

# Research protocol: part 1

## Project summary

**Background:** Clinical skill training (CST) is indispensable for first-year surgical residents. It can usually be carried out through video-based flipped learning (FL) within a web-based learning environment. However, we found that residents lack the process of reflection, blindly imitating results in losing interest and passion for learning in the traditional teaching pattern. The teaching method of "spot the difference" (SDTM), which is based on the fundamentals of the popular game of "spot the difference," is designed to improve students' participation and reflective learning during skill training. This study aimed to evaluate this novel educational model's short-term and long-term effectiveness for surgical residents in China.

**Methods:** The first-year residents who required a three-month rotation in the head and neck surgery department were recruited to participate in a series of CST. They were randomized into SDTM and traditional FL (control) groups. Clinical skill performances were assessed with validated clinical skill scoring criteria. Evaluations were conducted by comparing the scores which contain departmental rotation skill examination and the first China medical licensing examination (CMLE) performance on practical skill. Besides, two-way subjective evaluations were also implemented as the reference of training results. Training effects were assessed using t-test, Mann–Whitney–Wilcoxon, chi-square test, and correlativity.

**Results:** The SDTM group was superior to the control group in terms of after-department skill examination ( $t=2.149$ ,  $p<0.05$ ), taking medical history ( $t=2.665$ ,  $p<0.05$ ), and CMLE performance on practical skill ( $t=2.103$ ,  $p<0.05$ ), and there were statistical differences. The SDTM members rated the curriculum more highly than the control on the items relating to interestingness and participation ( $P < 0.05$ ). There was no statistical difference between the two groups on the score of the questionnaire about clinical competence ( $t=0.819$ ,  $p=0.415$ ), the first-time pass rate for CMLE ( $\chi^2=1.663$ ,  $p=0.197$ ), and short-term operational skills improvement ( $t=1.747$ ,  $p=0.084$ ). There is a positive correlation between the five evaluation outcomes ( $P < 0.05$ ).

**Conclusions:** SDTM may be an effective method for enhancing residents' clinical skills, and the effect is significantly short-term and long-term value. The improvement effect seemed to be more significant in the peer-involved SDTM than training alone. However, despite positive objective results, SDTM still faces the risk of learning burnout from students.

## General information

- The application of the spot the difference teaching method in clinical skills training for residents: a prospective controlled trial (September 2019 to September 2020)
- No sponsor/funder.
- Wen Li, MD (Department of Otolaryngology Head & Neck Surgery, West China Hospital, Sichuan University, 37 E Guoxue Alley, Chengdu, Sichuan, 610041, People's Republic of China) are responsible for conducting the research. LY., WL, JZ, developed the study concept and design. LY, WL, drafted the manuscript and perform the statistical analyses. WL and JZ supervised, directed the study and review and editing the manuscript. LY, JNA, BZ, YTZ, JMY, and JR performed the experiments and data collection. All authors read and approved the final manuscript.
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## Rationale & background information

Patient safety is an eternal subject in the medical field, and it is also the most basic starting point and the ultimate goal of medical services. Against such background, clinical skills training (CST) mode had transferred from the patient-oriented to video-based, and simulation-based flipped learning (FL)[1, 2]. This traditional pedagogical method consists of two steps: Watch the standard and flawless guide videos before class; implement the practical operation, and assess learning effectiveness in class. Although this teaching approach enabled the junior residents to avoid the risks associated with training directly in the clinical setting, the lack of introspection, dwindling interest in learning, and losing realistic sensory stimuli limit the training effectiveness. The development and implementation of flipped classroom teaching on CST still has some challenges, including preparing and improving pre-class materials, active participation, and persistent innovation. It gives us some implications that medical education researchers should explore new points which can be combined with FL to extend the efficiency of clinical skills training[3].

Spot the difference is a popular childhood game associated with a prototypical change blindness task, involves the identification of differences in local features of two otherwise identical scenes using an eye scanning and matching strategy[4]. During the game, the right posterior parietal cortex (RPPC) and visual centers are doubly activated. The connections between the two regions of the cerebral cortex can be built and affected[5]. The RPPC is concerned with the imitation of the actions of others, and the region displays a specific function in processing spatial aspects of complex movements[6, 7]. As imitation is the first and significant step for clinical skill acquisition, which belongs to precision and complex actions, the instructional approach associated with the spot the difference game might be effective for clinical skills improvement. In addition, stimulating the RPPC could also promote encoding of long-term memories that provides a possibility to develop a novel teaching method for achieving long-term learning effect[8]. Moreover, the RPPC played an essential role in the guidance of attention that laid a theoretical foundation for our consideration of cultivating concentration during learning[9].

The spot the difference teaching method (SDTM) is based on the term of this game. We aim to apply a similar course of the game to CST to stimulate students' enthusiasm and participation that results in satisfying learning effects. The common grounds between SDTM and the method of problem-based learning (PBL) are that problems detection by learners, teachers guide, problems discussion, and conclusion[10]. PBL has situation dependencies while SDTM does not, and thus the latter is more flexible, and its operation is easy for teachers to accept. In a broad sense, the differences are no longer limited to faults or problems, or they could be outstanding merits. SDTM is not following the rules of the game completely. An improved teaching method on this game theory is observing the differences or faults surrounding a movement to get how to perform the skill through self-reflection. SDTM is a novel teaching model integrating observation learning, PBL, guided learning, and student-teachers cooperative learning or peer-assisted teaching. We hypothesized that applying the SDTM to CST might enhance the efficiency of education based on the RPPC play in cognitive functions of learning and memory.

Taking medical history not only is the first step for doctors to diagnose and treat patients, but it provides a critical opportunity for doctor-patient communication and the establishment of a sound doctor-patient relationship. However, clinical training often fails to equip medical students with essential history-taking skills. History-taking skill training, which is considered a cultivating clinical reasoning ability, is indispensable for first-year medicine residents. Practicing history-taking depends on standardized patient training and constant improvement of a simulated patient based on artificial intelligence[11]. But, the lack of students' engagement and insufficiency of student supervision limits the history-taking training effect because the course lacks the teacher-student

and peer interaction within a non-communicative environment[12]. We hope the situation will improve through the well-designed SDTM.

Cardiopulmonary resuscitation and basic operations related to surgery are the skill contents that must be mastered for first-year surgical residents. These skills are the essential test points of the China medical licensing examination (CMLE) scheduled for the second year of employment. These basic skills must be mastered before attempting more complex tasks, and bad habits learned early are difficult to correct[13]. However, temporal and spatial constraints loom large during the training process[14]. The SDTM might provide a refined perspective on the efficiency of the skill education program. In addition to cardiopulmonary resuscitation, we selected three basic surgical operations as the training and assessment contents, including dressing change, disinfection and surgical drape placement in the operation area, wearing and taking off the operating gown, and sterile gloves.

To verify SDTM's validity in improving the effectiveness of clinical skills training, we selected first-year residents with the same baseline on the entrance examination performance as subjects. They were randomized into experimental and control groups that differed concerning the teaching methods: SDTM was adopted in the experimental group, while the traditional teaching method was adopted in the control group. We considered the departmental rotation examination (DTE) results and the two-way subjective evaluation between students and teachers as the short-term training effect. We regarded the performance of first-time CMLE as the long-term teaching effect. We compared the short-term and long-term results between the two groups statistically. We assumed the application of SDTM would result in superior skill learning results compared with the control group.

## References (of literature cited in preceding sections)

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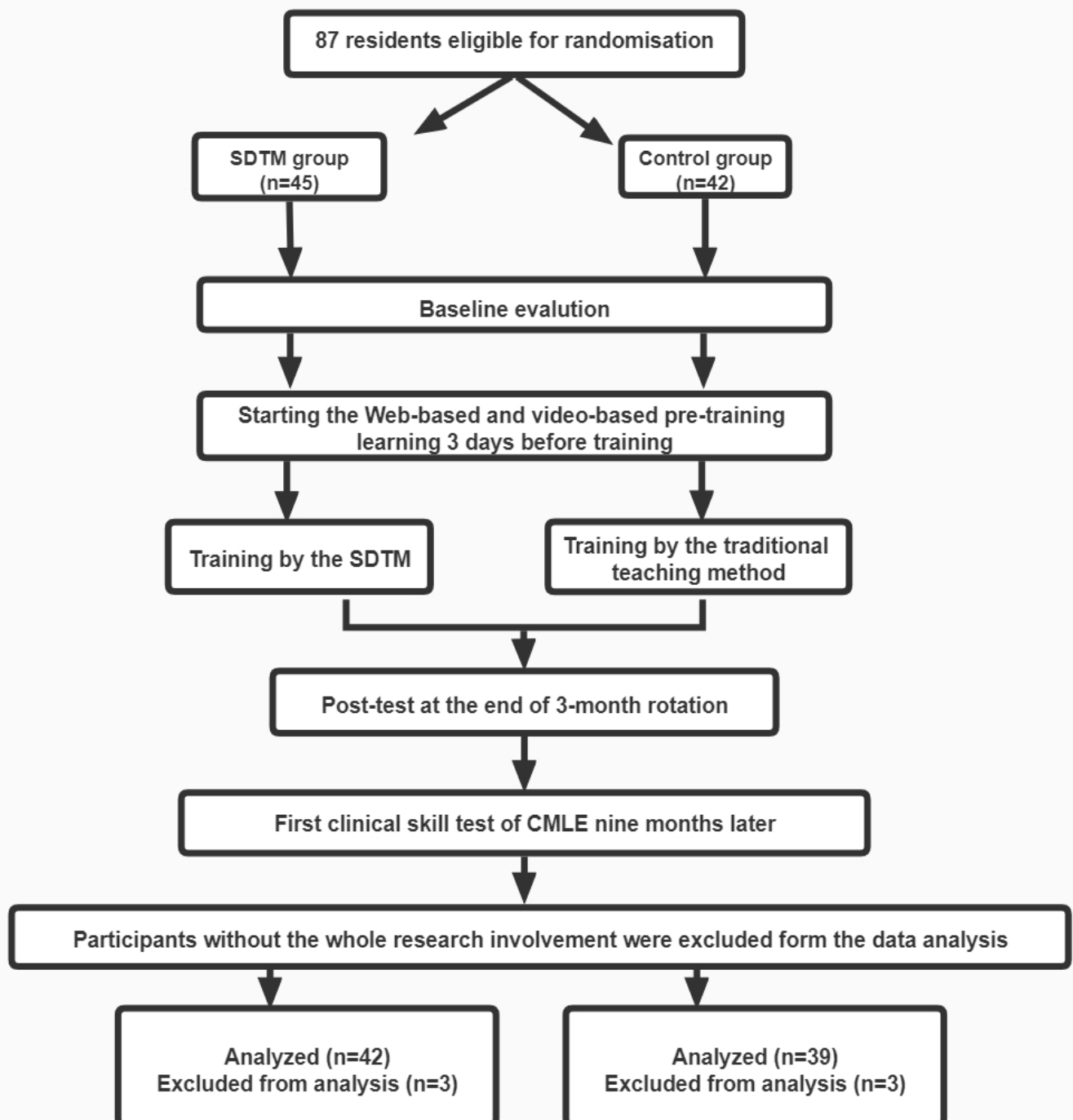
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## **Study goals and objectives**

To verify SDTM's validity in improving the effectiveness of clinical skills training, We assumed the application of SDTM would result in superior skill learning results compared with the control group.

## Study design

A summary of the study profile is shown in Fig. 1.



We enrolled the first-year residents required a three-month rotation in the Department of Head and Neck Surgery at our hospital from September 2019 to September 2020. Inclusion criteria: 1) the first-year residents who did not rotate to other surgical departments; 2) those who obtained a bachelor's degree in medicine. Exclusion criteria: 1) the residents who had rotated to other



surgical departments before the study; 2) Senior residents (working time  $\geq 1$  year) 3) the residents with the graduate degree; 4) the residents who have obtained the qualification certificate of a clinical practitioner; After screening, A total of 87 residents were selected as the research objects. They were divided into eight subgroups in the order of rotation, and the subgroups were randomly sorted into either traditional teaching group (the control) (n =42) or SDTM group (n =45) using a web-based randomization program. All of them had passed the entrance test, which was used as the baseline evaluation, and they would take the CMLE 9 months after the end of the rotation. The participation was voluntary, and informed consent was obtained. The students did not know which group they were randomized to, and the teacher grading the students did not know which group he/she belonged to. Participants were assured that all data would be treated anonymously. Each subgroup contained an SDTM and the control group, and there were three to six members in each of the two groups. Each subgroup was supervised by the tutorial group consisting of two instructors who held full-time professional positions within the head and neck surgery department and three assistants. The teachers grading the residents included two professionals (grade the exam objectively) and four clinical teachers (grade the clinical performance subjectively). They did not participate in the teaching process and had a professional title above the senior associate position. They were all practicing clinical physicians.

## **Methodology**

### **Preparation phase**

#### *History-taking training preparation*

First, four scripts were written for a standardized patient composed of two instructors with SP training certificates. Second, record a standard medical history-taking video (about 15minutes) based on acute suppurative tonsillitis, which did not belong to the above scripts. Third, send the email to contain the above record video and a PDF of history-taking scoring standards to all the participants three days ahead of the training course. The SPs should be familiar with the scripts and rehearsed at least once with a senior resident before class. Both SDTM and the control group were requested to watch the video at least once and reviewed the PDF file to comprehend the critical point of history-taking.

#### *Other introductory clinical skills training preparation*

First, the instructor prepared the flawless CST videos (about 8 minutes) about cardiopulmonary resuscitation, debridement and dressing change, disinfection, placing surgical drapes in the operation area, and wearing and taking off the operating gown and wearing sterile gloves, respectively. These videos were according to CMLE guidelines. Second, this is a critical point of this study called "the difference points design." The difference points (DPs) were error-prone points that are often overlooked in daily clinical skills operations. The DPs were discussed and decided by the teaching group members. There were roughly three DPs are arranged to be displayed in each standard video (**Table 1**). These videos contained the DPs were one-to-one correspondence with the standard videos, and the same performers recorded the flawed videos in the same settings. Finally, three days before class, the residents in the same subgroup would receive an email including a PDF of the point checklist on skill operation and the flawless videos. Every standard video would be sent in an orderly according to the curriculum schedule. Both two groups needed to observe the video at least once and review the critical point checklist of each operation.

### **Curriculum arrangement**

Since the rotation began, CST courses have been arranged every two weeks. The length of each class varies slightly depending on the number of students, averaging about 120 minutes per group. The control group and experimental groups training were placed in separate rooms because all participants were asked to keep discreet about the details of their training and not to disclose them to their fellow residents. The curriculum was arranged in the following order: history-taking,

cardiopulmonary resuscitation, dressing change, disinfection and surgical drape placement in the operation area, wearing and taking off the operating gown and sterile gloves.

**Table1: Difference points**

Standard operation procedure	Difference points
<b>Cardiopulmonary resuscitation</b>	
Correct compression depth (1.5–2 inches) and fingers off the chest	Compression depth (about 0.5 inches) and fingers on the chest
Remove secretions and foreign bodies from the mouth and nose and keep the airway opening (head tilt and chin lift)	Forget to remove secretions and foreign bodies of the airway and the chin is not lifted before the artificial respiration
Judge the resuscitation effect after five cycles	Judge the resuscitation effect after six cycles
<b>Dressing change</b>	
Remove the inner dressing with a tweezers	Remove the outer and inner dressing with the hand
The second disinfection scope should be narrower than that of the first	The second disinfection scope is equal to that of the first
A pair of tweezers contacts the incision, and the other is used to transfer the cleaning items of the dressing bowl.	Two pairs of tweezers are mixed-use
<b>Wearing and taking off the operating gown and sterile gloves</b>	
Extend the hands forward (not over the shoulders) during the dressing process	Extend the hands upward slightly (over the shoulders) during the dressing process
The gloved hand shall not touch the inner surface of the other glove	The thumb of the gloved hand touches the inner surface of the other glove
With the help of an assistant, take off the operating gown first and then the gloves	Take off the gloves first by oneself and then the operating gown with the help of an assistant
<b>Disinfection and surgical drapes placement (neck)</b>	
Disinfection range: Up to the lower lip, down to the nipple line, both sides to the anterior edge of the trapezius muscle	Disinfection range: Up to the submental plane, down to the clavicular pane, both sides to the anterior edge of the sternocleidomastoid
Keep the tip of the sterilizing forceps lower than the holding end	The tip of the sterilizing forceps is occasionally over the handheld end
Place four towels in the correct order: the lower part, opposite side, head side and trainee side	Place four towels in the wrong order: opposite side, lower part, trainee side and head side

### History-taking training program

The SDTM group members were randomly ranked, and a printed scoring sheet whose contents were the same as the previous PDF was distributed to everyone before class activities began. Then the resident orderly performed a history-taking process of the standard patient. Each resident performed a script which was selected from the four prepared. The remaining members were asked to watch the process and mark the deficiencies on the scoring sheet when they thought they spotted the difference from the standard procedure. Besides, if they observed some points that the testee

performed better than the standard answers, they can also write them down. Each resident would receive all the feedback items from other members at the end of the class, and the instructor summarized the class and went over the frequent errors raised during this course.

The preparation of the control group before class was the same as that of the experimental group while they were taught traditionally. Each trainee was trained individually. This training took place in a quiet room with only the trainee, the SP, and the instructor. The instructor scored their performance, and pointed the frequent weaknesses, and put forward some suggestions for improvement on the spot.

### **The introductory clinical skills training program**

A manikin was used for clinical skill training in both groups. Prior to their clinical skills training, The SDTM group watched the video containing the DPs while the control group reviewed the previous standard video. Both the control group and the experimental group were given one-on-one training in random order. The SDTM group members were required to promptly mark the flawed point on the scoring sheet when they spotted the difference from the standard procedure. After that, every resident performed the skill operation individually, and the trainee was asked to tell loud how to operate the modified skill when they got to a different point. If some differences were not detected or other operating defects existed, the instructor would tell the corresponding participant at the end of class.

In the control group, the instructor organized the skill training following the previously recorded standard video guidance and would provide individualized feedback at the end of training.

### **Safety considerations**

As this study did not involve human subjects, no adverse effect on individuals happened.

### **Follow-up**

The follow-up time will be 9 months after the rotation, when the trainees obtain the score of the skill test of China medical licensing examination. There was no adverse events during the follow-up.

### **Data management and statistical analysis**

We compiled the total score for each test. When a normal distribution was present, compare the results generated by each of the two groups using an independent sample T-test and reported as a mean $\pm$ SD. Otherwise, non-parametric test methods, such as the Mann–Whitney–Wilcoxon test, were used, and the result could be reported as a median (lower quartile, upper quartile). The Chi-squared test was used to analyze the difference in the rate between the two groups. We also analyzed the correlation of quantitative data of the study outcomes. All statistical analyses were performed using SPSS software (version 22.0). P-values of less than 0.05 were considered significant.

### **Quality assurance**

WL and JZ (clinical monitors) participate entirely to supervised, directed the study and review and editing the manuscript, and data management .



## **Expected outcomes of the study**

The SDTM in the primary clinical skill teaching for first-year residents in China. The teaching effect was achieved compared to using the traditional teaching method. Its teaching effect included not only the effect on short-term effect but also long-term retention of learning outcome.

## **Dissemination of results and publication policy**

This study points to possibilities for optimizing the training curriculum in clinical skill training for novices by letting them observe both flawless and flawed demonstrations and then conduct the corrective actions. BMC will take the lead in publication and be acknowledged in publications.

## **Duration of the project**

From September 2019 to September 2020, Since the rotation began, CST courses have been arranged every two weeks. The length of each class varies slightly depending on the number of students, averaging about 120 minutes per group. The control group and experimental groups training were placed in separate rooms because all participants were asked to keep discreet about the details of their training and not to disclose them to their fellow residents. The curriculum was arranged in the following order: history-taking, cardiopulmonary resuscitation, dressing change, disinfection and surgical drape placement in the operation area, wearing and taking off the operating gown and sterile gloves.

## **Problems anticipated**

Some participants will drop out with the irresistible causes, and data was analyzed excluding the drop-out members.

## **Project management**

LY., WL, JZ, developed the study concept and design. LY, WL, drafted the manuscript and perform the statistical analyses. WL and JZ supervised, directed the study and review and editing the manuscript. LY, JNA, BZ, YTZ, JMY, and JR performed the experiments and data collection.

## **Ethics**

This study was approved by the Institutional Review Board and Ethics Committee of the West China Hospital of Sichuan University. Written informed consent was obtained from all participating students. All authors confirm that all methods were carried out in accordance with relevant guidelines and regulations.

## **Informed consent forms**

Written informed consent was obtained from all participating students before training.

## **Research protocol: part 2**

### **Budget**

No budget

### **Other support for the project**

No

### **Collaboration with other scientists or research institutions**

No

### **Links to other projects**

No

### **Curriculum Vitae of investigators**

Wen Li, MD, Liu Yang and Jian Zou are MD in the Department of Otolaryngology Head & Neck Surgery, West China Hospital, Sichuan University

### **Other research activities of the investigators**

No

### **Financing and insurance**

No