

## Original Article

# Exploration of standardized clinical skills instruction video based on QR code management in clinical hospital teaching

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**Abstract:** Objective: To explore the application effect of standardized clinical skills instruction video based on QR code management in clinical teaching to promote the information reform and innovation of clinical teaching and seek a new practice method with a higher teaching efficiency. Methods: A total of 150 clinical, medical-technical, and nursing interns who completed their internship in our hospital by June 2021 after being enrolled in 2020 were assigned to the experimental group, and 84 interns who completed their internship by June 2020 after being recruited in 2019 were retrospectively included in the control group. The experimental group received standardized clinical skills instruction videos based on QR code management to clinical teaching, while the control group was given the traditional teaching method. The costs of teaching models, materials management, and human resources in the clinical skills center that were eventually consumed by the two groups were counted, and the satisfaction of the interns and teachers towards teaching activities was investigated by a satisfaction questionnaire. In addition, the scores of the final exam of internship skills and the pass rate of the enrollment skill exam for residency training were compared between the two groups. Results: After the application of standardized clinical skills instruction videos based on QR code management to clinical teaching, the cost of running the clinical skills center was significantly reduced (\$800 vs. \$10,000), and the intern trainees ( $\chi^2=10.088$ ,  $P=0.0064$ ) and teachers ( $\chi^2=6.1138$ ,  $P=0.0470$ ) who received these videos expressed higher satisfaction than those given the traditional teaching model, with better performance on the final exam of internship skills ( $t=11.952$ ,  $P=0.0000$ ) and a higher pass rate of the enrollment skills exam for residency training ( $\chi^2=6.402$ ,  $P=0.0114$ ). Conclusion: The standardized clinical skills instruction video based on QR code management can realize the synchronization of classroom teaching and network teaching and the decentralized network-independent learning, which promotes the information reform and innovation of clinical hospital teaching based on the integration of multimedia teaching and network learning and provides a novel practice method with a higher effect for clinical hospital teaching.

**Keywords:** QR code, clinical teaching, medical education, standardized clinical skills, teaching video, information reform

## Introduction

Clinical internship is the most important stage for medical students in their study career, which enables them to integrate theoretical knowledge with clinical practice and initially develop their own clinical thinking patterns [1]. With the revolution and innovation of information technology, resources such as CD-ROMs have been introduced into teaching to bridge the gap between traditional teaching models and modern education, which, however, fail to

be extensively accepted due to their inherent limitations [2]. Hence, QR code technology is considered as a new solution to the aforementioned problem. The standardized clinical skills instruction video based on QR code management can arouse the interest of interns in learning, with its novelty in clinical teaching, under which the fragmented learning approach allows interns to make full use of time and develop independent learning and ultimately improves clinical teaching effectiveness [3, 4]. Standardized clinical skills instruction video based on

## Standardized clinical skills instruction video in clinical hospital teaching

QR code management is to collect and upload the standardized clinical skills teaching video content, teaching webinar, manikin use and others recorded by the clinical skills center, and generate the corresponding QR code. Interns need to scan the QR code, complete the required video course hours, and arrange an appointment with the clinical skills center for simulated practice and examination. With the popularization of network coverage and intelligent technology, QR code has been extensively applied in fields including chronic disease nursing and medical teaching, and delivered fruitful results. However, the application of standardized clinical skill teaching video has not been reported. Accordingly, to promote the reform and innovation of clinical hospital teaching and explore a new practice method to improve the teaching effect, this study adopted the standardized clinical skills instruction video based on QR code management for interns and achieved remarkable results.

### Materials and methods

#### *General information*

A total of 150 clinical, medical-technical, and nursing interns who completed their internship in our hospital by June 2021 after being enrolled in 2020 were assigned to the experimental group, and 84 interns who completed their internship by June 2020 after being recruited in 2019 were retrospectively included in the control group.

#### *Inclusion and exclusion criteria*

The inclusion criteria: (1) Fresh intern trainees who officially registered in our institute for internship and abided by our internship rules and regulations; (2) those who could use cell phone training software skillfully with their smartphones. Exclusion criteria: (1) Those who failed to attend the final exam on time for their own reasons; (2) those who dropped out from the internship for various reasons; (3) those who seriously violated our rules and regulations on internship; (4) those who did not obey our teaching managers.

#### *Methods*

Contents such as the standardized clinical skills instruction video content and teaching

webinar recorded by the clinical skills center and the use of mannequin were uploaded to generate corresponding QR codes. The intern trainees were required to arrange and complete the required hours of video courses by scanning the QR codes and schedule their own appointments with the clinical skills center to do sufficient hours of simulation practice. The new teaching method was researched and approved by the Department of Education and Science, General Hospital of Pangang Group.

*Software support:* The identification program is developed by open API interface of “wechat public number”. The system architecture adopts the common MSSQL database +.NET language for development. The system deployment connects to Ali cloud server, which is safe and reliable, with quick and accurate response. The software contained basic instrument information, operation process and maintenance video, and my user. After loading of the edited first-aid equipment information and video link into the applet, the application software would generate a QR code on the page so that we could beautify and print the QR code graphics and seal them with a hard transparent film for the sake of convenient cleaning and prevention of damage and damp [5]. Finally, the completed QR code icon and instrument inspection register were pasted on the instrument. When the module information was updated or supplemented, red dots would appear for reminder, at which it was necessary to click to check the updated information.

*Electronic sign-in module:* With a small program of the meeting mode, new nurses filled in the name, mobile phone number, and email address to complete the registration via the registration link provided or forwarded. Hereafter, a corresponding QR code would be generated on the sign-in page for each operation training, with which the nurse could fill in the verification information within the specified time. Nurses can pass the verification and complete the sign-in only when their filled contents were the same as those filled in during registration, and then their WeChat avatar could be displayed on the screen terminal. Finally a sign-in screen would generate. The system automatically counted the check-in status, and considered repeated check-in invalid. Those whose avatars did not enter the check-in interface

## Standardized clinical skills instruction video in clinical hospital teaching

were considered late or absent. This interactive check-in method was used to increase the enthusiasm of the students and the accuracy of check-in.

### *Efficacy evaluation*

(1) After the internship, the total cost of teaching models, teaching materials, and faculty management consumed by the two groups within one year was recorded.

(2) After the internship, the satisfaction of the interns and teachers towards the teaching activities was evaluated by a satisfaction questionnaire. The questionnaire was composed of the following five dimensions: inspire the interest in learning, promote knowledge mastery, improve your problem-solving skills, arouse learning initiative, and hope the training pattern continues. Each dimension counted for 20 points, with a total score of 100 points. A higher score indicated higher satisfaction. The satisfaction was classified for three levels, including very satisfied (80-100 points), satisfied (60-100 points), and dissatisfied (<60 points).

(3) The scores of the final exam of internship skills and the pass rate of the enrollment skills exam for residency training were compared between the two groups.

(4) A self-made QR code management-based questionnaire was used to survey some selected nurses in the department to evaluate the nurses' ability. The QR code management questionnaire was composed of five dimensions, including accurate use of instruments, standardized maintenance, response to malfunction, instrument preservation, and instrument inventory. The Likert 5-point scale (5= very good, 1= very bad) was used for evaluation. A total of 150 questionnaires were distributed and collected, all of which were valid.

### *Statistical methods*

Data analysis R 3.4.3 (<https://www.r-project.org>) and R Studio 1.1.385 (<https://www.rstudio.com>) were used for statistical analysis of the obtained data. The scores of the final skills exam were continuous measurement data, expressed as mean  $\pm$  standard deviation ( $\bar{x} \pm sd$ ), and satisfaction and entrance exam pass rates were counting data, expressed as percentages (%). For the measurement data, the

paired t test was used for comparison between groups at different time points, while the two independent samples t-test was used for comparison between the two group. The t-test was used, and the chi-square ( $\chi^2$ ) test was used for the counting data, while the rank-sum test was used for the comparison of the rank data.  $P < 0.05$  indicates a statistically significant difference.

## Results

### *Comparison of the general data*

The experimental group consisted of 53 males and 97 females, aged 20-22 years, with a mean age of  $21.45 \pm 1.23$  years. The control group consisted of 32 males and 52 females, aged 19-23 years, with a mean age of  $20.43 \pm 1.13$  years. During the internship, 23 males and 45 females in the experimental group dropped out from the study, so the experimental group finally included 30 males and 52 females, aged 20-22 years, with a mean age of  $20.67 \pm 0.72$  years. After the exclusion of the withdrawn subjects, the two groups showed no significant difference in terms of general information ( $t = 1.8805$ ,  $P = 0.06211$ ).

### *Comparison of total costs*

The experimental group costed about \$800 in total in electricity, instructor's fees, equipment maintenance, materials printing, and purchase and maintenance of software, while the control group costed about \$10000 in total. The cost of the clinical skills center was significantly lower in the experimental group than that in the control group (\$800 vs. \$10,000).

### *Comparison of satisfaction*

The satisfaction of both the intern trainees and teachers in the experimental group was higher than that in the control group ( $P < 0.05$ ). See **Tables 1** and **2**. The difference was statistically significant in the overall satisfaction towards the training method between the two groups ( $Z = 1.56$ ,  $P < 0.01$ ). See **Tables 3** and **4**.

### *Comparison of scores of final exam of internship skills*

The experimental group had higher scores in the final exam of internship skills than the con-

## Standardized clinical skills instruction video in clinical hospital teaching

**Table 1.** Comparison of interns' satisfaction (cases, %)

Groups	Case (n)	Very satisfied	Satisfied	Dissatisfied	Total satisfaction rate
Experimental group	82	50 (60.98)	30 (36.59)	2* (2.44)	97.56%
Control group	84	40 (47.62)	30 (35.71)	14 (16.67)	83.33%
$\chi^2$					10.088
P-value					0.0064

\*indicates fisher exact rate.

**Table 2.** Comparison of teachers' satisfaction (cases, %)

Groups	Case (n)	Very satisfied	Satisfied	Dissatisfied	Total satisfaction rate
Experimental group	81	50 (61.73)	28 (34.57)	3* (3.70)	96.30%
Control group	81	42 (51.85)	27 (33.33)	12 (14.81)	85.19%
$\chi^2$					6.1138
P-value					0.0470

\*indicates fisher exact rate.

**Table 3.** Satisfaction of the experimental group towards the training method

Items	Vary satisfied	Satisfied	Dissatisfied
Help to improve independent learning skills	80 (97.56)	2 (2.44)	0 (0)
Help to understand and consolidate the operation process	79 (96.34)	3 (3.66)	0 (0)
Help to learn anytime and anywhere	82 (100)	0 (0)	0 (0)
Help to share learning experience	82 (100)	0 (0)	0 (0)

**Table 4.** Satisfaction of the control group towards the training method

Items	Very satisfied	Satisfied	Dissatisfied
Help to improve independent learning skills	70 (83.33)	4 (4.76)	10 (11.90)
Help to understand and consolidate the operation process	72 (85.71)	6 (7.14)	6 (7.14)
Help to learn anytime and anywhere	72 (85.71)	10 (11.90)	2 (2.38)
Help to share learning experience	70 (83.33)	10 (11.90)	4 (4.76)

**Table 5.** Comparison of the final exam of internship skills (score,  $\bar{x} \pm sd$ )

Groups	Scores	t	P-value
Experimental group	91.50 $\pm$ 2.22		
Control group	80.43 $\pm$ 8.19	11.952	0.0000

**Table 6.** Comparison of the pass rate of enrollment skills exam for residency training (n, %)

Groups	Case (n)	Passed	Failed	Pass rate
Experimental group	82	71 (86.59)	11 (13.41)	86.59%
Control group	84	59 (70.24)	25 (29.76)	70.24%
$\chi^2$				6.402
P-value				0.0114

control group (t=11.952, P=0.0000), as shown in **Table 5.**

### *Comparison of the pass rate of enrollment skills exam for residency training*

A higher pass rate of enrollment skills exam for residency training was recorded in the experimental group as compared with the control group ( $\chi^2=6.402$ , P=0.0114). See **Table 6.**

### *Comparison of instrument use and management before and after QR code application*

The evaluation results of accurate use, standardized maintenance, response to malfunction, instrument preservation, and inventory of instruments in the department were all improved after the application of QR code management (P<0.05). See **Table 7.**

## Standardized clinical skills instruction video in clinical hospital teaching

**Table 7.** Comparison of instrument use and management before and after QR code application

Items	Before application	After application	t	P-value
Accurate use	3.97±1.05	4.63±0.89	1.454	<0.01
Standardized maintenance	3.61±0.99	4.28±0.86	2.745	<0.01
Response to malfunction	3.88±0.97	4.22±0.96	3.745	<0.01
Instrument preservation	3.52±0.91	4.35±1.02	5.786	<0.01
Instrument inventory	3.63±0.83	4.11±1.01	6.787	<0.01

### Discussion

The 14th Five-Year Plan of China has explicitly stated that it is an important and urgent strategic task to establish a scientific and systematic medical education system, to clear the channels through the growth of high-quality clinicians, and to insist on “medical-education synergy” as a necessary requirement for the comprehensive deepening of the reform of higher medical education. Medical education is the starting point of medical profession, in which clinical medicine is the key. With the basic medical theory in hand, medical students must take training in a clinical skills center before engagement in clinical work [5].

In this study, standardized clinical skills instruction videos based on QR code management to clinical teaching could reduce running cost of the clinical skills center. The intern trainees and teachers expressed higher satisfaction than those given the traditional teaching model, with better performance in the final exam of internship skills and a higher pass rate of the enrollment skills exam for residency training. The results suggest that standardized clinical skills instruction videos based on QR code management have significant advantages over the traditional approach. The traditional clinical teaching model is mainly limited to traditional forms of learning, such as textbooks, research papers, and lectures, which requires a large number of teaching resources in the form of specimens, human tissues, gross bodies, and simulation equipment [6]. Moreover, teachers give lessons to students gathered together, with a teacher-led modality through the whole class, mainly involving the presentation of the taught content and acceptance of the students [7]. This model is accompanied with little teacher-student interaction, low student initiative, and scant involvement in knowledge construction and problem-solving [8]. In addition, it is difficult for students to master all the knowledge

within the specified time [9], and the quality and content homogeneity of the lectures can be hardly guaranteed due to the varying levels of professional skills and teaching status of teachers [10]. The standardized clinical videos and course materials can be uploaded to a web platform to generate QR codes, with which students can obtain the relevant materials by cell phones and thus master the key learning contents more quickly [11]. Students can scan QR codes on simulation devices frequently involved in teaching to understand the operation process of the instruments, review the previous learning contents after class, and preview the learning contents of the next class [12]. This substantially saves the storage space of cell phones, and also facilitates fragmented learning against the forgetfulness of operation steps and neglect of details due to infrequent use of some operations.

In addition, there may be a poor motivation of interns to learn or (and) a lack of financial support and teaching resources allocation in teaching hospitals, which will compromise the improvement of interns in professional skills and trigger a cascade of troubles for clinical educators in traditional clinical teaching model [13]. The standardized clinical skills instruction video can help achieve a unified standard of specialty operation, which can reduce repeated lectures and demonstrations by teachers while ensuring the safety and quality of teaching [14]. However, the traditional teaching video is less convenient in portability and storage due to the playback medium, so it is difficult to realize the function of fragmented learning at any time. With the development of the Internet and the full coverage of the high-speed wireless network, QR code, as a new type of storage media, has been appreciated for its advantages of a large amount of information storage, small size, low cost, and simple production. Furthermore, it facilitates the monitoring and statistics of interns' learning and the use of

simulation equipment in the hospital [15], and also allows for targeted optimization and improvement of the teaching in response to the students' performance. Therefore, with the rapid development and extensive application of QR code technology and the reform and innovation of information technology, a new approach that revolutionizes the traditional teaching mode has come into being [16], which well addresses various drawbacks of traditional paper-based textbooks, such as closed content, poor dissemination, and long update cycle [17]. Moreover, in response to the development of times, the application of QR codes in teaching activities is no longer limited to the traditional teaching methods [18]. However, there were still some limitations in this study. First, as the change of traditional education method is gradual, it is difficult to evaluate the effect in a short term. Second, this study is a retrospective study, and the educational background, practice time and teachers of patients in the two groups are all significant confounding factors. Third, the small sample size of this study and the lack of blind method compromise the reliability of the results to a certain extent. A multicenter, large-sample, long-follow up randomized controlled study is urged for the application of standardized clinical skills instruction video based on QR code management.

The standardized clinical skills instruction video based on QR code management can realize the synchronization of classroom teaching and network teaching and the decentralized network-independent learning, which promotes the information reform and innovation of clinical hospital teaching based on the integration of multimedia teaching and network learning and provides a novel practice method with a higher effect for clinical hospital teaching.

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## Disclosure of conflict of interest

None.

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## Standardized clinical skills instruction video in clinical hospital teaching

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