The scores were converted to percentages so that the highest possible score was 100. Then, total score was presented by mean, standard deviation, median and inter quartile range of item scores.

In addition, six deep interviews about the technical and operational dimensions and efficacy of the simulator in training ophthalmology residents was performed with managers and responsible faculties of residency programs and a semi-structured question-naire was filled based on their point of view by a trained interviewer. The interviews were subjected to a content analysis including record, organization perusal, and classification phases.

Table 1: Face Validity of EYESI Simulator Based on the Resident Opinion

Technical aspects	Residents' responses			Validity scores[§]	
	Week	Intermediate	Good	n	%
Unit Pedal	-	6 (31.6%)	13 (68.4%)	320	82.05
Microscope	-	4 (21.1%)	15 (78.9%)	340	87.18
Three – Dimensional View	-	7 (36.8 %)	12 (63.2%)	310	79.49
Capsulorrhexis Module	3 (15.8%)	7 (36.8 %)	9 (47.4%)	250	64.10
Divide And Conquer Module	4 (21.1%)	8 (41.1%)	5 (26.3%)	180	46.15
Forceps Practices	1 (5.3%)	5 (26.3%)	11 (57.9%)	270	69.23
Total scores	mean ± standard deviation: 71.36± 14.98 median (Inter-quartile range): 74.36 (59.61- 83.33)				

[§]Scoring criteria: Week =0, Intermediate =10, Good =20; Scoring percentages: (score amount/highest possible score)*100
The highest possible score would be 380 if all 19 residents scored "Good" to an item

Table 2: Face Validity of the EYESI Simulator Based on the Fellows' Opinions

Technical aspects	Fellows' responses			Validity scores[§]	
	Week	Intermediate	Good	n	%
Unit Pedal	-	3 (75%)	1 (25%)	50	62.5
Microscope	1 (25%)	-	3 (75%)	70	87.5
Three – Dimensional View	1 (25%)	3 (75%)	-	30	37.5
Capsulorrhexis Module	3 (75%)	-	1 (25%)	20	25.0
Divide and Conquer Module	-	4 (100%)	-	40	50.0
Forceps Practices	1 (25%)	3 (75%)	-	30	37.5
Total	mean ± standard deviation:50.00±22.36 median (Inter-quartile range): 43.75 (34.37-68.75)				

[§]Scoring criteria: Week =0, Intermediate =10, Good =20; Scoring percentages: (score amount/highest possible score)*100
The highest possible score would be 80 if all 4 fellows scored "Good" to an item

Table 3: EYESI Simulator's Content Validity Based on the Fellows' Opinions

Content validity items	Fellows' responses			Validity scores[§]	
	Week	Intermediate	Good	n	%
General satisfaction	-	3 (75%)	1 (25%)	50	62.5
How much simulator is useful for training ophthalmologic residents?	-	3 (75%)	1 (25%)	50	62.5
Is practice on simulator better than practice on animal model?	-	4 (100%)	-	40	50
Do you agree that simulator should be used for training of other eye surgeries?		-	-4 (100%)	80	100
Is it appropriate to identify a passing score in working with simulator before starting real eye surgery?	1 (25%)	-	3 (75%)	60	75
Total	mean ± standard deviation: 71.58%±22.66% median (Inter-quartile range): 76.32 (52.62-88.16)				

[§]Scoring criteria: Week =0, Intermediate =10, Good =20; Scoring percentages: (score amount/highest possible score)*100
The highest possible score would be 80 if all 4 fellows scored "Good" to an item

Table 4: EYESI Simulator's Content Validity Based on the Residents' Opinions

Content validity items	Residents' responses			Validity scores[§]	
	Week	Intermediate	Good	n	%
General satisfaction	2 (10.5%)	5 (26.3%)	12 (63.2%)	290	76.32
How much simulator is useful for training ophthalmologic residents?	-	7 (36.8 %)	12 (63.2%)	310	81.58
Is practice on simulator better than practice on animal model?	4 (21.1%)	3 (15.8%)	12 (63.2%)	270	71.05
Do you agree that simulator should be used for training of other eye surgeries?	-	2 (10.5%)	17 (89.5%)	360	94.74
Is it appropriate to identify a passing score in working with simulator before starting real eye surgery?	12 (63.2%)	1 (5.3%)	6 (31.6%)	130	34.21
Total	mean ± standard deviation: 70.00%± 18.95% median (Inter-quartile range): 62.5 (52.62-87.5)				

[§]Scoring criteria: Week =0, Intermediate =10, Good =20; Scoring percentages: (score amount/highest possible score)*100
The highest possible score would be 380 if all 19 residents scored "Good" to an item

Table 5: Outcomes of Simulator – Based Training According to Opinions of Ophthalmologic Training Instructors in Labbafinejad Medical Center

• Improving patients safety
• Reducing training time
• Improving training quality
• Improving resident orientation to the operating room environment
• Eye- foot-hand coordination and harmonization
• Turning knowledge into skill

RESULTS

Out of 21 residents with two or three years of work experience, 19 residents filled out the related questionnaire (response rate = 90.47%), among which 11 individuals (57.9%) were at second year and 8 individuals (42.1%) were at third year of residency. Overall, 13 male (68.4%) and 6 female (31.6%) residents participated in the study.

The face validity scores are presented in Tables **1** and **2**. Most of the residents scored different face validity aspects like unit pedal, microscope adjustment, three – dimensional view, the exercises provided with

forceps as completely or partially desirable. However, more complex tasks like “divide and conquer” and “capsulorhexis” modules received lower scores. Compared to residents, the fellows gave lower scores to all items of face validity with lowest being capsulorrhexis.

Tables **3** and **4** illustrate the content validity scores. The fellowships candidates gave higher scores to content validity compared to face validity of the simulator (71.58%±22.66% *vs*. 50.00±22.36) and their scores were quite similar to content validity scores given by the ophthalmology residents (70.00%± 18.95%). Most fellows believed that working with simulator could be useful for initial familiarity of the novice residents with ophthalmic surgery and preparing them to enter a real operating room.

In addition, 6 university faculties who were involved in residency training programs were interviewed. The majority of the interviewed instructors (5 out of 6) stated that the simulator would reduce time of training and improve quality. The instructors believed the residents who had been trained with simulator obtained adequate skills before entering the operation room. It became evident, too, that the hand – eye coordination, and hand-foot coordination improved during operation with ensuing reduced complications. Finally, the instructors and managers were asked about the objectives of simulator- based training method and their scores are shown in table 5 in order of importance.

DISCUSSIONS

The quality of services delivered to patients depends chiefly on the surgeon's skill in performing medical interventions. Furthermore, acquiring practical skills is an essential component of most medical specialties such as interventional cardiology, gastroenterology and radiology. With increasing complexity of medical interventions, “learning through watching” seems to be no longer the best training method. Thus, the virtual simulators for surgery have been highly noted by those involved with the surgical training.

Before successful application of simulators, their validity should be confirmed [5-8]. Validity can be evaluated by subjective or objective tools [5, 8-10]. In subjective methods, judgment of novice and experienced surgeons are recorded in a questionnaire and face and content validity of the simulator would be measured.

In this study, face and content validity of EYESI Simulator have been measured subjectively. According to the resident opinions, the simulators face and content validity was more than 70 out of 100 scores and fellowship candidates also ranked content validity more than 70%. Nevertheless, face validity scores were significantly lower and only half of the ophthalmic fellows believed that the face validity is desirable and close to real condition. In a similar study in this field, [11], all participants believed that ESESI simulator had a good structure and its pedal and microscope were completely appropriate. In our study, the majority of ophthalmic residents and fellows (>70%) believed that it is easy to work with the simulator microscope, however, other aspects including capsulorhexis module got lower scores both by residents and fellowship candidates. In our study, anterior segment fellows had been trained in cataract surgery before being familiar with EYESI simulator. Therefore, it is possible as they had the experience of real surgical environment, they gave lower scores to face validity items compared to the residents in our study who were first trained by the simulator before entering the operating room. This is similar to the participant of Ong's study who also considered EYESI to be close to the real situation. In the current study, only 26% of residents considered the “divide and conquer” module real, and all fellows relatively believed it is real. In Ong's study only 33% of participants stated this module was close to real situation. Therefore, it is suggested that some aspects of face validity including ‘divide and conquer‘ can be improved to simulate the real surgical environment in different clinical settings.

Some other studies have attempted to assess the efficacy of simulators in improving the training efficiency and performance. Solverson *et al.* compared experienced surgeons speed with that of the residents trained by EYESI simulator and realized that working with simulator could improve the residents' hand skills considerably and regularly [12].

Feudner revealed that the quality of capsulorrhexis in pig eye models was significantly better in residents who were trained with simulator than the residents trained with traditional methods (P= 0.001) [13].

Folgar compared the results of cataract surgery by the residents who had been trained by EYESI simulator with those who were trained using theoretical methods and wet lab. The researchers concluded that in the residents trained with simulator, the time of surgery, ultrasound time and energy reduction rate are smaller

and they relied less on the instructor's interventions during surgery [14]. In the current study, most instructors believed that the simulator could increase the resident's readiness for entering the operating room.

Although simulator-based surgery has been widely favored, many instructors have little experience in dealing with this new training method. In addition, there are different aspects including financial and logistic issues, simulator content, innovation of simulators, validity and reliability concepts, instruments and guidelines that are not fully addressed and open to the instructors yet [15], In addition, introduction of any new technology may bring about some criticisms.

In a study on experienced surgeons and residents, both groups accepted simulator as an appropriate and efficient training procedure [16]. In our study, 75% of fellows believed that EYESI simulator could be appropriate for training the residents and all recommended similar software for other ophthalmic surgeries.

Three main steps for designing a simulator – based teaching program have been mentioned including training needs analysis, training progress design and training media specification [17, 18]. The results of the current study can be used to evaluate some aspects of these three steps; however, it is recommended to study more aspects of simulators objectively in future.

Our study had some limitation too; only subjective methods were employed to identify the validity and efficacy of simulator and only cataract surgery module was assessed in this study. Since it was a new technology in our setting and applied to all new residents, there were no residents trained with simulator having done adequate number of phaco operations to record and compare the complications of cataract surgery and surgical skills between those trained with EYESI simulator and those who entered operating room without similar training module. Thus, we attempted to determine the content validity with regard to the opinions of residents, instructors and fellowship candidates that had different skill levels and encounter this method of training in different stages of their specialty period.

Finally, it is necessary to point out that design of a training program is complex and requires a multidisciplinary research and consultation [19, 20] cooperation between ophthalmologists, residents and training specialists could lead to the design of a dynamic training program responsive to training and organizations needs.

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