

# Development of a Mini-CEX tool in simulation and evaluation of the subcutaneous drug administration skills of senior nursing students before graduation: A Pilot Study

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## Abstract

**Aim:** This study was conducted in order to development of a Mini-CEX tool based on the core competencies of nurses and evaluation of the subcutaneous drug administration skills of senior nursing students before graduation.

**Materials and Methods:** A Mini-CEX tool was developed based on the core competencies of nurses. When opinion of the expert's evaluation was confirmed, the students' clinical competencies of the subcutaneous drug administration skills were evaluated simultaneously in standardized patient simulation with the Mini-CEX form (n=66).

**Results:** The mean score for the whole mini-CEX was  $6.13 \pm 1.20$  (range = 1-9). The results of this research indicate the feasibility of using our Mini-CEX tool. The mean student satisfaction score was high at  $4.59 \pm 0.46$  (range = 1-5). 69.7% (n=46) of students thought that feedback is an important their professional development and 62.1% (n=41) of students thought that mini-CEX are an important educational tool.

**Conclusion:** The results of this research indicate the feasibility of using our Mini-CEX tool. The study supports of the use of the Mini-CEX to assess clinical competence through simulation. The study recommends the use of applications that increase the level of realism such as the use of standardized patients or moulages in examinations which aim to simultaneously evaluate student skills such as communication and decision making.

**Keywords:** Mini-CEX; moulage; nursing competence; nursing education; simulation; standardized patient

## INTRODUCTION

The primary objective of nursing education is to train competent nursing professionals who possess the knowledge, skills, and attitudes appropriate to the needs of society, the ability to solve problems, and to exhibit clinical competence (1). Clinical competence includes many aspects that are closely related such as the application of knowledge and the exhibiting of proper behaviors and attitudes, rather than just purely possessing clinical skills (2). Along with the developments in science and educational technologies, nursing education has evolved to provide the appropriate environment and opportunity to train competent nursing professionals (3). Laboratory practices, in which students experience patient care prior to their clinical experience, and various simulators set at different reality levels, have become an integral part of today's education for the nursing profession.

## Background and Conceptual Framework

Assessment and evaluation methods in clinical education should be restructured accordingly in order to generate more systematic feedback on students' performances by simulating the clinical environment wherever possible (4). Multidimensional and structured evaluation methods should be used within student evaluation processes that include the use of simulated applications (5). One such method is the Mini-Clinical Evaluation Exercise (Mini-CEX), which is a performance evaluation method developed by the American Board of Internal Medicine to evaluate occupational competencies (6). Educators can objectively evaluate their students' interaction with patients across all or individual topics of overall clinical competence such as communication, clinical decision-making, or values and professionalism in the patient-care environment (7). Studies have shown that Mini CEX, which was developed for the evaluation of specialist physicians' competencies,

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is an effective assessment-evaluation method used in the evaluation of medical faculty students' clinical competence (8-10). Mini-CEX has also been introduced in other health professions, including dentistry, midwifery, and nursing, in addition to medical training (11-13). According to the review and meta-analytical study of Lörwald et al. (2018), assessment and evaluation methods including direct observation and feedback from educators such as Mini-CEX and Direct Observation of Procedural Skills (DOPS) can have a positive effect on educational outcomes, and therefore health professionals should be included in the training process (14). Wilkinson et al. (2008) reported that the clinical environment in which applications are performed and case complexity affect students' Mini CEX scores (15).

### **Importance of Subcutaneous Drug Administration Management**

Competent nurses are expected to manage drug administration using the appropriate technique, and that they take all necessary precautions in the application of drugs in order to prevent and reduce drug administration errors, which are considered one of the most common medical errors (17). Subcutaneous (SC) injections are frequently performed by nurses in clinical settings, and also by patients due to the necessity for self-application outside of the clinical setting (18). If the injection technique is not paid adequate attention to during SC drug administration, certain complications may develop. For example, ecchymosis, hematoma and pain due to poor injection technique may develop subsequent to SC injections. These problems may also lead to a narrowing of the area required for subsequent SC injections, and also to unnecessarily slow drug absorption (19). This situation may also cause the need for recurrent patient hospitalization, creating unnecessary financial burden and reducing patient satisfaction. Such problems in SC injections can be prevented through good nursing management such as site selection, application of interstitial rotation, proper entry angle for tissue thickness, and effective patient communication (17,18).

Key points in the reduction and prevention of medication errors are the enablement of nursing students to be better prepared for their profession by expressing their experiences with regards to drug applications, to provide them with the opportunity to review the topic of drug application during their training, and to identify any knowledge gaps or areas of competence deficiency (20).

In reviewing the literature on nursing, assessment instruments for Mini-CEX in nursing education have been developed (12,16), but that the number of studies evaluating the clinical competence of students was found to be limited (12). For this reason, the primary objective of the current study is to development of a Mini-CEX tool for the evaluation of nursing students' competence in simulation environment, and to determine the levels of student satisfaction. This skill was selected because students frequently have the opportunity to perform

them during clinical practice and are expected to be competent in this skill. Prior to their graduation, nursing students should acquire comprehensive knowledge on the management of subcutaneous injections. Therefore, the secondary objective of the current study is to evaluate the performances of senior nursing students on their administration of subcutaneous drug. This objective is also founded on the importance of evaluation of students' theoretical knowledge with regards to applying medications in practice.

## **MATERIALS and METHODS**

### **Study Design**

The instrument was devised and tested in four phases: The Mini-CEX instrument was developed according to nurses' core competencies and current literature; A workshop for evaluators was held the Mini-CEX instrument to ensure inter-rater reliability; A pilot test on a group of senior nursing students was held to provide feedback for re-evaluation; Workshops were held for evaluators before the main study; Descriptive statistics were used to examine the students' Mini-CEX scores based on the duration of their training.

### **Instrument development**

This study focused on the professional development of nurses and measurement the standards with which a competent nurse is expected to be equipped before the graduation. This study considered the core competencies of nurses as defined by the Turkish Nursing Accreditation Council (21). Seven core competency dimensions were selected for this study: communication skills, psychomotor skills, patient safety behavior, professionalism, clinical decision-making, ethical approach, and overall clinical competence. We focused on observable competencies each domain; such as addressing the patient by name, introducing you to patient with sincerely, reflecting the patient's concerns or feelings.

### **Validity and reliability check of the Mini-CEX tool**

The instrument was validated by five experts: three academic specialists in the field of Fundamentals of Nursing and two academic specialists in the field of educational measurement and evaluation. They assessed the feasibility and wording of the items and detailed descriptions in the expert opinion form. We utilized three ratings to decide whether or not to include dimensions: dimension is important and should be retained (3 points), dimension is important but needs revision (2 points), and dimension is not important and must be removed (1 point). Wording of items and descriptions was modified and rechecked if experts awarded 2 points.

The final version of the Mini-CEX tool included three sections. In the first section, the students' demographic information is sought. The second section of the Mini-CEX focuses on the skills expected to be performed by the students. The section contains 7 domains that are scored using a 9-point, Likert-type scale (1-2-3: insufficient, 4-5-6: sufficient, 7-8-9: excellent) in which the student's

performance is evaluated (22). The titles of the 7 domains are communication skills, psychomotor skills, patient safety behavior, professionalism, clinical decision-making, ethical approach, and overall clinical competence. In the third and final section of the Mini-CEX, there is a blank section where trainers can write notes for presenting their opinions and evaluation about the application as suggestions in subsequent feedback sessions.

### **Participants and sample**

The pilot study was conducted with final year intern nursing students from a nursing school in Turkey between February and March of 2019 ( $n = 66$ ). First, the students were fully briefed about the study process, and volunteer participants then invited to participate in the study. No incentive was offered to the participants, and all joined the study on a volunteer basis. All students were volunteered to participate in the study. Inclusion criteria were their voluntary participation and having each completed the same theoretical and practical education, clinical experience, and evaluation process for medical administration during their nursing education.

### **Preparation of Simulation**

The use of standardized patients (SPs) as a simulation method in the evaluation of students has gained the support of both the Best Evidence Medical Education (BEME) and the U.S. Agency for Healthcare Research and Quality (AHRQ) (23). The two SPs were recruited and trained. Each training session lasted approximately four hours. A feedback guide was designed concerning the SPs' tasks, responsibilities, and scenarios were practiced accordingly, and their performance was standardized. The SPs simulated an adult patient who had been diagnosed with diabetes for a period of 5 years, and who had received subcutaneous injections three times each day. Two academicians who were working in the nursing department and who were experienced in simulation evaluated the scenarios in terms of content validity. The scenarios were revised based on their suggestions. Educators can transform evaluation into real-world treatments by adding applications that provide environmental fidelity such as moulage to standardized patients (24-26). An injection pad was placed on the abdomen and arms of the SPs (hybrid simulation) in order to enhance the reality of the procedure, and to decrease the risk of injury. In addition, bruises, and ecchymosis had formed in both arms and the abdominal region of the patient. A fixative was applied to the moulage in order to ensure that it remained constant throughout the day. Arrangements were made for the simulation design in the simulation laboratory of the hospital where the study was held.

### **Implementation of Simulation**

The participant students were informed about the simulation application and the Mini-CEX. The simulation application commenced with a briefing. The students were informed about the study and were asked not to discuss the scenarios with their peers. Each student

performed the actions they were assigned for a period of 15 minutes and were simultaneously evaluated by the different instructor using the Mini-CEX. In this study, SP feedback was not an outcome that was measured. After completion of their assigned actions, the students left the simulation room for the subsequent debriefing stage. The debriefs were conducted by the different instructor using the plus/delta method (27), and the students' performance experiences were discussed. Following the debriefing stage, the feedback form was then administered to the participants. The Mini-CEX simulation feedback form is a 4-point, Likert-type scale consisting of eight items. It was prepared in order to determine students' opinions about simulated applications in which their performances were evaluated with the Mini-CEX.

### **Data Analysis**

The data were analyzed using IBM's SPSS/WIN 22.0 Statistical Program. In the analysis of the descriptive data, number, percentage, mean, standard deviation was used. Continuous variables were presented as median (min-max), and categorical variables were described with frequencies and percentages. The students' Mini-CEX scores was presented in numbers and percentages. Mini-CEX satisfaction scores was presented in median.

### **Ethical Considerations**

Approval was obtained from the Ethical Committee of the University (reference number: 88/20.02.2019). Oral consent was also obtained from each of the participant students prior to the commencement of the study.

## **RESULTS**

The mean age of the participant students was  $22.12 \pm 0.81$  years old, and 75.8% ( $n = 50$ ) of them were female. The mean score of the participant students on the whole Mini-CEX was  $6.13 \pm 1.20$  (range = 1-9). When the mean scores of the participant students on the 7 domains of the Mini-CEX were examined, the mean score for communication was  $6.09 \pm 1.30$ , for patient safety behavior it was  $6.21 \pm 1.49$ , psychomotor skill was  $6.50 \pm 1.50$ , professionalism was  $6.21 \pm 1.30$ , clinical decision-making was  $5.18 \pm 1$ , ethical approach was  $6.78 \pm 1.60$ , and the mean score for overall clinical performance was  $5.95 \pm 1.30$  points (Table 1).

**Table 1. Students' Mean scores (Mean  $\pm$  SD), Mini-CEX and Mini-CEX items ( $n = 66$ )**

Items	Mean $\pm$ SD
Communication skills	$6.09 \pm 1.30$
Patient safety	$6.21 \pm 1.49$
Professionalism	$5.18 \pm 1.55$
Ethical approach	$6.78 \pm 1.60$
Psychomotor skills	$6.50 \pm 1.50$
Clinical decision	$5.18 \pm 1.55$
Overall clinical competence	$5.95 \pm 1.30$
<b>Total scores</b>	<b><math>6.13 \pm 1.20</math></b>

**Table 2. Specific Behaviors Under Seven Domains of Clinical Competence (n = 66)**

Domain of clinical competence	n	%
<b>Communication skills</b>		
Address the patient by name	53	80.3
Introduced yourself to patient with sincerely	28	42.4
Empathy (e.g., reflecting the patient's concerns or feelings)	45	68.2
Terminology (e.g., understandable by the patient)	41	62.1
<b>Patient safety</b>		
Patients' ID verification	41	62.1
Informed the procedure	40	60.6
Giving safety position	48	72.7
Right documentation	38	57.6
<b>Professionalism</b>		
Autonomy	40	60.6
<b>Ethical approach</b>		
Receiving patients 'consent	38	57.6
Respecting patient privacy and dignity	45	68.2
<b>Psychomotor skills</b>		
Subcutaneous drug administration (e.g. preparing the necessary equipment, applying the insulin with the right technique from the right site)	49	74.2
<b>Clinical decision</b>		
Questioning the site rotation	36	54.5
Noticing the ecchymosis	53	80.3
Defining the right site for injection	28	42.4

The frequency distributions of specific behaviors for each domain are shown in Table 2. For the communication domain, 80.3% (n = 53) of the participant students addressed the patient by their name, 42.4% (n = 28) introduced them with sincerely to the patient, 68.2% (n = 45) approached the patient with empathy, and 62.1% (n = 41) used understandable terminology with the patient. For the patient safety behavior domain, 62.1% (n = 41) of the participant students identified the patient's name, 60.6% (n = 40) explained the process to the patient, 72.7% (n = 48) ensured that their patient was in the right position, and 57.6% (n = 38) had the correct documentation.

The autonomy skills of the students were evaluated under the professional competence domain, with 60.6% (n = 40) of the participant students found to exhibit the right ratio of autonomy skills. For the ethical approach domain, 57.6% (n = 38) of the participant students obtained approval from their patient prior to the application, whilst 68.2% (n = 45) protected their patient's privacy and dignity.

The subcutaneous drug administration skills of the participant students were evaluated under the psychomotor skills competence domain, with 74.2% (n = 49) of the participant students having applied the correct technique. With regards to the clinical decision domain, 54.5% (n = 36) of the participant students considered the site rotation prior to applying the subcutaneous injection, whilst 80.3% (n = 53) noticed the ecchymosis, and 42.4% (n = 28) determined the correct injection site.

**Table 3. Students' Satisfaction Scores**

Questions	Strongly Disagree	Disagree	Slightly Agree	Agree	Strongly Agree	Mean± SD
	% (n)	% (n)	% (n)	% (n)	% (n)	
I enjoy mini-CEX experiences	1.5% (1)	12.1% (8)	12.1% (16)	62.1% (41)	0%	4.45 ± 0.82
I think that mini-CEX are an important educational tool	1.5% (1)	0%	7.6% (5)	28.8% (19)	62.1% (41)	4.72 ± 0.88
I am satisfied to be evaluated in the simulated environment	0%	0%	7.6% (5)	24.2% (16)	68.2% (45)	4.32 ± 0.56
I am pleased to be evaluated with standardized patient	0%	0%	4.5% (3)	18.2% (12)	77.3% (51)	4.60 ± 0.62
I believe that moulage are an important educational helpful hint	0%	0%	6.1% (4)	33.3% (22)	60.6% (40)	4.54 ± 0.61
I believe that feedback is an important my professional development	0%	0%	4.5% (3)	25.8% (17)	69.7% (46)	4.88 ± 0.45
<b>Total</b>	0%	0%				<b>4.59 ± 0.46</b>

The mean student satisfaction score with the Mini-CEX was considered high at  $4.59 \pm 0.46$  (range = 1-5) (Table 3). When the mean scores of the participant students' satisfaction was examined, they agreed that the Mini-CEX was enjoyable ( $4.45 \pm 0.82$ ). So that they believed Mini-CEX to be as an important educational tool ( $4.72 \pm 0.88$ ). Also, the participant students felt satisfied to be

evaluated in the simulated environment ( $4.32 \pm 0.56$ ), and with a standardized patient ( $4.60 \pm 0.62$ ). The participant students agreed that the use of moulage increased the level of realism in the Mini-CEX ( $4.54 \pm 0.61$ ) and believed that the feedback received was important to their professional development ( $4.88 \pm 0.45$ ).

## DISCUSSION

The objective of this pilot study was to introduce Mini-CEX as a tool for the formative evaluation of nursing students in a simulated clinical environment, and to determine the satisfaction of the participant students toward this method of evaluation. In this section, the participant students' performances in the Mini-CEX, and the findings related to their satisfaction as students, are discussed.

### Mini-CEX outcomes

Although the findings of the current study suggest that the nursing senior students' performance levels in conducting subcutaneous injections were deemed "sufficient," significant results were obtained from the 7 domains of clinical competence that the Mini-CEX evaluated. For the communication domain, 80.3% ( $n = 53$ ) of the participant students addressed the patient by using their name, but only 42.4% ( $n = 28$ ) introduced themselves with sincerely to the patient. In total, 68.2% ( $n = 45$ ) of the students approached a patient undergoing subcutaneous injection due to a chronic disease process. The ratio of the participant students who included their patient in the process by using terminology which was understandable to them was 62.1% ( $n = 41$ ).

The participant students' performances show that the students' communication skills were above the level of being sufficient but were not deemed as being fully developed. Nursing is a profession based on the management of human relations; therefore, the effectiveness of nursing care depends on the effective communication skills of nurses with other individuals. While nurses try to understand individuals' experiences through verbal and non-verbal communication, they should also have the ability to express themselves appropriately and to communicate effectively with individuals as caregivers. The developments of such skills is of significant importance in professional nursing, and are developed primarily during formal education with structured exams that are based on feedback such through employing SPs and applications such as the Mini-CEX.

When the findings of the current study were examined in terms of patient safety behavior, the ratio of identity validation by the participant students was found to be 61.2% ( $n = 41$ ), the ratio of process explanation was 60.6% ( $n = 40$ ), ensuring the correct position of their patients was 72.7% ( $n = 48$ ), and 57.6% ( $n = 38$ ) ensured that they had the right documentation. These findings may indicate that the students' skills required to ensure their patient's safety still require further development. In another study which was conducted to investigate the methods used to teach patient safety to nursing students, it was emphasized that the methods in which they actively participated in the learning process and received feedback on their competence were important in developing their behaviors towards patient safety (28). Similarly, the internalization of patient safety, which is of significant importance in nursing, was suggested as needing to be ensured primarily during nursing education through the application of simulations

and tests structured based on feedback such as the Mini-CEX. In the literature, the basic characteristics of nursing professionalism are generally stated as being scientific knowledge, using theory in practice, focusing on vital issues, professional organization, and autonomy (29). In terms of the professional behavior of nurses, developing problem-solving skills, observing personal differences of individuals receiving care, critical thinking, all fall within the framework of ethical principles (30).

During the subcutaneous drug administration, the participant nursing students in the current study were expected to manage the process by determining the right site for the injection to be applied. During this process, it was expected that the participant students would check the nurse registration form, pay attention to the rotation of the site, and find the right site through appropriate evaluation. These subjects were also discussed under the domain title of clinical decision-making. However, some students only enquired from the SP about the most recent injection site used. This behavior was considered to be harmful to the patient's trust and the nurses' professionalism, with only 60.6% of the participant students ( $n = 40$ ) having managed this process correctly.

In other studies, it was determined that the perception of professionalism in nursing students varied according to their education and clinical experience (31,32). Providing appropriate opportunities for building and developing professional perception within the education process and reflecting that back into patient care. It is important for nursing students in terms of exhibiting professional behaviors in the clinical field. This information in the literature demonstrates the importance of structured testing based on feedback in the clinical setting.

When the findings about ethical approach adequacy were analyzed, 57.6% ( $n = 38$ ) of the participant students had obtained approval from the patient prior to the application, whilst 68.2% ( $n = 45$ ) protected their patient's privacy and dignity. These findings may indicate that the participant students' ethical approaches still need further development. Professionalism in nursing requires that care be provided systematically, evidence-based, in accordance with ethical principles, and by taking into account their patients' rights (33). The development of ethical behaviors in students is important in terms of demonstrating their perception of professional identity even during their educational life. Therefore, opinion and criticism on student nurses' ethical behaviors should be provided throughout the feedback process.

When the psychomotor skills competencies for subcutaneous injection were examined, 74.2% ( $n = 49$ ) of the participant students applied the correct technique. Repetitions and skills practice are important in putting student nurses' psychomotor skills into practice. Sometimes, only a few repetitions and applications can be sufficient to obtain the desired results, while hundreds of repetitions and applications may be required in other cases (34). All of the participant students in the current

study had managed to successfully administer a drug subcutaneously to at least one patient during their previous clinical practice. It could be said to be representative of inadequate development of the students' hand skills and possibly their clinical anxiety. At this point, it is thought that communicating the complications and costs due to misapplications to nursing students during the feedback process is important in terms of preventing further unnecessary misapplications in the future.

A total of 54.5% ( $n = 36$ ) of participant students questioned the site rotation prior to applying the subcutaneous injection, and 80.3% ( $n = 53$ ) noticed the ecchymosis induced by the moulage; however, only 42.4% ( $n = 28$ ) were able to determine the correct injection site. Clinical decision-making is an integral part of nursing practice, but the study's findings showed that the participant students' clinical decision-making levels still needed further development. It has been stated that theoretical knowledge alone is inadequate in developing clinical decision-making in students in a purely formal education setting; whereas, it is actually a skill that is acquired mostly within the clinical environment (35). This finding also showed that the use of measures to increase the level of reality, such as moulage for example, is a necessary element to developing nursing students' clinical decision-making skills. This finding is also supported by the literature (24-26).

### **Students Satisfaction**

According to the current study's findings, it can be seen that the satisfaction levels of the participant nursing students towards the Mini-CEX in simulation were high (Table 3). Considering the potential problems that may occur in the evaluation of students in a clinical setting, it is suggested that students' opinions are of considerable importance in terms of the usability of Mini-CEX in simulated environments. Accordingly, it is suggested that simulation using Mini-CEX may be effective, especially in the transition of senior nursing students to the actual live clinical patient-care environment, and that this approach may help to increase the self-confidence levels of students by further developing their clinical decision-making and application skills.

### **CONCLUSION**

The results of this pilot research indicate the feasibility of using our Mini-CEX tool. The study supports of the use of the Mini-CEX to assess clinical competence through simulation. Findings suggest that nurse educator should evaluate the use of objectively structured feedback-based techniques such as Mini-CEX to evaluate the quality of nursing care provided or competencies of students prior to their live clinical work. Educators can easily use this tool to evaluate a student's strengths and weaknesses, and to give timely formative feedback. Nevertheless, further studies are needed to investigate multiple evaluation strategies in improving the clinical skills of nursing students. Additionally, the study also recommends the use of applications that increase the level of realism such as the

use of standardized patients or moulages in examinations which aim to simultaneously evaluate student skills such as communication and decision making.

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