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Impact of a Digital Tool on Pharmacy Students' Ability to Perform Medication Reviews: A Randomized Controlled Trial

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Abstract: Digital Medication Review Tools (DMRTs) are increasingly important in pharmacy practice. To ensure that young pharmacists are sufficiently competent to perform medication reviews after graduation, the introduction of DMRTs teaching in academic education is necessary. The aim of our study was to demonstrate the effect of DMRTs use on pharmacy students' performance when conducting a medication review (MR) in a randomized controlled pre-post design. Forty-one pharmacy students were asked to complete a MR within 60 min, followed by a 10-min consultation with (intervention group) and without a DMRT (control group). The MR performance was subdivided into four categories: communication skills, subjective and objective patient data, assessment, and plan. Performance was assessed using objective structured clinical examinations (OSCEs) and analytical checklists. With the use of DMRTs, the overall performance was improved by 17.0% compared to the control group ($p < 0.01$). Improvement through DMRTs was seen in the subcategories "Assessment" and "Plan". Furthermore, pharmacy students liked using DMRTs and felt more confident overall. Our study results demonstrate that DMRTs improve the performance of MRs, hence DMRTs should become an integral part of pharmacy curriculum. Consequently, digitally enabled pharmacists using DMRTs will be better prepared for their professional careers in pharmacy practice.

Keywords: digital health; digital tool; medication review; pharmacy education; medication safety; pharmaceutical services; eHealth

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1. Introduction

In recent years, there has been a steady and dynamic change in the professional image of pharmacists in Germany, which has evolved from exclusively being a distributor of pharmaceuticals to becoming a key health care professional, with various consultation services in primary care [1,2]. Since 2022, the "On-Site Pharmacy Strengthening Act" allows pharmacists to offer selected "pharmaceutical care services to patients", reimbursed by health insurances [1,3,4]. One core element of these services is the extended medication counseling for patients with polymedication [4] with ≥five systematic long-term medications/inhalants. The service includes pharmacists performing a brown-bag review [5] and a subsequent medication review, which can be provided and reimbursed once every 12 months [6]. If at least three acting medications/inhalants have been substituted, the service can also be reimbursed before the end of the 12-month period [6]. Pharmacists can independently initiate a medication analysis, without consulting a physician, if the above-mentioned legal criteria are met and if the patient has agreed to the service. The

new pharmaceutical services profoundly increase pharmacists' responsibility in primary health care, offering an in-depth medication service, outside the typical realm addressed by general practitioners. With this approach, the German health care system provides a foundation for enhanced medication safety, systematically integrating pharmacists as specialists to oversee complex medication regimens. Pharmacies in Germany have an estimated amount of one billion patient contacts per year and serve three million patients daily, therefore making use of pharmacists' competencies and services is indispensable [7].

As Remelli et al. have demonstrated in their systematic review, almost two out of three type 2 diabetes mellitus (T2DM) patients are affected by polypharmacy [8]. Bauer et al. reported that T2DM patients in Germany are prescribed an average of 8.4 drugs [9]. Therefore, one important patient group that could benefit from medication counseling are T2DM patients. Pharmaceutical services in T2DM patients provided by pharmacists have already been shown to have benefits not only for patients, but also for health care systems by reducing the avoidable costs of T2DM [10–12].

A new trend of digital health and progressive digitalization has been steadily observed in German community pharmacies in recent years, with the aim of facilitating pharmacists' daily work. For example, there are drug interaction alert software programs that inform pharmacists of potential drug interactions when drugs are being dispensed [13]. Digital competencies are being integrated into the practice of other pharmaceutical services, such as medication review tools, designed to assist pharmacists with performing medication reviews [14]. Studies have already demonstrated that performing medication review with similar tools identified more drug-related problems than without the use of such tools [15,16].

The rising popularity of digital health tools in everyday practice has led to numerous considerations to introduce the topic of digital health into the curriculum of health care professional students [17–23]. Since the use of digital health tools has been increasingly established among pharmacists for several years, there are already initial approaches or demands to implement digital health topics in the pharmacy curriculum in countries outside of Germany, especially in the United States and Canada [24–29]. To keep pace with recent digital healthcare developments and to prepare pharmacy students for the digital pharmaceutical care services, the Institute of Clinical Pharmacy and Pharmacotherapy Heinrich Heine University Duesseldorf introduced an elective practical course in mHealth and diabetes and digital health seminar. Additionally, its aim is to support a new generation of "digitally enabled pharmacists" [23].

The current study was designed to find out whether students can perform better by using a digital medication review tool compared to conducting medication reviews without such a tool. We decided to use the tool "MediCheck Education" (version 4.1.6). "MediCheck" is a well known commercial tool for German pharmacies, which is created to support medication review [30]. Furthermore, we also wanted to investigate the acceptance of digital tools among students in pharmacy education.

2. Materials and Methods

2.1. Participants and Study Design

The approval for this study was granted by the Ethics Committee of the Faculty of Medicine, Heinrich Heine University Duesseldorf. (Study number: "2022-1942-andere Forschung erstvotierend"). A total of 45 pharmacy students who were in their eighth and final semester at Heinrich Heine University Duesseldorf were considered for participation in the study. The study was conducted from May until June 2022 in the summer semester as a part of the clinical pharmacy course. Students were informed face-to-face by a clinical pharmacy lecturer during a seminar about the opportunity to participate in the study and were provided with a participation information sheet and a consent form, including a data protection statement. The inclusion criteria for the study were: signed informed consent form for participation in the study and signed data protection statement. Four students have already engaged with the medication review tool during a two-week internship

prior to their eighth semester, thus they were excluded from the study. Voluntariness to participate in the study was emphasized and participation was not a requirement for passing the course. In order to preserve the confidentiality of personal data, participants were pseudonymized with study codes. Participants were randomly assigned to the intervention or control group. The overall study design is illustrated in Figure 1.

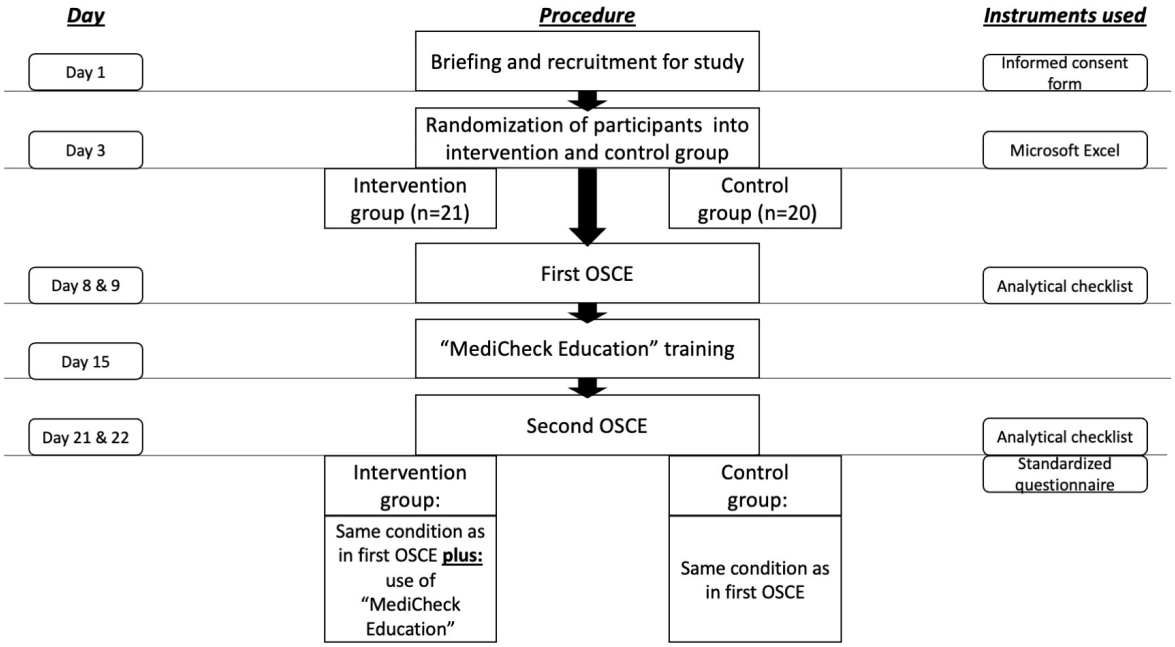

Figure 1. Study procedure and time-schedule. OSCE = objective structured clinical examination.

2.2. Procedure of First and Second OSCE

Performance of the participants in reviewing patient's medication was assessed through first and second OSCEs. OSCE stands for "Objective Structured Clinical Examination" and is a modern verbal–practical examination method that has already been researched at the Institute of Clinical Pharmacy and is used as an innovative teaching and examination method [31–34]. OSCEs include about 20 stations, where one to two aspects of competence are tested per station. The present study, however, includes only one OSCE station, which deals with the conduct of a medication review. For reasons of linguistic comprehensibility, the term "OSCE" is used in the following instead of "single-station OSCE".

In the first OSCE, the intervention and control group used the same analysis methods and did not use supportive digital medication review tools (DMRT). The participants received the respective case description, subjective and objective data of the patient, the patient's medication schedule, and a form in which the participants could record their results. For research purposes, each participant was provided with a computer. Participants had access to a personal computer and were thus able to retrieve, for example, summaries of product characteristics of drugs and treatment guidelines. For both groups, the use of any DMRT was not allowed in the first OSCE. Each participant had exactly one hour to complete the medication review.

After the predetermined 60 min, participants were led to a room where they talked to an acting physician about the patient's medication. In a role play scenario, physicians were played by two faculty members and an eighth semester student who did not participate in the study, whereas the study participants took on the role of the pharmacists. This conversation was documented and scored by a third person party, the OSCE examiner, using a standardized OSCE checklist. The OSCE examiners were all three clinical pharmacy faculty members and pharmacists qualified to rate the role play performance. The participants performed the OSCEs in a time-shifted manner (15-min time slots) to prevent

possible exchange between the students, in the case that patient cases were the same. In addition, new patient cases were added for medication review after the first half of the day, throughout each day performing OSCE.

The student participants played the role of the pharmacists who informed the role-play physician about drug-related problems, drug interactions, and other errors regarding the patient's medication. The physician–pharmacist consultation was limited to 10 min.

During the second OSCE, the procedure was identical; in terms of resources, the intervention and control groups differed. While the control group received the same equipment as in the first OSCE, the intervention group also used the DMRT "MediCheck Education" (by "pharma4u GmbH", Eschborn, Germany) [30]. Both groups similarly had 60 min for the medication review and 10 min for the interview with the acting physician. To obtain the most objective assessment possible through the analytic checklist, the same examiner was always selected for each participant for the first and second OSCE. The study had a "blinded design", and the student participants were not informed whether they belonged to the intervention group (working with "MediCheck Education") or the control group (without "MediCheck Education") until the beginning of the second OSCE. Throughout the study, neither the role-play physicians, nor the OSCE examiners, knew which participant belonged to intervention or control group. Prior to the OSCEs, both groups of role-play physicians and OSCE examiners were instructed on their respective tasks in order to be familiar with the procedure.

2.3. Patient Cases

For the first and second OSCE, four realistic patient cases were developed. It was considered that the cases were solvable within one hour. Three faculty members participated in the generation of the total of eight patient cases (SL, EO, and AD). To generate realistic patient cases, the anonymized patient cases from the EMDIA case series were used and modified accordingly [35]. The patient cases created were multimorbid elderly patients, all with T2DM. Other frequently occurring comorbidities were hypertension (n = 7) and dyslipidemia (n = 5). Overall, patients had a minimum of four and a maximum of six concomitant diseases, with some differences in diagnosis and medications. However, the patient cases were all kept at the same difficulty level. Moreover, it was ensured that for each patient case an equal number of participants from the control and intervention groups were allocated. In addition to eight OSCE patient cases, two further cases were designed for the "MediCheck Education" training. Each patient case is displayed in detail in Appendix A.

2.4. Software Tool "MediCheck Education"

"MediCheck" is a commercial web-based tool that can assist pharmacists in conducting medication reviews. Any web browser can be used to access the website, which requires a login. After logging in, an entry screen appears, which is divided into five categories and must be filled in with patient details for the medication review. The first category is called "Patient", where the basic patient details, such as the patient's age, height, and body weight are entered. The second category is called "Medication". Here, all prescription and non-prescription medicines are recorded, including details of the package size, dosage, dosage regimen, dosage form, time of intake, and indication of the medicine. In the third category, problems and symptoms reported by the patient can be indicated. In the fourth category, all available laboratory and vital parameters of the patient are entered, such as cholesterol or blood sugar values from the last blood test. The fifth and last category includes the indication of diagnosed diseases or existing allergies of the patient. Once all five categories have been completed, the medication can be analysed. For the analysis, "MediCheck" uses an extensive database that contains, for example, different guidelines or product information on all medicines approved in Germany. This means, for instance, that an adjustment of the dose of metformin can be recommended in the case of existing renal insufficiency. The system checks for numerous parameters, such as drug–drug

interactions, drug–disease interactions, contraindications, wrong dosages, and also the divisibility of tablets. After the analysis, all detected problems are listed and categorised in four risk categories with different colours. When listing all detected problems, the program lists sources and reasons as to why a problem was detected and additionally suggests corresponding alternatives. "MediCheck Education" and "MediCheck" do not differ in their functions; "MediCheck Education" is, however, merely used for training purposes.

2.5. "MediCheck Education" Training

Between the first and second OSCE, participants received training in DMRT "MediCheck Education". Both control group and intervention group participants received this training simultaneously. By training both groups equally and at the same time, it was not revealed to participants whether they were in the intervention group or control group until the second OSCE appointment. The training lasted 2.5 h and was conducted online. Participants registered for the medication review tool without having to provide any personal information, as pseudonymized unlock codes were provided by the company. The pseudonymized activation codes ensured compliance with data protection requirements. After registration and login, participants were shown the user interface and general application options by an institute employee responsible for the entire study. The participants were then presented two fictitious patient cases for which they had to perform a medication review. For the processing of the patient cases, 45 min were calculated in each case. After the patient cases were reviewed, the results were discussed among all participants, as well as how "MediCheck Education" can be included in the medication review.

2.6. Measurement Instruments

2.6.1. Analytical Checklist for OSCE

Participants' performance was assessed through an analytic checklist. The checklists were individualized to each patient's case, resulting in a total of eight different checklists. The same faculty members who created the patient cases (SL, EO, and AD) also created the respective checklists. The checklist always had the same structure, which was classified into four subcategories, namely, "Communication Skills", "Patient data (subjective and objective)", "Assessment", and "Plan". Due to the uniform structure of the checklist, it was easier for the OSCE examiners to adapt to a quick overview regarding the checklist. In addition to measuring the overall performance between groups, dividing the checklist into categories made it possible to conduct a subcategory analysis and thus to have a deeper insight for which areas the DMRT could be especially supportive. Each element was weighted equally. If an element was mentioned by the participant during the OSCE, the participant received one point. For each element, there was also a space for the OSCE examiners to take notes for any special occurrences or ambiguities. Since the patient cases were different, the checklists had different maximum scores. The checklist with the most items contained 29 points, whereas the checklist with the fewest contained 21. To create comparability between the different checklists, performance was measured as percentage. Since the checklists had different maximum scores, the subcategories were also scored differently, depending on the patient case. The subcategories "Communication Skills" and "Patient Data (subjective and objective)" had four points each for each patient case, whereas "Assessment" and "Plan" had different scores, depending on the patient case, and the measuring of performance was based on percentages, as well. The corresponding checklists for the patient cases are attached in Appendix A.

2.6.2. Self-Assessment and Satisfaction Questionnaire

After the second OSCE, both the intervention and control groups were asked to complete a questionnaire with three questions about participants' demographic data, such as age, sex, and previous professional experience in community pharmacies, as well as eight statements that the participants should rate. Regarding age, the option was given to select the age ranges "23 years or younger", "24–30 years", and "30 years or older". For

the sake of data protection, we decided against the disclosure of the exact age. For sex, there was a choice between "male", "female", and "diverse". The options for answering the question of previous professional experience in pharmacies were "yes" and "no". The eight statements were related to the participants' self-assessment regarding the process of the OSCEs (6 statements) and the use of digital tools (2 statements) in teaching clinical pharmacy. The rating was carried out by a five-point Likert scale (1 = "Strongly agree", 2 = "Agree" 3 = "Neither agree nor disagree", 4 = "Disagree", 5 = "Strongly disagree"). The statistical analysis of the statements was displayed by a forest plot. The eight statements are shown in Table 1.

Table 1. The eight statements of the participants' questionnaire.

Statement 1	"I feel generally competent to perform a medication review"
Statement 2	"I feel more confident conducting the medication review today than I did during the medication review in the first OSCE"
Statement 3	"The time provided for the medication review was sufficient for me"
Statement 4	"The documentation provided for the medication review was sufficient for me (subjective and objective patient data, medication schedule, PC for research purposes, medication review tool if used)"
Statement 5	"I feel generally competent to have a face-to-face meeting with a physician"
Statement 6	"I feel more confident in today's face-to-face meeting than I did in the face-to-face meeting in the last OSCE"
Statement 7	"The use of digital tools such as "MediCheck Education" is a useful addition for a medication review"
Statement 8	"The use of digital tools such as "MediCheck Education" is a useful addition to teaching in clinical pharmacy"

2.7. Data Protection, Analysis, and Statistical Methods

All data collected by means of questionnaires and checklists were pseudonymized through the use of a code not indicating the names of the participants. During data analysis, a coding list existed that linked the names of the participants to the codes. The coding list was accessible only to the study director and project staff of the "Institute of Clinical Pharmacy and Pharmacotherapy at Heinrich Heine University", Duesseldorf, and was destroyed after completion of the data analysis. After the destruction of the coding list, the data are available in anonymized form so that it is no longer possible to draw conclusions about individual participants.

Randomization of participants into the intervention and control groups was performed using the "RAND function" by "Microsoft Excel" (version 2019). "Microsoft Excel" was used for data collection, and "RStudio" was used for data analysis.

A two-sided Mann-Whitney test was performed for the first OSCE for the comparison of performance between the intervention and control groups before using DMRT. For the second OSCE, a one-sided Mann-Whitney test was performed for the comparison of performance between the intervention and control groups after the use of the DMRT. To examine improvement in performance between the first and second OSCE within each group, a one-sided Wilcoxon signed-rank test was performed for the intervention group. Based on the hypothesis that the control group would not improve on the second OSCE, we performed a two-sided Wilcoxon signed-rank test on the control group. A significance level of $\alpha = 0.05$ was considered in all statistical tests.

The same statistical methods used for the overall data analysis were also employed for the respective subcategories. The aim was to be able to make a more precise statement about the field in which the performance of the participants changed if the performance changed between the first and second OSCE.

The questionnaire was analysed using the following method: After the demographic data was collected, it was analysed in percentage terms and presented in a table, divided

into control and intervention group, representing demographic characteristics. The numbers from the Likert-scale for each of the eight statements of the questionnaire were analysed by calculating the arithmetic mean and the 95% confidence interval (CI). All means and 95% CIs were displayed in a forest plot. Consensus on a statement was reached when the 95% CI interval did not intersect the vertical line depicting "3" in the forest plot.

3. Results

3.1. Participants Characteristics

The response rate for recruitment was 100%, and all 41 eligible final-semester students signed the informed consent form and privacy policy agreement and were randomized into intervention and control group. Four students who did not participate in the study were scheduled to assist with the study. All 41 recruited participants attended all study appointments, including OSCEs before and after training with "MediCheck Education". Randomization resulted in a group size of 21 participants for the intervention group and 20 participants for the control group. Table 2 describes demographic characteristics for control and intervention groups. Both the intervention and control group show very similar characteristics in terms of age, gender, and the number of those who had a previous professional experience in a community pharmacy.

Table 2. The demographic characteristics of the study participants.

	Intervention Group (*n* = 21) *n* (%)	**Control Group (*n* = 20) *n* (%)**
Age range		
23 years or younger	13 (62)	10 (50)
24–30 years old	5 (24)	7 (35)
30 years or older	3 (14)	3 (15)
Gender		
Female	16 (76)	14 (70)
Male	5 (24)	6 (30)
Previous professional experience (community pharmacy)		
Yes	5 (24)	5 (25)
No	16 (76)	15 (75)

3.2. Analytical Checklist—OSCE

3.2.1. The Result of the Overall Performance

The performance assessment was conducted with an analytical checklist during both OSCEs. The performance scores are listed in Table 3. There was no significant difference ($p = 0.784$) between the intervention and control group at the first OSCE. After practicing with the DMRT "MediCheck Education" and using the tool in the second OSCE by the intervention group, the intervention group (52.1%) showed significantly better ($p < 0.01$) overall performance than the control group (35.1%). While the intervention group improved significantly ($p < 0.05$) in the second OSCE compared to the first OSCE, the control group deteriorated in the second OSCE when compared with the first OSCE ($p < 0.05$), as shown in Figure 2.

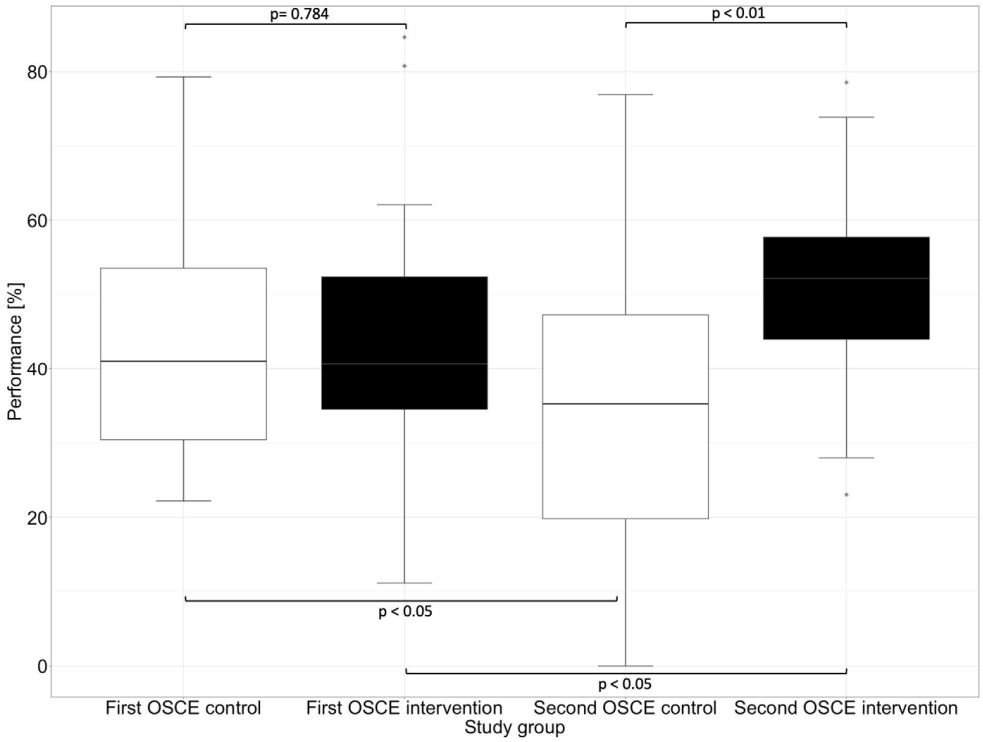

Figure 2. Overall performance in the first and second OSCE measured by an analytic checklist. Horizontal line = median; (*) = outlier.

Table 3. Performance scores of the control and intervention groups in the first and second OSCE.

	Intervention Group (*n* = 21) Score in %	**Control Group (*n* = 20) Score in %**
First OSCE		
Mean (SD)	45.0 (18.1)	43.4 (15.8)
Median (MAD)	40.7 (16.5)	41.1 (17.7)
Second OSCE		
Mean (SD)	52.1 (13.4)	35.1 (19.7)
Median (MAD)	52.2 (12.1)	35.3 (21.9)

OSCE = objective structured clinical examination; SD = standard deviation, MAD = mean absolute deviation.

In our study, in addition to the overall performance of the groups, we evaluated the progress in the performance of medication reviews between the first and second OSCE. While significant progress regarding the performance could be observed in the intervention group, where the participants improved by a mean of 7.1% and a median of 8.9%, a negative performance development could be observed in the control group. The control group showed a deterioration of 8.4% in the mean and 5.6% in the median. Figure 3 shows the performance development of the participants in reviewing the patient's medication between the first and the second OSCE.

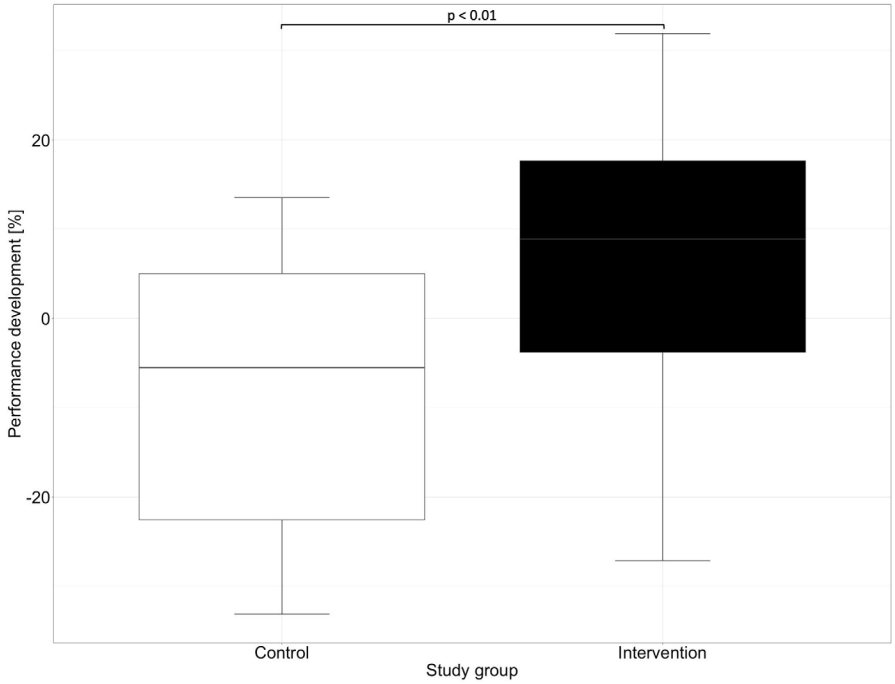

Figure 3. Performance development for the control and the intervention groups between the first and the second OSCE. Performance development was generated by subtracting participants' performance on the second OSCE with their performance on the first OSCE. Horizontal line = median.

3.2.2. Subcategory Analysis

The performance of the participants' medication review was recorded through an analytical checklist during the OSCEs. The checklist was divided into four categories. (1st "Communication Skills", 2nd "Patient Data (subjective and objective)", 3rd "Assessment" and 4th "Plan"). It was assessed in which areas the performance of the participants has improved through "MediCheck Education". Table 4 shows the performance scores of the respective subcategories.

Table 4. Performance scores of the first and second OSCE in four subcategories.

	Intervention Group (*n* = 21) Mean (SD) Score in %	**Control Group (*n* = 20) Mean (SD) Score in %**
Communication Skills		
First OSCE	52.4 (22.2)	57.5 (28.2)
Second OSCE	57.1 (25.2)	47.5 (29.1)
Patient data		
First OSCE	50.0 (22.3)	52.5 (21.3)
Second OSCE	47.6 (20.8)	38.8 (26.3)
Assessment		
First OSCE	45.2 (19.5)	41.9 (21.7)
Second OSCE	58.4 (18.0)	36.3 (22.8)
Plan		
First OSCE	33.2 (26.3)	27.1 (22.9)
Second OSCE	40.6 (20.0)	20.9 (22.5)

OSCE = Objective Structured Clinical Examination; SD = standard deviation.

In the first OSCE, the control group and the intervention group did not differ significantly (e.g., $p = 0.448$ in the subcategory "Assessment" and $p = 0.430$ in the subcategory "Plan") from each other in any of the subcategories. In the second OSCE, there was no significant difference in performance between the intervention and control groups in the categories of "Communication Skills" ($p = 0.126$) and "Patient Data (subjective and objective)" ($p = 0.156$). However, there were differences in performance in the categories "Assessment" and "Plan", where the intervention group performed significantly ($p < 0.01$) better than the control group in the second OSCE.

In the "Assessment", which deals with the identification of drug-related problems, such as dosing errors or drug interactions, the intervention group performed significantly better than the control group in the second OSCE. The category "Plan" focuses on solutions to problems that were either known and recorded in the category "Patient Data (subjective and objective)" or uncovered in the "Assessment", such as incorrect dosing or occurring drug-related problems. The difference between the intervention and the control group in the first and second OSCE is shown graphically in Figure 4 for the subcategory "Assessment" and in Figure 5 for the subcategory "Plan".

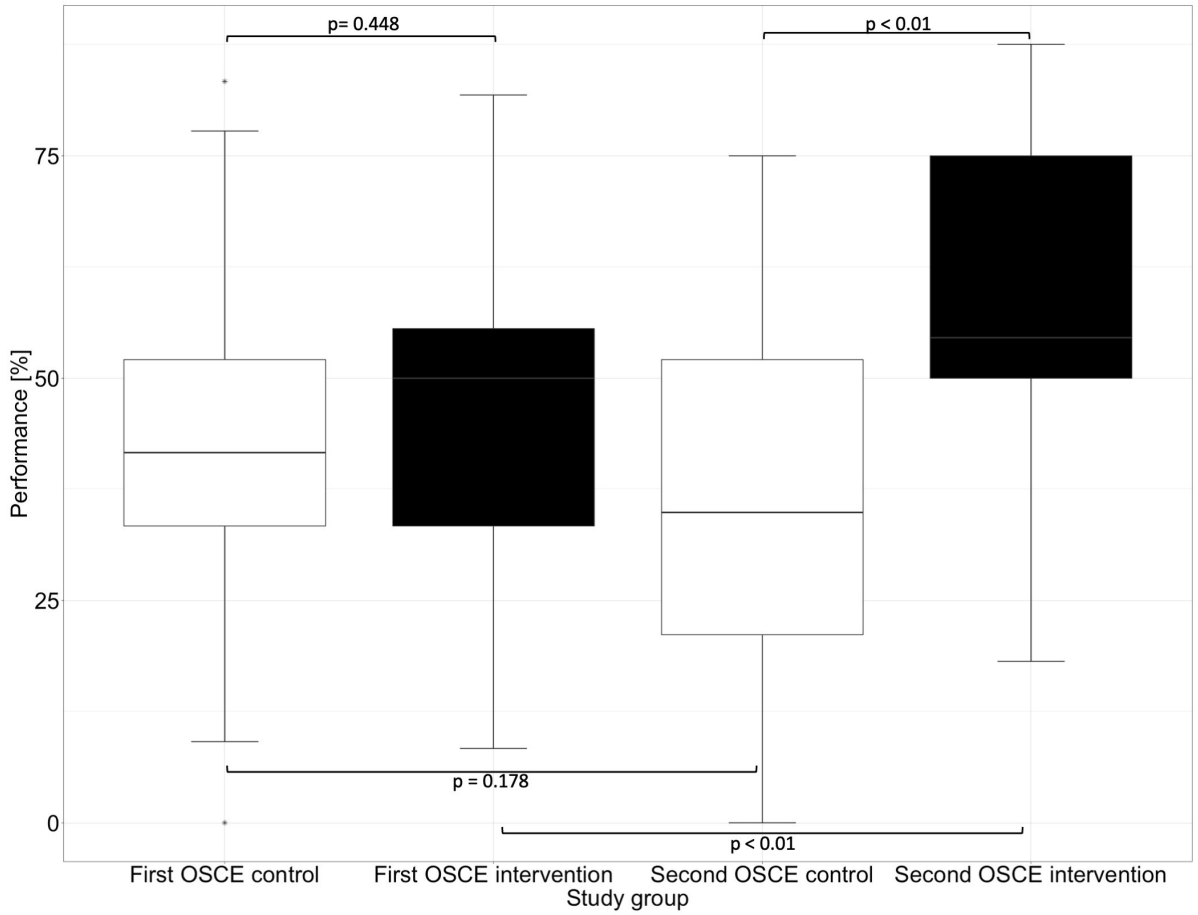

Figure 4. Performance of the first and second OSCE in the subcategory "Assessment". Horizontal line = median; (*) = outlier.

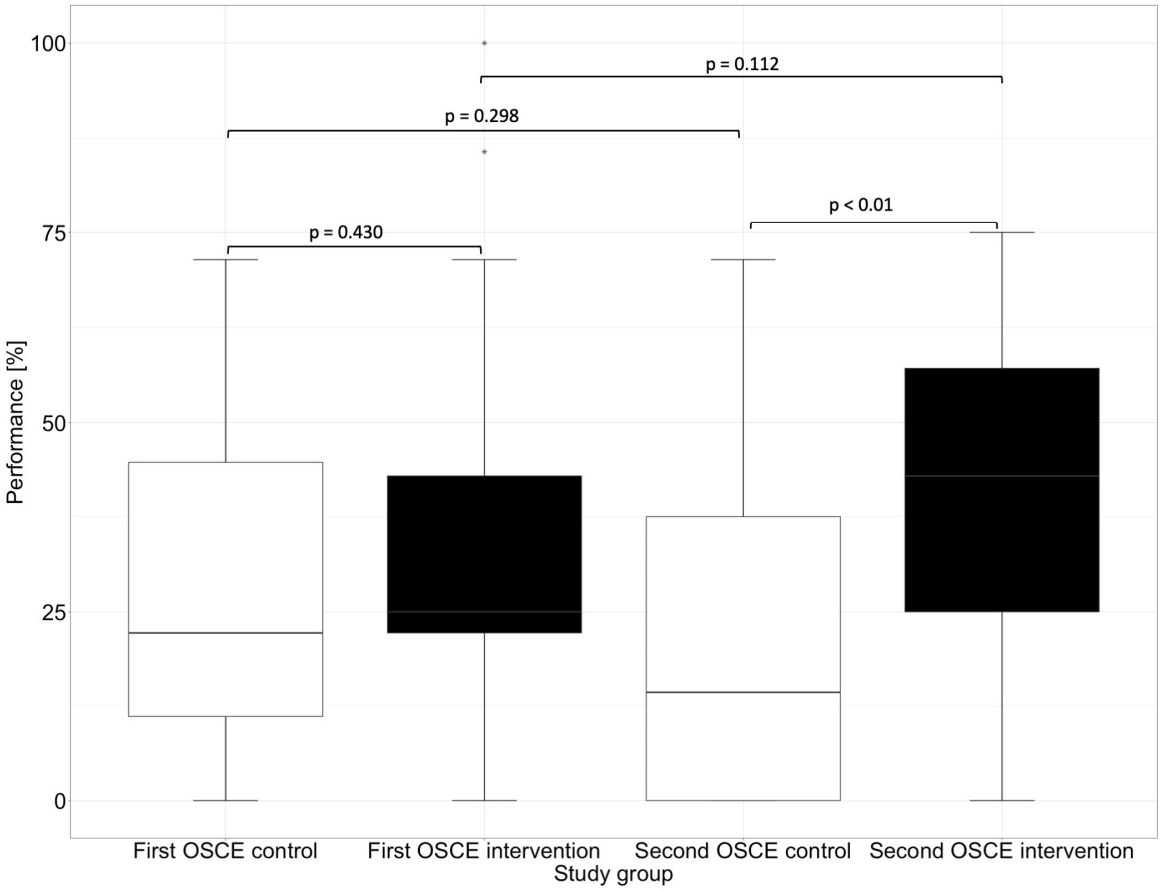

Figure 5. Performance of the first and second OSCE in the subcategory "Plan". Horizontal line = median; (*) = outlier.

3.3. Self-Assessment and Satisfaction Questionnaire

Participants received questionnaires to provide statements about their self-assessment of performance during OSCEs and the use of digital tools in clinical pharmacy, as defined in Table 1. The analysis of the questionnaires was conducted using a forest plot, as shown in Figure 6. The statements were rated using a five-point Likert scale ranging from one ("strongly agree") to five points ("strongly disagree"). Consensus on a statement was reached when the 95% confidence interval did not intersect the vertical line depicting "3" in the forest plot.

For half of the statements (statement number 1, 4, 7, and 8), there is consensus in both the intervention group and the control group. In particular, statements 7 and 8, which dealt with the use and meaningfulness of digital tools in general and their introduction into teaching, there was a strong agreement and support for implementation and establishment of digital tools to support medication reviews in teaching.

Regarding statements 2, 3, 5, and 6, the intervention group reached consensus, whereas the control group showed a similar tendency, but no consensus. Especially, the time aspect was rated very much as sufficient by the intervention group, and not by the control group. Statements 5 and 6, dealing with self-confidence during the conversation with the physician, showed that the intervention group felt more confident than the control group.

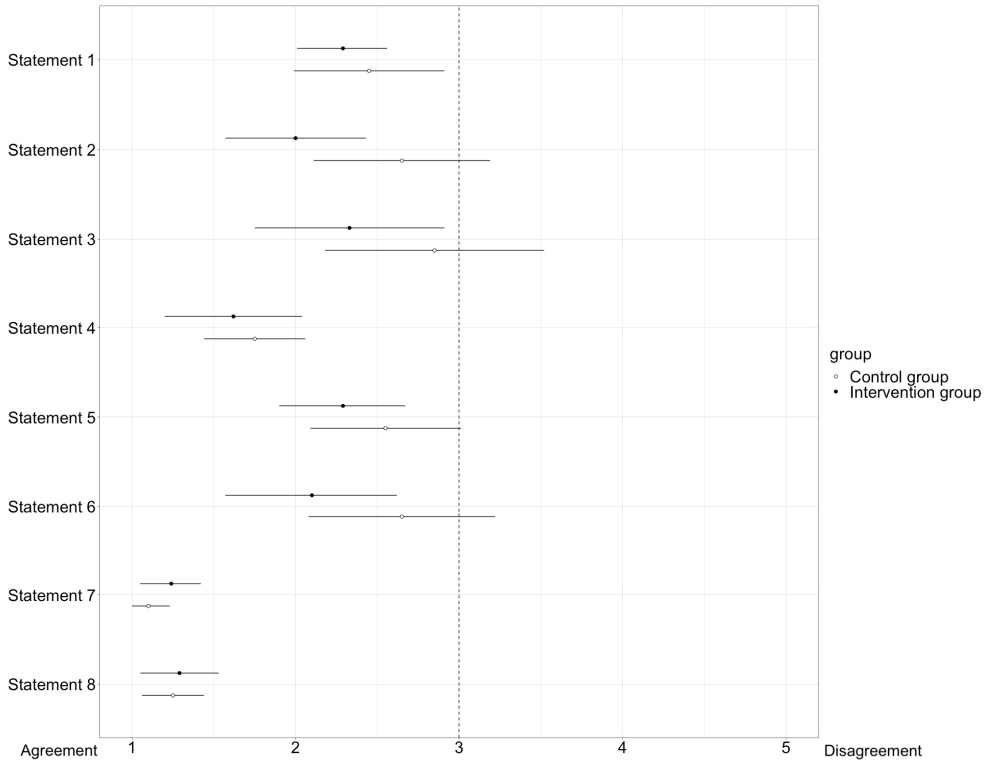

Figure 6. Display of the results of the questionnaire in a forest plot. The box represents the arithmetic mean. The horizontal lines to the left and right of the box indicate the 95% confidence interval. Consensus on a statement is reached when the confidence interval does not intersect the vertical line on 3 of the X-axis of the forest plot. While consensus was reached on all statements for the intervention group, no consensus was reached on statements 2, 3, 5, and 6 for the control group.

4. Discussion

In our randomized controlled trial, we found that pharmacy students using a DMRT performed better on medication review than students not using a digital tool. The performance of the DMRT-group was significantly better than the performance of the non-DMRT-group. The use of DMRTs helped pharmacy students with performing assessment, as well as creating the action plan for patients, whereas communication and collection of subjective and objective patient data performed equally with and without the digital support tool. In addition, the DMRT group's satisfaction regarding the performance of the medication review, as well as the confidence to interact with the role play physician, were significantly greater than in the non-DMRT-group.

To our knowledge, there are no studies investigating the performance of pharmacy students using DMRTs yet. However, some non-randomized studies with practising pharmacists are available and support our findings [27,28]. Curtain et al. demonstrated that pharmacists using medication review software for their medication review identified more drug-related problems than pharmacists without supporting software [15]. Verdoorn et al. investigated the impact of a clinical decision support system (CDSS) in a medication review [16]. In this study, a pre- to post-analysis of clinical medication review using a CDSS showed that the number of DRP identified increased. Both studies were retrospective. Our prospective RCT study design provides high quality evidence that DMRT use results in better outcomes of medication reviews.

By further examining the subcategories of the medication review process, we were able to identify the categories where DMRT was most useful. Especially in the areas of assessing the medication prescribed and creating effective and safe medication plans, a digital assistant program proves to be a useful tool within the medication review process. This is in line with results from Curtain et al., emphasizing that software may help pharmacists in

making good decisions and detecting important drug-related problems [36]. On the other hand, categories, such as communication skills and collection of all relevant subjective and objective patient data, were not affected by the digital tool. This is not surprising and can be expected, since DMRTs were not designed for these "soft skills".

In this study, DMRT was able to give pharmacy students more satisfaction and self-confidence. A major difference was the time required to complete the DMRT. The participants had one hour to solve each patient case; in contrast to the control group, the intervention group tended to agree that the time allotted was sufficient. In the studies by Levivien et al., Skalafouris et al., and Verdoorn et al., dealing with the use of digital tools in medication review, all emphasized the time-consuming factor that plays an important role in a medication review [16,37,38]. Verdoorn et al. even recommended to analyse the time aspect during a medication review in future studies. The different results between the DMRT-group and the non-DMRT-group, regarding the time aspect, could indicate that medication review is more efficient when using digital tools. However, it should be noted that this finding is based on a survey questionnaire, and the time for medication review was limited. Whether the intervention group carried out the medication review in a more time-efficient way was not analysed.

Our study may have some limitations. Firstly, the DMRT software reaches its limits when it comes to product characteristics of drugs or the implementation of current guidelines. As a result, digital tools cannot only create correct, but also incorrect correlations between drugs or suggest therapy recommendations that are no longer state of the art. Therefore, the use of digital tools in medication review is only warranted for pharmacists with clinical training and pharmacotherapy knowledge. Hence, our students received DMRT training ("MediCheck Education" training) and were trained to prioritize and solve drug-related problems.

Secondly, the assessment of a participant's performance was performed by an OSCE examiner. The OSCE examiner, however, could have some degree of subjectivity in the assessment and could have biased the results. These biases were addressed by strictly following the analytical checklists, as well as a uniform training for of all study staff evaluating the performance of the participants and grading the analytical checklist. Furthermore, the same examiner was always assigned to each participant in the first and second OSCE to prevent examiner-dependent variation in scoring. Moreover, care was taken to ensure that the individual items were clearly defined in the analytic checklist so that there was little room for interpretation by the examiners to assess performance.

Regarding the simulation of the physician role, the pharmacy faculty members and a student were also uniformly trained by the study author, and rehearsals of role plays were conducted. During those rehearsals, questions that arose were clarified, and clear guidelines were given in terms of communication. Again, before the first OSCE began, we discussed possible scenarios with participating role play physicians and analysed all patient cases in detail so that the interview would be as authentic as possible. Moreover, during the conversation with the study participants, the physicians in the role play were provided with documents, such as patient's medication schedule and other fictitious data.

Our checklists were established in a two-step approach. First, two faculty members (AD and SS) tested the checklists on four pharmacy students as part of an internship in a small pilot study. These four students were not included in the later study. In this pilot study, the two faculty members investigated potential strengths and weaknesses of the checklists. Afterwards, the checklists were discussed with two other faculty members (EO and SL) who already had experience in creating OSCE checklists from previous studies [31–33], and the checklists were further optimised. Nevertheless, an assessment of the validity of our checklist by an external expert panel would have further strengthened our method.

When we analysed our results, we noticed that the non-DMRT-group performed worse in the review of patient's medication in the second OSCE than in the first OSCE, which we had not anticipated before. While the DMRT-group, using the "MediCheck Education", performed better and fulfilled more criteria on the analytical checklists, the analysis of our

data showed that the non-DMRT-group deteriorated significantly. We suspect two causes that might be responsible for this observation: the first cause could be that participants in the non-DMRT-group were no longer as motivated in the second OSCE as they were in the first OSCE. Unlike participants of the DMRT-group, non-DMRT-group participants were not allowed to work with new methods to analyse patients' medication. Another reason could be that the level of difficulty of the patient cases in the second OSCE was higher than in the first. The faculty members made sure that patient cases were approximately similar in terms of the number of diseases, as well as drugs, in order to generate patient cases of the same level of difficulty. Nevertheless, there is a possibility that the participants found the patient cases as a total more difficult in the second OSCE. Despite that, we ensured that approximately equal numbers of participants from the DMRT and non-DMRT groups were allocated to each patient case. However, in the event that the second case was deemed more difficult for the students to solve, it would make an even more positive statement in favour of using DMRT in medication review.

5. Conclusions

To the best of our knowledge, this is the first study to investigate the use of digital tools to support medication review in pharmacy students. Our study was able to demonstrate that pharmacy students do not only perform better in medication reviews when using "MediCheck Education", but also feel more self-confident in the process. In addition, we could observe that students welcomed digital assistance and expressed their satisfaction with the introduction of digital tools in clinical pharmacy education.

In our study, we observe that the use of digital tools requires training and clinical reasoning skills. DMRTs work best when they are assissted by trained medication experts—pharmacists—who are able to prioritize drug-related problems and provide correct recommendations in medication reviews.

Therefore, it is mandatory to introduce digital tools in teaching early, in a continuous effort to adapt pharmacy education to real-life pharmacy practice. The pharmacy curriculum at German universities does not require students to work in hospitals or pharmacies with real scenarios and real patients. Thus, an introduction of a course on the use of digital tools is even more important, so that, after graduation, students have at least acquired a theoretical knowledge in their daily work and have applied such tools on the basis of patient cases. However, further studies with larger sample size are needed to underline the establishment of digital tools in pharmacy teaching.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of the Faculty of Medicine, Heinrich Heine University Duesseldorf (Study number: "2022-1942-andere Forschung erstvotierend").

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The dataset presented in this study is available from the corresponding author on reasonable request.

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Appendix A

Subjective and objective patient data
Patient 1

Name:	Patient One
Date of birth:	01 March 1957
Sex:	male
Weight:	1.86 m
Height:	90 kg

Information from the patient

non-smoker; In the past, stomach pain due to the antibiotic and the painkiller, which had to be taken for a short time; was prescribed by the dentist due to an infection in the mouth and throat; currently no longer taking the antibiotic and the painkiller; complains of vertigo and cold sweat which occur regularly

Laboratory and vital parameter

Blood pressure:	158/91 mmHg
Heart rate:	78 bpm
LDL-c:	110 mg/dl
HbA1c:	7.4 %
Last blood glucose measurement:	200 mg/dl

Diagnosed diseases

Hypertension

Diabetes mellitus type 2

Hypothyroidism

Figure A1. Subjective and objective patient data—Patient 1 in the first OSCE.

Medication schedule	Patient 1

Agent	Product name	Dosage	Dosage form	morning	noon	evening	night	Unit	Time of intake	Indication
Long-term medication										
Metformin hydrochloride	METFORMIN 850-1A PHARMA	850 mg	Tabl	1	0	1	0	piece	On empty stomach	Diabetes mellitus type 2
Metoprolol succinate	METOHEXAL SUCC 47.5MG	47.5 mg	RetTabl	½	0	½	0	piece	with meal	Hypertension
Glibenclamide	GLIBENCLAMID ABZ 1.75MG	1.75 mg	Tabl	1	0	1	0	piece	On empty stomach	Diabetes mellitus Typ 2
Levothyroxine sodium	L-THYROXIN HENNING 100	0.1 mg	Tabl	1	0	0	0	piece	On empty stomach	Hypothyriodism
Omeprazole	OMEPRAZOL ABZ 40MG	40 mg	Kaps	1	0	0	0	piece	with meal	Reflux
Ibuprofen	IBU 600-1A PHARMA	600 mg	Tabl	1	1	1	0	piece	with meal	Inflammation as a result of an injury
Short-term medication										
Amoxicillin	AMOXICILLIN ABZ 1000MG	1000 mg	Tabl	1	0	1	0	piece		Dental abscess

Figure A2. Medication schedule—Patient 1 in the first OSCE.

Subjective and objective patient data
Patient 2

Name:	Patient Two
Date of birth:	01 January 1956
Sex:	male
Height:	1.76 m
Weight:	93 kg

Information from the patient

Non-smoker; According to own statements a little "forgetful" when taking medication; Frequent muscle soreness, muscle spasms and musculoskeletal pain even though physical activity is "kept to a minimum"; has been suffering from annoying onychomycosis for a long time

Laboratory and vital parameter

Blood pressure:	130/80 mmHg
Heart rate:	69 bpm
GFR:	99 ml/min
LDL-c:	72 mg/dl
HbA1c:	8.9 %

Diagnosed diseases:

Obesity

Hypertension

Diabetes mellitus type 2

Onychomycosis

Insomnia

Figure A3. Subjective and objective patient data—Patient 2 in the first OSCE.

Medication schedule	Patient 2

Agent	Product name	Dosage	Dosage form	morning	noon	evening	night	Unit	Time of intake	Indication
Long-term medication										
Metformin hydrochloride / Sitagliptin	JANUMET 50MG/850MG	50 mg 850 mg	Tabl	1	0	1	0	piece		Diabetes mellitus type 2
Candesartan	CANDESARTAN-ABZ 16MG	16 mg	Tabl	1	1	1	0	piece		Hypertension
Amitriptyline	AMITRIPTYLIN-CT 25MG	25 mg	Tabl	0	0	1	0	piece		Insomnia
Simvastatin	SIMVASTATIN ABZ 40MG	40 mg	Tabl	1	0	0	0	piece		Hypercholesterolemia
Short-term medication										
Itraconazole	ITRACONAZOL ABZ 100MG	100 mg	Kaps	1	0	0	0	piece		Onychomycosis
Ciclopirox	CICLOPOLI GEGEN NAGELPILZ	80 mg	NAW	1	0	0	0			Onychomycosis
Omeprazole	OMEPRAZOL ABZ 40MG	40 mg	Kaps	1	0	1	0	piece	On empty stomach	Reflux

Figure A4. Medication schedule—Patient 2 in the first OSCE.

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Subjective and objective patient data
Patient 3

Name:	Patient Three
Date of birth:	1 January 1953
Sex:	female
Height:	1.64 m
Weight:	76 kg

Information from the patient

Non-smoker; has been struggling with dry mouth a lot lately, even though she drinks enough. She feels dizzy during the day

Laboratory and vital parameter

Blood pressure:	137/81 mmHg
Heart rate:	69 bpm
GFR:	58 ml/min
LDL-c:	70 mg/dl
HbA1c:	7.1 %

Diagnosed diseases:

Diabetes mellitus type 2

Hypertension

Osteoporosis

Chronic kidney disease

Figure A5. Subjective and objective patient data—Patient 3 in the first OSCE.

Medication schedule	Patient 3

Agent	Product name	Dosage	Dosage form	morning	noon	evening	night	Unit	Time of intake	Indication
Long-term medication										
Ramipril	RAMIPRIL ABZ 5MG	5 mg	Tabl	1	0	1	0	piece		Hypertension
Calciumcarbonate	CALCIUM 1000MG HEXAL	2500 mg	EffervTabl	1	0	0	0	piece	On empty stomach	Osteoporosis
Doxazosin	DOXAZOSIN ABZ 4MG	4 mg	RetTabl	1	0	0	0	piece		Hypertension
Alendronic acid	ALENDRONSÄURE-RATIOPHARM...	70 mg	Tabl	once a week				piece	On empty stomach	Osteoporosis
Metformin hydrochloride	METFORMIN 850-1A PHARMA	850 mg	Tabl	1	1	1	0	piece		Diabetes mellitus type 2
Vitamin D3	DEKRISTOL 1000 I.E.	1000 I.U	Tabl	1	0	0	0	piece	On empty stomach	Osteoporosis

Figure A6. Medication schedule—Patient 3 in the first OSCE.

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Subjective and objective patient data
Patient 4

Name:	Patient Four
Date of birth:	01 January 1956
Sex:	male
Weight:	1.73 m
Height:	90 kg

Information from the patient

Non-smoker; since the prescription of insulin; patient has complained of rapid weight gain; Has been having difficult respiratory problems and dizziness on and off lately. According to the patient, he also has sweaty hands more often due to the weight gain; FEV (1) has always been good, but recently more often less than 60%.

Laboratory and vital parameter

Blood pressure:	124/75 mmHg
Heart rate:	65 bpm
LDL-c:	100 mg/dl
HbA1c:	6.6 %
FEV (1):	58 %
Fasting blood glucose value (last time measured):	54 mg/dl

Diagnosed diseases

Diabetes mellitus type 2

Bronchial asthma

Vitamin D deficiency

Migraine

Figure A7. Subjective and objective patient data—Patient 4 in the first OSCE.

Medication schedule	Patient 4

Agent	Product name	Dosage	Dosage form	morning	noon	evening	night	Unit	Time of intake	Indication
Long-term medication										
Metformin hydrochloride	METFORMIN 1000-1A PHARMA	1000 mg	Tabl	1	0	1	0	piece		Diabetes mellitus type 2
Vitamin D3	DEKRISTOL 20000 I.E.	20 mg	Kaps	see next line				piece		Vitamin D-deficiency
once a week										
Insulin glargine	LANTUS 100 EINHEITEN/ML INJEKTIO...	300 E.	Amp	0	0	20	0	IU		Diabetes mellitus type 2
Beclometasone dipropionate	BECLOMETASON-RATIOPHARM...	0.05 mg	Spray	0	0	1	0	spray		Bronchial asthma
Metoprolol tartrate	METOPROLOL 100 HEUMANN	100 mg	Tabl	½	0	½	0	piece		Migraine
Short-term medication										
Salbutamol	SALBUTAMOL-RATIOPHARM...	0.1 mg	Spray	1	1	1	0	spray		Bronchial asthma
Sumatriptan succinate	SUMATRIPTAN ABZ 100MG	140 mg	Tabl	1	0	0	0	piece		Migraine

Figure A8. Medication schedule—Patient 4 in the first OSCE.

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Subjective and objective patient data
Patient 5

Name:	Patient Five
Date of birth:	01 January 1961
Sex:	male
Height:	1.78 m
Weight:	87 kg

Information from the patient

Non-smoker; Migraine is often associated with nausea and vomiting, so in addition to aspirin migraine and sumatriptan, domperidone has recently been prescribed; few days ago, he suffered another migraine attack, with new symptoms such as dizziness, rapid heart rate and syncope.
Suffering from urticaria lately, but cause still unknown. Appointment with dermatologist is in two months. Until the appointment, the GP has prescribed something for the hives. GP prescribed something "great that works against both the hives and the difficulty in falling asleep".

Laboratory and vital parameter

Blood pressure:	134/77 mmHg
Heart rate:	72 bpm
GFR:	99 ml/min
LDL-c:	139 mg/dl
Total cholesterol value:	250 mg/dl
HbA1c:	8.2 %

Diagnosed diseases:

Diabetes mellitus type 2

Migraine

Hypercholesterolemia

Urticaria

Figure A9. Subjective and objective patient data—Patient 5 in the second OSCE.

Medication schedule	Patient 5

Agent	Product name	Dosage	Dosage form	morning	noon	evening	night	Unit	Time of intake	Indication
Long-term medication										
Metformin hydrochloride	METFORMIN 1000-1A PHARMA	1000 mg	Tabl	1	0	1	0	piece		Diabetes mellitus type 2
Dapagliflozin	FORXIGA 5MG	5 mg	Tabl	1	0	0	0	piece		Diabetes mellitus type 2
Simvastatin	SIMVA BASICS 10MG	10 mg	Tabl	1	0	0	0	piece		Hypercholesterolemia
Medication if required										
Domperidone	DOMPERIDON ABZ 10MG	10 mg	Tabl	1	0	0	0	piece		Migraine with vertigo
Acetylsalicylic acid	ASPIRIN MIGRÄNE	500 mg	EffervTabl	2	0	0	0	piece	On empty stomach	Migraine
Sumatriptan succinate	SUMATRIPTAN ABZ 100MG	140 mg	Tabl	1	0	0	0	piece	On empty stomach	Migraine
Short-time medication										
Hydroxyzine dihydrochloride	ATARAX 25MG	25 mg	Tabl	1	0	1	0	piece		Insomnia, Urticaria

Figure A10. Medication schedule—Patient 5 in the second OSCE.

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Subjective and objective patient data
Patient 6

Name:	Patient Six
Date of birth:	01 January 1960
Sex:	male
Height:	1.72 m
Weight:	86 kg

Information from the patient

Smoker. Measurements of low blood glucose levels with the blood glucose measuring device have been observed for quite some time now. He is very desperate: Some time ago he had severe pain. The GP therefore prescribed painkillers. The pain has gone, but new symptoms have appeared. Increased heart rate, (inner) restlessness, dry mouth, increased sweating and insomnia. In addition, spasms and tremor of the hands. He suspects an allergy to the prescribed painkiller.

Laboratory and vital parameter

Blood pressure:	168/94 mmHg
Heart rate:	95 bpm
GFR:	98 ml/min
HbA1c:	8.7 %
Fasting blood glucose value	47 mg/dl

Diagnosed diseases:

Obesity	Unipolar depression
Hypertension	Chronic pain
Diabetes mellitus type 2	
Hypercholesterolemia	

Figure A11. Subjective and objective patient data—Patient 6 in the second OSCE.

Medication schedule	Patient 6

Agent	Product name	Dosage	Dosage form	morning	noon	evening	night	Unit	Time of intake	Indication
Long-time medication										
Metformin hydrochloride	METFORMIN 1000-1A PHARMA	1000 mg	Tabl	1	0	1	0	piece		Diabetes mellitus type 2
Tilidine hydrochloride Naloxone hydrochloride	TILIDIN 50/4 RETARD-1A PHARMA	50 mg 4 mg	RetTabl	1	0	1	0	piece		Chronic pain/ Back pain
Ramipril	RAMIPRIL ABZ 5MG	5 mg	Tabl	1	0	0	0	piece		Hypertension
Simvastatin	SIMVA BASICS 20MG	20 mg	Tabl	1	0	0	0	piece		Hypercholesterolemia
Spironolactone	SPIRONOLACTON ACCORD 25MG	25 mg	Tabl	1	0	0	0	piece		Hypertension
Fluoxetine	FLUOXETIN 20-1A PHARMA	20 mg	Tabl	1	0	0	0	piece		Unipolar depression
Glibenclamide	GLIBENCLAMID ABZ 3.5MG	3.5 mg	Tabl	1	0	0	0	piece		Diabetes mellitus type 2

Figure A12. Medication schedule—Patient 6 in the second OSCE.

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Subjective and objective patient data
Patient 7

Name:	Patient Seven
Date of birth:	01 January 1955
Sex:	male
Height:	1.82 m
Weight:	101 kg

Information from the patient

Non-smoker; Has been complaining of muscle pain and swollen ankles for some time, but these have not been swelling as much as before; Recently, he has to go to the toilet more often, especially at night. His dry cough is not getting any better either, although the allergy period should be over.

Laboratory and vital parameter

Blood pressure:	132/80 mmHg
Heart rate:	76
GFR:	111 ml/min
LDL-c:	122 mg/dl
HDL-c:	40mg/dl
HbA1c:	9.2 %
Fasting blood glucose value:	155 mg/dl

Diagnosed diseases:

Obesity	Coronary artery disease
Hypertension	Hypercholesterolemia
Diabetes mellitus type 2	

Figure A13. Subjective and objective patient data—Patient 7 in the second OSCE.

Medication schedule	Patient 7

Agent	Product name	Dosage	Dosage form	morning	noon	evening	night	Unit	Time of intake	Indication
Long-term medication										
Metformin hydrochloride	METFORMIN 500-1A PHARMA	500 mg	Tabl	1	0	1	0	piece	with meal	Diabetes mellitus type 2
Acetylsalicylic acid	ASS 100-1A PHARMA TAH	100 mg	Tabl	1	0	0	0	piece	with meal	Coronary artery disease
Clopidogrel	CLOPIDOGREL HEUMANN 75MG	75 mg	Tabl	1	0	0	0	piece		Coronary artery disease
Metoprolol succinate	METOPROLOLSUCCINAT AL 47.5MG	47.5 mg	RetTabl	1	0	0	0	piece	with meal	Coronary artery disease
Ramipril	RAMILICH 2.5MG	2.5 mg	Tabl	1	0	0	0	piece		Hypertension
Hydrochlorothiazide	HCT-RATIOPHARM 25MG	25 mg	Tabl	0	0	1	0	piece	with meal	Ankle oedema
Valsartan Amlodipine	DAFIRO 5MG/160MG	160 mg 5 mg	Tabl	1	0	0	0	piece		Hypertension
Atorvastatin	ATORVASTATIN ABZ 20MG	20 mg	Tabl	0	0	1	0	piece		Hypercholesterolemia

Figure A14. Medication schedule—Patient 7 in the second OSCE.

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Subjective and objective patient data
Patient 8

Name:	Patient Eight
Geburtsdatum:	01 January 1948
Sex:	female
Height:	1.65 m
Weight:	73 kg

Information from the patient

Non-smoker; Patient had a fall a few months ago. She did not suffer any fractures, but has been in severe pain since then. Recently, haematomas have also been occurring more frequently

Laboratory and vital parameter

Blood pressure:	138/83 mmHg
Heart rate:	65
GFR:	52 ml/min
INR:	3.4
HbA1c:	6.9 %
Fasting blood glucose value	98 mg/dl

Diagnosed diseases:

Diabetes mellitus type 2	Unipolar depression
Supraventricular tachycardia	Chronic pain
Hypertension	Stroke
Chronic kidney disease	

Figure A15. Subjective and objective patient data—Patient 8 in the second OSCE.

Medication schedule	Patient 8

Agent	Product name	Dosage	Dosage form	morning	noon	evening	night	Unit	Time of intake	Indication
Long-term medication										
Metformin hydrochloride	METFORMIN 1000-1A PHARMA	1000 mg	Tabl	1	1	1	0	piece	with meal	Diabetes mellitus type 2
Apixaban	ELIQUIS 5MG	5 mg	Tabl	1	0	1	0	piece		Stroke
Escitalopram	ESCITALOPRAM ABZ 10MG	10 mg	Tabl	1	0	0	0	piece		Unipolar depression
beta-Acetyldigoxin	NOVODIGAL 0.2MG	0.2 mg	Tabl	1	0	0	0	piece		Tachyarrhythmia absoluta
Metoprolol succinate	METOPROLOLSUCCINAT AL 47.5MG	47.5 mg	RetTabl	1	0	0	0	piece		supraventricular tachycardia
Atorvastatin	ATORVASTATIN ABZ 20MG	20 mg	Tabl	0	0	1	0	piece		Stroke prophylaxis
Candesartan	CANDESARTAN AUROBINDO 8MG	8 mg	Tabl	1	0	0	0	piece		Hypertension
Short-term medication										
Metamizole	NOVAMINSULFON LICHTENSTEIN 500MG	500 mg	Tabl	1	1	1	0	piece		chronic pain

Figure A16. Medication schedule—Patient 8 in the second OSCE.

Checklist First-OSCE Patient 1
Participant (pseudonym):

Pharmaceutical consultation	Criterion met	Criterion not met	Notes
Communication Skills			
Welcome and introduction of the pharmacist			
Presentation of the patient for whom the medication review was performed			
Patient data - subjective and objective – The pharmacist…			
gets an overview of the situation …			
… including the disease pattern (T2DM, hypertension, hypothyroidism)			
… including already prescribed medication (metformin, metoprolol, glibenclamide, levothyroxine, omeprazole; **discontinued drugs:** amoxicillin and ibuprofen)			
… as well as complaints of the patient which have been communicated to the pharmacist (vertigo, cold sweating)			
… asks the physician for additional patient information (e.g., HDL-C value, GFR, thyroid hormone levels)			
Assessment – The pharmacist …			
Diabetes mellitus type 2			
… determines that the HbA1c-level is located in the therapeutically acceptable range with 7.4%			
… determines that the fasting glucose value is (too) high			
… determines that the T2DM therapy not in line with guidelines			
… determines that the symptoms such as dizziness and cold sweat possibly due to hypoglycaemia			
… determines that a possible cause of hypoglycaemiais the combination of glibenclamide and metformin			
Hypertension			
… notes that the present blood pressure value (158/91) is to be classified in the range of hypertension grade 1			
…determines that the hypertension therapy not in line with guidelines (beta-blockers not first-line)			
… explains that metoprolol masks most symptoms of hypoglycaemia; beta-blocker is not preferred in diabetes patients			
…asks why metoprolol was prescribed as a blood pressure lowering drug			
Hypothyroidism			
… has no objections with levothyroxine therapy			
Other aspects			
… asks the physician whether omeprazole prescription is still necessary because ibuprofen and amoxicillin have already been discontinued again			
… determines that the LDL level is too high for diabetics			

Figure A17. *Cont.*

Checklist First-OSCE Patient 1
Participant (pseudonym):

Plan – The pharmacist recommends…			
Diabetes mellitus type 2			
… not to continue prescribing glibenclamide			
… a change in therapy according to the guideline: Metformin + SGLT2-inhibitors or GLP-1 agonists			
Hypertension			
… to discontinue metoprolol gradually			
.. a change of therapy according to guideline: Initial therapy dual combination			
… ACE or AT1 inhibitor + calcium channel blocker or diuretic			
Omeprazole			
… that omeprazole can be gradually discontinued			
LDL-level			
… a statin therapy due to elevated LDL level			
Communication Skills – The pharmacist …			
… asks for any remaining questions from the physician			
… thanks the physician for the conversation and ends the conversation			

Figure A17. Corresponding OSCE checklist for Patient 1 in the first OSCE.

Checklist First-OSCE Patient 2
Participant (pseudonym):

Pharmaceutical consultation	Criterion met	Criterion not met	Notes
Communication Skills			
Welcome and introduction of the pharmacist			
Presentation of the patient for whom the medication review was performed			
Patient data - subjective and objective – The pharmacist…			
gets an overview of the situation …			
… including the disease pattern (T2DM, hypertension, hypercholesterolemia, onychomycosis, reflux disease, insomnia)			
… including already prescribed medication (metformin, sitagliptin, candesartan, itraconazole, ciclopirox, omeprazole, amitriptyline, simvastatin)			
… as well as complaints of the patient which have been communicated to the pharmacist (muscle spasm and musculoskeletal pain)			
… asks the physician for additional patient information (e.g., total cholesterol value, HDL-c value, triglycerides value, Fasting glucose value)			
Assessment – The pharmacist …			
Diabetes mellitus type 2			
… determines that the HbA1c-level is not located in the therapeutically acceptable range with 8.9%			
… identifies the reason for a high HbA1c-level by a possible low adherence of the patient			
Onychomycosis			
… mentions that Onychomycosis may be related to poorly controlled diabetes.			
Hypertension			
… notes that the blood pressure of 130/80 mmHg is within the target range according to the guideline (130 – 140 mmHg systolic)			
… notes that the candesartan dosage is too high (32 mg maximum dose).			
Interactions			
… identifies an absolute contraindication to simvastatin and itraconazole			
… explains that Itraconazole is a (potent) CYP inhibitor			
… explains that there may be increased risks of myopathy/myalgia/rhabdomyolysis			
… identifies that the musculoskeletal pain and muscle spasms have as their cause the interaction			
Other aspects			
… explains that amitriptyline is on the PRISCUS list and is not suitable for elderly patients			
…explains that omeprazole is overdosed			
… explains that the medication schedule recommends taking the simvastatin in the morning			

Figure A18. *Cont.*

Checklist First-OSCE Patient 2
Participant (pseudonym):

Plan – The pharmacist…			
Diabetes mellitus type 2			
… proposes to conduct an educational talk with the patient himself in order to improve the patient's adherence.			
… recommends replacement of sitagliptin with a GLP-1 agonists (preferred) or 3-drug therapy of metformin, sitagliptin and GLP-1 agonist (due to obesity).			
… recommends consulting a podiatrist/diabetologist as the Onychomycosis may be related to poorly controlled diabetes.			
Hypertension			
… recommends reducing the dose to a maximum of 32 mg candesartan per day			
… recommends ACE- or AT1-inhibitor + calcium channel blocker or diuretic for the treatment of hypertension if monotherapy is not sufficient			
Interactions			
... advises discontinuation of itraconazole			
Other aspects			
...recommends replacing the amitriptyline with another drug that is not on the PRISCUS list (zolpidem, zopiclone, melatonin, mirtazapine)			
… recommends limiting the dose of omeprazole to a maximum of 40 mg per day			
… recommends changing the intake of simvastatin from morning to evening			
Communication Skills – The pharmacist …			
… asks for any remaining questions from the physician			
… thanks the physician for the conversation and ends the conversation			

Figure A18. Corresponding OSCE checklist for Patient 2 in the first OSCE.

Checklist First-OSCE Patient 3
Participant (pseudonym):

Pharmaceutical consultation	Criterion met	Criterion not met	Notes
Communication Skills			
Welcome and introduction of the pharmacist			
Presentation of the patient for whom the medication review was performed			
Patient data - subjective and objective – The pharmacist…			
gets an overview of the situation …			
… including the disease pattern (T2DM, hypertension, chronic kidney disease, osteoporosis)			
… including already prescribed medication (metformin, ramipril, calcium, alendronic acid, vitamin D3, doxazosin)			
… as well as complaints of the patient which have been communicated to the pharmacist (dry mouth, vertigo)			
… asks the physician for additional patient information (e.g., HDL-C value, Fasting glucose value, total cholesterol value)			
Assessment – The pharmacist …			
Chronic kidney disease			
… identifies mild to moderate renal insufficiency in the patient			
… explains that dose adjustments must be considered accordingly for many medicines			
Diabetes mellitus type 2			
… states that the HbA1c value (7.1%) is basically well adjusted			
... states that in mild to moderate renal insufficiency, the maximum dose of metformin is 2000 mg/day.			
... notes that in this case metformin is overdosed (3x850mg daily) due to renal insufficiency			
Hypertension			
... determines that the blood pressure values are not within the target range			
... states that the maximum daily dose of ramipril for a GFR of 30 – 60ml/min is 5 mg.			
… notes that Ramipril is overdosed at 2x5mg/day due to renal insufficiency			
... states that doxazosin for the treatment of hypertension is not first-line therapy			
PRISCUS drugs			
... identifies doxazosin as a PRISCUS drug			
Other aspects			
... explains that the complaints of dry mouth and vertigo are a common DRP of doxazosin.			

Figure A19. *Cont.*

Checklist First-OSCE Patient 3
Participant (pseudonym):

Plan – The pharmacist…			
Diabetes mellitus type 2			
… recommends dose adjustment of metformin to a maximum of 2g/day			
… recommends an optional additional therapy with SGLT2 inhibitor (e.g., liraglutide) if diabetes is not adequately controlled with metformin.			
Hypertension			
… recommends adjusting the dose of ramipril to a maximum of 5mg/day			
… recommends to a change in therapy according to the guideline: Initial therapy Dual combination			
… recommends besides ACE- or AT1- inhibitors an additional therapy with calcium channel blockers (or diuretics but only under special caution)			
… recommends a discontinuation of doxazosin because of the DRP that occur.			
Osteoporosis			
… recommends to monitor calcium levels more closely due to calcium intake and vitamin D3 supplementation to avoid hypercalcaemia.			
Communication Skills – The pharmacist …			
… asks for any remaining questions from the physician			
…thanks the physician for the conversation and ends the conversation			

Figure A19. Corresponding OSCE checklist for Patient 3 in the first OSCE.

Checklist First-OSCE Patient 4
Participant (pseudonym):

Pharmaceutical consultation	Criterion met	Criterion not met	Notes
Communication Skills			
Welcome and introduction of the pharmacist			
Presentation of the patient for whom the medication review was performed			
Patient data - subjective and objective – The pharmacist…			
gets an overview of the situation …			
… including the disease pattern (obesity, T2DM, bronchial asthma, vitamin D deficiency, chronic migraine)			
… including already prescribed medication (metformin, insulin glargine, beclometasone, salbutamol, vitamin D3, metoprolol, sumatriptan)			
… as well as complaints of the patient which have been communicated to the pharmacist (low FEV (1), dyspnea, vertigo, cold sweating, low blood sugar level, weight gain)			
… asks the physician for additional patient information (e.g., total cholesterol values, GFR)			
Assessment – The pharmacist …			
Diabetes mellitus type 2			
... states that the HbA1c value of 6.6 is basically well adjusted			
... asks whether therapy with SGLT2 inhibitor or GLP-1 agonist was considered before insulin was prescribed, or explains that SGLT2 inhibitors and GLP1 analogues are agents of choice alongside metformin therapy			
... explains that the available fasting blood glucose value is quite low			
... identified that the cause of the symptoms (cold sweating, vertigo) could be hypoglycaemia			
... states that metoprolol for migraine prophylaxis can mask further symptoms of hypoglycaemia			
Bronchial asthma			
... determines that the FEV (1) has declined			
... states that metoprolol is contraindicated in bronchial asthma			
... finds out that the metoprolol could be a possible cause of the worsening of the asthma			
LDL-C-value			
... notes that LDL levels are elevated according to the guideline for diabetics			

Figure A20. *Cont.*

Checklist First-OSCE Patient 4
Participant (pseudonym):

Plan – The pharmacist recommends…			
Diabetes mellitus type 2			
… reducing the dose of insulin therapy and monitoring blood glucose levels more closely in the near future, or recommends an alternative therapy with metformin + SGLT2 inhibitor or GLP-1 agonist			
Migraine prophylaxis			
… gradually discontinuing metoprolol			
… alternative medication (flunarizine, valproate, topiramate) for migraine prophylaxis.			
LDL-C-value			
… starting statin therapy due to elevated LDL levels			
Communication Skills – The pharmacist …			
… asks for any remaining questions from the physician			
… thanks the physician for the conversation and ends the conversation			

Figure A20. Corresponding OSCE checklist for Patient 4 in the first OSCE.

Checklist Second-OSCE Patient 5
Participant (pseudonym):

Pharmaceutical consultation	Criterion met	Criterion not met	Notes
Communication Skills			
Welcome and introduction of the pharmacist			
Presentation of the patient for whom the medication review was performed			
Patient data - subjective and objective – The pharmacist…			
gets an overview of the situation …			
… including the disease pattern (T2DM, hypercholesterolemia, migraine, urticaria)			
… including already prescribed medication (metformin, dapagliflozin, domperidone, simvastatin, acetylsalicylic acid, hydroxyzine, sumatriptan)			
… as well as complaints of the patient which have been communicated to the pharmacist (vertigo, syncope, nausea, tachycardia)			
… asks the physician for additional patient information (e.g., HDL-c-value, total cholesterol value, fasting glucose value)			
Assessment – The pharmacist …			
Diabetes mellitus type 2			
... says that the HbA1c of 8.2% is within the target range, but could be improved			
... identifies the underdosing of dapagliflozin			
Hypercholesterolemia			
... determines that the LDL levels for the diabetes patient are too high with 139 mg/dl			
...says that simvastatin is dosed too low			
Drug related problems			
... identifies that vertigo, syncope and nausea can be symptoms as a result of interactions			
... explains that there is an absolute contraindication between domperidone and hydroxyzine			
... explains that the interaction may lead to an increased risk of ventricular tachycardia and possibly torsade de pointes			
Migraine			
... explains that domperidone is to be taken fasting and not independently of the meal, as described on the medication plan			

Figure A21. *Cont.*

Checklist Second-OSCE Patient 5
Participant (pseudonym):

Plan – The pharmacist recommends…			
Diabetes mellitus type 2			
… an increase in the dose of metformin to 1000 mg 3 times a day			
… an increase in the dose of dapagliflozin to 10 mg daily			
Hypercholesterolemia			
… an increase in the simvastatin dose to 20 – 40 mg			
… that simvastatin must be taken in the evening rather than in the morning			
Drug related problem			
… a replacement of the antihistamine as described in the guideline (levocetirizine or desloratadine as first-line therapy).			
Other aspects			
… a change of the indication instruction from domperidone to fasting in the medication plan.			
… another agent for the patient in case of sleep disorders, if necessary (e.g., zopiclone, zaleplon, herbal preparations, melatonin).			
Communication Skills – The pharmacist …			
… asks for any remaining questions from the physician			
…thanks the physician for the conversation and ends the conversation			

Figure A21. Corresponding OSCE checklist for Patient 5 in the second OSCE.

Checklist Second-OSCE Patient 6
Participant (pseudonym):

Pharmaceutical consultation	Criterion met	Criterion not met	Notizen
Communication Skills			
Welcome and introduction of the pharmacist			
Presentation of the patient for whom the medication review was performed			
Patient data - subjective and objective – The pharmacist…			
gets an overview of the situation …			
… including the disease pattern (T2DM, hypertension, chronic pain, unipolar depression, hypercholesterolemia, obesity)			
… as well as complaints of the patient which have been communicated to the pharmacist (metformin, glibenclamide, tilidine, ramipril, simvastatin, spironolactone, fluoxetine)			
… as well as complaints of the patient which have been communicated to the pharmacist (restlessness, tachycardia, tremor, sweating, dry mouth, insomnia, spasms, low blood sugar levels)			
… asks the physician for additional patient information (e.g., LDL-c values, total cholesterol value)			
Assessment – The pharmacist …			
Diabetes mellitus type 2			
... says that the HbA1c of 8.7% is above the therapeutic target range			
... explains that the cause of the resulting hypoglycaemias may be the glibenclamide			
... justifies that the guideline refers to an increased risk of hypoglycaemia with a combination of metformin + glibenclamide compared to metformin+placebo.			
... explains that the existing diabetes therapy is not in line with guidelines			
Hypercholesterolemia			
... states that the LDL levels are too high for the diabetic patient			
Drug related problems			
... identified that tachycardia, restlessness, tremor, sweating, dry mouth, insomnia and muscle spasms can be symptoms of DRP			
... explains that there is a potentially serious drug interaction between fluoxetine and tilidine.			
... explains that interaction between fluoxetine and tilidine can lead to serotonin syndrome and these signs are given in the patient			
Hypertension			
... explains that spironolactone should only be given as an add-on or reserve agent in the guideline.			
... states that there is a potentially serious drug interaction between ramipril and spironolactone.			
... explains that there is an increased risk of hyperkalaemia with the combined intake of ramipril and spironolactone.			

Figure A22. *Cont.*

Checklist Second-OSCE Patient 6
Participant (pseudonym):

Plan – The pharmacist…			
Diabetes mellitus type 2			
… recommends an SGLT2 inhibitor or a GLP-1 agonist instead of glibenclamide in addition to metformin for the treatment of T2DM			
Hypercholesterolemia			
… recommends that simvastatin should be taken in the evening rather than in the morning			
… recommends to increase the simvastatin dose or switching to a higher potency statin (atorvastatin or rosuvastatin).			
Interaction between fluoxetine and tilidine			
… recommends changing the antidepressant to one that does not interfere with serotonergic metabolism (e.g., mirtazapine) **or** advises more careful monitoring of the patient because symptoms of serotonin syndrome have been noticed.			
… questions whether the tilidine is still necessary for the pain and recommends discontinuing the tilidine if necessary.			
… explains that the interaction can be expected to continue for a few days after discontinuation (half-life of fluoxetine: 3 –7 days)			
Hypertension			
… recommends antihypertensive therapy according to guideline with ACE- or AT1-inhibitor + calcium channel blocker or diuretics (only under special caution).			
Communication Skills – The pharmacist …			
… asks for any remaining questions from the physician			
… thanks the physician for the conversation and ends the conversation			

Figure A22. Corresponding OSCE checklist for Patient 6 in the second OSCE.

Checklist Second-OSCE Patient 7
Participant (pseudonym):

Pharmaceutical consultation	Criterion met	Criterion not met	Notes
Communication Skills			
Welcome and introduction of the pharmacist			
Presentation of the patient for whom the medication review was performed			
Patient data - subjective and objective – The pharmacist…			
gets an overview of the situation …			
… including the disease pattern (T2DM, obesity, coronary artery disease, hypertension, hypercholesterolemia)			
… including already prescribed medication (metformin, acetylsalicylic acid, clopidogrel, atorvastatin, metoprolol, amlodipine, ramipril, hydrochlorothiazide, valsartan)			
… as well as complaints of the patient which have been communicated to the pharmacist (muscle pain, frequent need to urinate, need to urinate at night, dry cough, swelling of the ankles)			
… asks the physician for additional patient information (e.g., GFR, triglyceride value, total cholesterol value)			
Assessment – The pharmacist …			
Diabetes mellitus type 2			
... says that the HbA1c of 9.2% is not in the target range according to the guidelines			
... notes that the fasting glucose value is quite elevated			
... determines that diabetes therapy is not in line with guidelines			
Hypertension			
… notes that blood pressure is well adjusted at 132/80 mmHg			
... recognizes that the cause of the cough is probably the ramipril			
... recognizes that the cause of the ankle oedema is probably the amlodipine			
... recognizes that the cause of the nocturnal urge to urinate is probably the hydrochlorothiazide			
... identifies a potential prescribing cascade, as the hydrochlorothiazide was prescribed due to the adverse drug reaction of the amlodipine			
… recognises that two different renin-angiotensin-aldosterone inhibitors have been prescribed			
Hypercholesterolemia			
... recognizes that the patient's LDL level of 122 mg/dl is too high for diabetics			
... mentions that the patient has muscle pain and that the atorvastatin could be a possible cause.			
Coronary artery disease			
... recognizes that both ASA and clopidogrel were prescribed as antiplatelet agents			

Figure A23. *Cont.*

Checklist Second-OSCE Patient 7
Participant (pseudonym):

Plan – The pharmacist recommends…			
Diabetes mellitus type 2			
… either increasing the metformin dose up to 3000mg/day or advises metformin therapy with either an SGLT2 inhibitor or GLP1 agonist.			
Hypertension			
… discontinuation of amlodipine as it may be the possible cause of the ankle oedema			
… discontinuation of ramipril due to concomitant medication with valsartan			
… discontinuation of ramipril, as cough is a common adverse event with ramipril and is less common with valsartan			
… changing the hydrochlorothiazide intake from evening to morning in the medication schedule in order to reduce the urge to urinate at night			
… discontinuation of hydrochlorothiazide in the medium term, as the ankle oedema is unlikely to recur after discontinuation of amlodipine.			
Hypercholesterolemia			
… switching to rosuvastatin, another high-intensity statin, as atorvastatin is probably not well tolerated			
Coronary artery disease			
… comments that dual antiplatelet therapy is only useful in certain cases (after elective stent implantation) and that therapy with a single antiplatelet agent is usually sufficient enough			
Communication Skills – The pharmacist …			
… asks for any remaining questions from the physician			
…thanks the physician for the conversation and ends the conversation			

Figure A23. Corresponding OSCE checklist for Patient 7 in the second OSCE.

Checklist Second-OSCE Patient 8
Participant (pseudonym):

Pharmaceutical consultation	Criterion met	Criterion not met	Notes
Communication Skills			
Welcome and introduction of the pharmacist			
Presentation of the patient for whom the medication review was performed			
Patient data - subjective and objective – The pharmacist…			
gets an overview of the situation …			
… including the disease pattern (T2DM, supraventricular tachycardia, chronic kidney disease, hypertension, unipolar depression, stroke, chronic pain)			
… including already prescribed medication (metformin, metoprolol, metamizole, apixaban, escitalopram, digoxin, atorvastatin, candesartan)			
… as well as complaints of the patient which have been communicated to the pharmacist (haematomas, severe pain)			
… asks the physician for additional patient information (e.g., LDL-c value, total cholesterol value)			
Assessment – The pharmacist …			
Chronic kidney disease			
... identifies mild to moderate renal insufficiency in the patient			
... explains that dose adjustments need to be considered accordingly for many medicines			
Diabetes mellitus type 2			
... says that the HbA1c value (6.9%) is basically well adjusted			
... states that in mild to moderate renal insufficiency, the maximum dose of metformin is 2000 mg/day			
... notes that in this case metformin is overdosed (3x1000mg daily) due to renal insufficiency.			
Hypertension			
... determines that the blood pressure values are within the target range			
Supraventricular tachycardia			
… identifies digoxin as PRISCUS drug			
... notes that the digoxin at 0.2 mg daily exceeds the maximum daily dose			
Drug interaction			
... identifies a potentially serious drug interaction between apixaban and escitalopram			
... explains that the interaction of apixaban and escitalopram can lead to serious bleeding complications			
... identifies that the cause of the bruises could be an increased bleeding tendency			
... identifies a potentially serious drug interaction between atorvastatin and digoxin			
... explains that the consequence of the interaction of digoxin and atorvastatin may be an increased digoxin plasma concentration.			

Figure A24. *Cont.*

Checklist Second-OSCE Patient 8
Participant (pseudonym):

Plan – The pharmacist recommends…			
Diabetes mellitus type 2			
… a dose adjustment of metformin to a maximum of 2000mg/day			
… optional additional therapy with SGLT2 inhibitor or GLP-1 agonist if diabetes is not adequately controlled with metformin alone.			
Supraventricular tachycardia			
… a dose adjustment of digoxin due to renal insufficiency or to a change of therapy to digitoxin			
Drug interactions			
… another antidepressant that does not interact with apixaban (e.g., mirtazapine, bupropion)			
Communication Skills – The pharmacist …			
… asks for any remaining questions from the physician			
…thanks the physician for the conversation and ends the conversation			

Figure A24. Corresponding OSCE checklist for Patient 8 in the second OSCE.

References

1. Schulz, M.; Griese-Mammen, N.; Müller, U. Clinical pharmacy services are reimbursed in Germany: Challenges of real world implementation remain. *Int. J Clin. Pharm.* **2022**, *45*, 245–249. [CrossRef] [PubMed]
2. Seidling, H.M.; Send, A.F.J.; Bittmann, J.; Renner, K.; Dewald, B.; Lange, D.; Bruckner, T.; Haefeli, W.E. Medication review in German community pharmacies—Post-hoc analysis of documented drug-related problems and subsequent interventions in the ATHINA-project. *Res. Soc. Adm. Pharm.* **2017**, *13*, 1127–1134. [CrossRef] [PubMed]
3. Eickhoff, C.; Griese-Mammen, N.; Müeller, U.; Said, A.; Schulz, M. Primary healthcare policy and vision for community pharmacy and pharmacists in Germany. *Pharm. Pract.* **2021**, *19*, 2248. [CrossRef]
4. Federal Union of German Associations of Pharmacists. Pharmazeutische Dienstleistungen. 2022. Available online: https://www.abda.de/pharmazeutische-dienstleistungen/ (accessed on 20 December 2022).
5. Nathan, A.; Goodyer, L.; Lovejoy, A.; Rashid, A. 'Brown bag' medication reviews as a means of optimizing patients' use of medication and of identifying potential clinical problems. *Fam. Pract.* **1999**, *16*, 278–282. [CrossRef] [PubMed]
6. Federal Union of German Associations of Pharmacists. Erweiterte Medikationsberatung bei Polymedikation. 2022. Available online: https://www.abda.de/pharmazeutische-dienstleistungen/erweiterte-medikationsberatung-bei-polymedikation/ (accessed on 20 December 2022).
7. Federal Union of German Associations of Pharmacists. Die Apotheke: Zahlen, Daten, Fakten 2022. Available online: https://www.abda.de/aktuelles-und-presse/publikationen/detail/die-apotheke-zahlen-daten-fakten-2022/ (accessed on 20 December 2022).
8. Remelli, F.; Ceresini, M.G.; Trevisan, C.; Noale, M.; Volpato, S. Prevalence and impact of polypharmacy in older patients with type 2 diabetes. *Aging Clin. Exp. Res.* **2022**, *34*, 1969–1983. [CrossRef] [PubMed]
9. Bauer, S.; Nauck, M.A. Polypharmacy in people with Type 1 and Type 2 diabetes is justified by current guidelines—A comprehensive assessment of drug prescriptions in patients needing inpatient treatment for diabetes-associated problems. *Diabet. Med.* **2014**, *31*, 1078–1085. [CrossRef]
10. Wang, W.; Geng, L.; Sun, C.; Li, H.; Wang, J. Efficacy of Pharmaceutical Care in Patients with Type 2 Diabetes Mellitus and Hypertension: A Randomized Controlled Trial. *Int. J. Clin. Pract.* **2022**, *2022*, 7681404. [CrossRef]
11. Chen, J.H.; Ou, H.T.; Lin, T.C.; Lai, E.C.; Kao, Y.H. Pharmaceutical care of elderly patients with poorly controlled type 2 diabetes mellitus: A randomized controlled trial. *Int. J. Clin. Pharm.* **2016**, *38*, 88–95. [CrossRef]
12. Antoine, S.L.; Pieper, D.; Mathes, T.; Eikermann, M. Improving the adherence of type 2 diabetes mellitus patients with pharmacy care: A systematic review of randomized controlled trials. *BMC Endocr. Disord.* **2014**, *14*, 53. [CrossRef]
13. Yu, K.H.; Sweidan, M.; Williamson, M.; Fraser, A. Drug interaction alerts in software—What do general practitioners and pharmacists want? *Med. J. Aust.* **2011**, *195*, 676–680. [CrossRef]
14. Waltering, I.; Lücht, U. To "Tool" or Not to "Tool". Deutsche Apotheker Zeitung. 2019. Available online: https://www.deutsche-apotheker-zeitung.de/daz-az/2019/daz-33-2019/to-tool-or-not-to-tool (accessed on 24 February 2023).
15. Curtain, C.; Bindoff, I.; Westbury, J.; Peterson, G. An investigation into drug-related problems identifiable by commercial medication review software. *Australas. Med. J.* **2013**, *6*, 183–188. [CrossRef] [PubMed]
16. Verdoorn, S.; Kwint, H.F.; Hoogland, P.; Gussekloo, J.; Bouvy, M.L. Drug-related problems identified during medication review before and after the introduction of a clinical decision support system. *J. Clin. Pharm. Ther.* **2018**, *43*, 224–231. [CrossRef] [PubMed]

17. Khurana, M.P.; Raaschou-Pedersen, D.E.; Kurtzhals, J.; Bardram, J.E.; Ostrowski, S.R.; Bundgaard, J.S. Digital health competencies in medical school education: A scoping review and Delphi method study. *BMC Med. Educ.* **2022**, *22*, 129. [CrossRef] [PubMed]
18. Baumgartner, M.; Sauer, C.; Blagec, K.; Dorffner, G. Digital health understanding and preparedness of medical students: A cross-sectional study. *Med. Educ. Online* **2022**, *27*, 2114851. [CrossRef]
19. Park, J.Y.; Min, J. Exploring Canadian pharmacy students' e-health literacy: A mixed method study. *Pharm. Pract.* **2020**, *18*, 1747. [CrossRef] [PubMed]
20. Olsen, A.A.; Minshew, L.M.; Morbitzer, K.A.; Brock, T.P.; McLaughlin, J.E. Emerging Innovations and Professional Skills Needed Within Pharmacy Curricula. *J. Med. Educ. Curric. Dev.* **2020**, *7*, 2382120520943597. [CrossRef]
21. Aungst, T.D.; Patel, R. Integrating Digital Health into the Curriculum—Considerations on the Current Landscape and Future Developments. *J. Med. Educ. Curric. Dev.* **2020**, *7*, 2382120519901275. [CrossRef]
22. Odone, A.; Buttigieg, S.; Ricciardi, W.; Azzopardi-Muscat, N.; Staines, A. Public health digitalization in Europe. *Eur. J. Public Health* **2019**, *29* (Suppl. S3), 28–35. [CrossRef]
23. Obarcanin, E.; Ali-Sherazi, B.; Dabidian, A.; Schlottau, S.; Deters, M.A.; Läer, S. Introducing m-Health and Digital Diabetes Apps in Clinical Pharmacy Education in Germany. *J. Diabetes Clin. Res.* **2022**, *4*, 17–19. [CrossRef]
24. Rodis, J.; Aungst, T.D.; Brown, N.V.; Cui, Y.; Tam, L. Enhancing Pharmacy Student Learning and Perceptions of Medical Apps. *JMIR Mhealth Uhealth* **2016**, *4*, e55. [CrossRef]
25. Bryant, J.E.; Richard, C.A.H. Pharmacy students' use and perceptions of Apple mobile devices incorporated into a basic health science laboratory. *Curr. Pharm. Teach. Learn.* **2017**, *9*, 78–83. [CrossRef] [PubMed]
26. Frenzel, J.; Porter, A. The Need to Educate Pharmacy Students in Telepharmacy and Telehealth. *Am. J. Pharm. Educ.* **2021**, *85*, 8566. [CrossRef] [PubMed]
27. Owensby, J.K.; Kavookjian, J. Pharmacy students' perceptions of the usefulness of motivational interviewing and the use of mobile health applications on patient counseling in the future. *Curr. Pharm. Teach. Learn.* **2017**, *9*, 568–575. [CrossRef] [PubMed]
28. Skoy, E.T.; Eukel, H.N.; Frenzel, J.E.; Schmitz, T.M. Performance and Perceptions: Evaluation of Pharmacy Students' Consultation via Telepharmacy. *J. Pharm. Technol.* **2015**, *31*, 155–160. [CrossRef] [PubMed]
29. Fox, B.I.; Umphress, D.A.; Hollingsworth, J.C. Development and delivery of an interdisciplinary course in mobile health (mHealth). *Curr. Pharm. Teach. Learn.* **2017**, *9*, 585–594. [CrossRef]
30. Pharma4u GmbH. MediCheck: AMTS Für Apotheker Mit Profil. 2023. Available online: https://www.pharma4u.de/apotheker/medicheck/infos/ (accessed on 24 May 2023).
31. Farahani, I.; Farahani, S.; Deters, M.A.; Schwender, H.; Laeer, S. Efficacy of an Objective Structured Clinical Examination Training Approach for Training Pharmacy Students in Diabetes Mellitus Counseling: A Randomized Controlled Trial. *Pharmacy* **2020**, *8*, 229. [CrossRef]
32. Farahani, I.; Farahani, S.; Deters, M.A.; Schwender, H.; Laeer, S. Training Pharmacy Students in Self-Medication Counseling Using an Objective Structured Clinical Examination-Based Approach. *J. Med. Educ. Curric. Dev.* **2021**, *8*, 23821205211016484. [CrossRef] [PubMed]
33. Farahani, S.; Farahani, I.; Deters, M.A.; Schwender, H.; Burckhardt, B.B.; Laeer, S. Blended Learning on Blood Pressure Measurement: Investigating Two In-Class Strategies in a Flipped Classroom-Like Setting to Teach Pharmacy Students Blood Pressure Measurement Skills. *Healthcare* **2021**, *9*, 822. [CrossRef]
34. Harden, R.M. What is an OSCE? *Med. Teach.* **1988**, *10*, 19–22. [CrossRef]
35. Deters, M.A.; Obarcanin, E.; Schwender, H.; Läer, S. EMDIA Case Series—Effective Medication Therapy Management (MTM) for Diabetes Type 2 Patients—A Proof of Concept Study. *Pharmacy* **2021**, *9*, 137. [CrossRef]
36. Ofori-Asenso, R.; Ilomäki, J.; Tacey, M.; Si, S.; Curtis, A.J.; Zomer, E.; Bell, J.S.; Zoungas, S.; Liew, D. Predictors of first-year nonadherence and discontinuation of statins among older adults: A retrospective cohort study. *Br. J. Clin. Pharmacol.* **2019**, *85*, 227–235. [CrossRef] [PubMed]
37. Levivien, C.; Cavagna, P.; Grah, A.; Buronfosse, A.; Courseau, R.; Bézie, Y.; Corny, J. Assessment of a hybrid decision support system using machine learning with artificial intelligence to safely rule out prescriptions from medication review in daily practice. *Int. J. Clin. Pharm.* **2022**, *44*, 459–465. [CrossRef] [PubMed]
38. Skalafouris, C.; Blanc, A.L.; Grosgurin, O.; Marti, C.; Samer, C.; Lovis, C.; Bonnabry, P.; Guignard, B. Development and retrospective evaluation of a clinical decision support system for the efficient detection of drug-related problems by clinical pharmacists. *Int. J. Clin. Pharm.* **2022**, *45*, 406–413. [CrossRef] [PubMed]

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