

Medical clerkships do not reduce common prescription errors among medical students

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Abstract Prescribing correctly represents one of the most essential skills of a doctor when it comes to patient safety. Unfortunately, prescribing errors still account for a large proportion of avoidable drug-related problems (DRP). Despite this shortcoming, many medical schools do not provide specific prescribing training and assume that students acquire sufficient prescribing skills during regular medical clerkships. We therefore investigated whether there is an association between the individual time spent by students in internal-medicine clerkships and the number of prescription errors committed in a standardized prescribing test for common drug-related problems in a medical inpatient setting. Seventy-four fifth-year medical students (25±3 yrs, 24 m, 50 f) who had completed their formal pharmacology training filled in prescription charts for two standardized patient paper cases. The charts were rated by two blinded consultants from the field of internal medicine using a checklist for common prescription errors. Students were divided into three groups according to the number of weeks previously spent in internal-medicine clerkships.

Group differences in the number of prescription errors made were subsequently examined. Students committed 69%±12% of all possible prescription mistakes. There was no significant difference between the group without clerkships in internal medicine (G1) (71±9%), the group with one to four weeks (G2) (67±15%), and the group with more than five weeks of clerkships (G3) (71±10%), $p=.76$. Medical students do not seem to acquire the necessary skills to avoid common prescription errors during regular clerkships in internal medicine. This study provides evidence to suggest that specific prescription training within medical education is warranted in order to prevent DRP.

Keywords Drug-related problems · Adverse drug reaction · Adverse drug event · Prescription error · Medication error · Pharmacotherapy · Medical education · Medical student

Introduction

Drug-related problems are one of the most common reasons for hospitalization, and most of these problems are considered to be avoidable (Patel and Zed 2002; Krahenbuhl-Melcher et al. 2007; Thomsen et al. 2007). In turn, a major proportion of drug-related problems are due to prescription errors (Bates et al. 1995; Leape et al. 1995; Benjamin 2003). Frequent mistakes relate to over-medication, under-medication, the prescription of non-indicated drugs, wrong doses, or ambiguous dosage ordering (Lesar et al. 1997; Garbutt et al. 2005).

Apart from the ability to fill out prescriptions in a formally correct manner, there are specific patterns that constitute a risk for frequent drug-related problems. According to a review by Kraehenbuehl-Melcher, every fourth medication error concerns non-authorized medication, that is, the administration of drugs without the approval of a doctor (Krahenbuhl-Melcher et al. 2007). In

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situations in which, for example, a doctor is not readily available and certain symptoms emerge, under-medication or non-authorized medication will occur unless optional medication has been prescribed (i.e., an optional pain-killer for a patient suffering from chronic back pain). Other common problems include adverse drug reactions which should be detected as soon as possible in order to prevent further damage. In the present paper, we therefore refer to “prescribing skills” as the ability to prescribe drugs and order diagnostic tests in a way that minimizes the risk of drug-related problems as described by the “Safe Prescribing Working Group” of the General Medical Council and Medical Schools Council 2007 (Agrawal et al. 2009; Likic and Maxwell 2009).

Recently graduated doctors are known to be most prone to committing prescription errors (Tobaiqy et al. 2007; Coombes et al. 2008; Likic and Maxwell 2009). However, the majority of medical schools do not offer specific undergraduate prescribing training in which the various clinical specialties provide instruction on typical medication scenarios and pitfalls as a supplement to regular pharmacology training (Orme and Reidenberg 1989; Lesar et al. 1990; Maxwell and Walley 2003; Lempp et al. 2005; Agrawal et al. 2009; Ross and Loke 2009). Medical students are generally expected to acquire their prescribing skills during clerkships. Interestingly, there are - to our knowledge - currently no data available regarding the validity of this assumption. With regard to the four-month period of obligatory clerkships which is to be completed by medical students, German Medical Licensing Regulations only stipulate one general learning objective according to which “students are to be familiarized with caring for patients in an outpatient and inpatient setting”. In a broad sense, this objective can be considered to include prescribing. We therefore investigated whether the performance of medical students with large variations in the number of unstructured clerkships completed in the field of internal medicine differed with respect to common prescription errors which typically arise in the medical inpatient setting. Do the clerkships which are currently implemented in German medical schools and which are based on only one very general learning objective contribute to a prescribing technique which aims to minimize drug-related problems?

Methods

Participants and study design

A total of 74 fifth-year medical students, all of whom had already completed their curricular pharmacology training, participated in the study. A written test comprising the

completion of prescription charts for the case vignettes of two patients with diseases which were common for a medical inpatient setting was conducted in order to assess students’ active prescribing skills. Since the test was designed to assess prescribing skills rather than general medical knowledge, students were informed of patient diagnoses three days in advance. During the test, students were required to complete the prescription charts within a timeframe of 45 minutes per case. A questionnaire assessing the number of weeks spent in internal-medicine clerkships was completed prior to the test. On account of the fact that the majority of clerkships last for four weeks, students were divided into three groups according to the number of weeks previously spent in internal-medicine clerkships: Group 1 (G1) 0 weeks, Group 2 (G2) 1–4 weeks, and Group 3 (G3) more than 4 weeks. Study participation was voluntary, and the study protocol was approved by the local ethics committee.

Previous pharmacology training

Students at our faculty attend 14 lectures (90 min each) and 14 seminars (90 min each) on general pharmacology in their third year of training as well as 14 lectures and 14 seminars on clinical pharmacology in their fourth year. Written (multiple-choice) exams are sat following each pharmacology course. There is no specific problem-based teaching module that addresses prescribing or common drug-related problems and these topics are not examined.

Clerkships

German Medical Licensing Regulations require medical students to complete 16 weeks of clerkships during their third to fifth year of training. Between four and eight weeks are to be completed in an ambulatory setting (mostly with a general practitioner) and between eight and twelve weeks in a hospital setting. The only learning objective stipulated in the licensing regulations is that “students are to be familiarized with caring for patients in an outpatient and inpatient setting”. Students are not provided with further learning goals by our university and are free to complete clerkships in the university hospital, in teaching hospitals, or abroad. Since our university hospital is located in a rather small town with only one other limited-capacity hospital, it also serves as district hospital.

Assessment

Students were randomly assigned one of three different case pairs. The pairs were chosen in such a way that one case involved an infectious disease and the other renal insufficiency. The assessment cases were standardized

Table 1 Blueprint of the patient paper cases and the checklist for raters

Case	Communicate the contraindication	Discontinue non-indicated drug in the previous medication	Prescribe thromboembolic prophylaxis/ anticoagulation	Adjust diuretics/ fluids to hydration status	Prevent non-authorized medication
Community-acquired pneumonia	Typical neuroleptics in a confused patient with severe Parkinson's disease	Diuretic for a severely dehydrated, normotensive patient with fever	Thromboembolic prophylaxis	Dehydrated patient, fever, prescribe fluids, discontinue diuretics	Sedatives/ atypical neuroleptics for confusion, antipyretics
Pyelonephritis	NSAIDs in severe renal insufficiency and chronic back pain	NSAID in severe renal insufficiency	Thromboembolic prophylaxis	Dehydrated patient, fever, prescribe fluids, reduce diuretics	Non-nephrotoxic analgesics, antipyretics
Thrombosis with pulmonary embolism	NSAIDs in severe renal insufficiency and chronic pain (plasmocytoma)	Contraceptive in acute pulmonary embolism	Anticoagulation	Dehydrated patient, prescribe fluids, reduce or discontinue diuretics	Non-nephrotoxic analgesics
Atrial fibrillation	Contrast medium, iodine in hyperthyroidism	Iodine prophylaxis in hyperthyroidism	Anticoagulation	Congestive heart failure due to fibrillation, prescribe diuretic	Sedative for an agitated patient with hyperthyroidism
New onset of Type 2 diabetes mellitus	Allergy to penicillin	Diuretic for a severely dehydrated patient	Thromboembolic prophylaxis	Dehydrated patient, prescribe fluids, reduce or discontinue diuretics	Antihypertensive drug in poorly controlled hypertension
Exacerbation of chronic obstructive pulmonary disease	Allergy to contrast medium	Beta-blocker in COPD	Thromboembolic prophylaxis	Congestive heart failure due to pulmonary hypertension, prescribe diuretic	Sedative for withdrawal in alcohol dependency

according to the criteria listed below. Further details of the paper cases are provided elsewhere (Celebi et al. 2009), see Table 1:

- One non-indicated drug in formerly prescribed medication
- One contraindication for a drug or drug class
- Indication for thromboembolic prophylaxis or anticoagulation (Rockson and Albers 2004; Lemos Silva et al. 2007; Rocha et al. 2007)
- One risk factor for under-medication or non-authorized medication, for example chronic back pain (pain killers), uncontrolled hypertension (antihypertensive drug), or insomnia (sedative).
- Previously prescribed diuretic therapy that had not been adjusted to the patient's current fluid status.

Overview of paper-cases used for assessment in this study - In order to test students' prescribing skills, we asked them to write prescriptions for two of the above-listed standardized patients. Students were expected to solve each of the five tasks listed above for each patient, to additionally monitor the common and severe side effects of each prescribed drug, and to state an unambiguous and realistic dosage for each drug.

Students completed paper cases using the hospital's medical history and examination form. The atrial-fibrillation case is illustrated below (Table 2):

Table 2 Example of a patient paper case

Ms. Viola, born 21.03.1941	Diagnosis: atrial fibrillation
History	Fatigue and fast, irregular heartbeat for 24 hours. Dyspnea when climbing stairs (one floor). Patient very anxious.
Previous illnesses	Gout Hypertension Goiter Varicosis (phlebography last week, stripping planned for following week)
Medication	L-Thyroxine/Jodine 75/200 µg 1-0-0 Allopurinol 300 mg 1-0-0 Lisinopril 5 mg 1-0-0
Allergies	Penicillin
Stimulants	No cigarettes, 1–2 glasses of wine per day
Occupation	Teacher, retired
Physical examination	Reduced general state of health, sweaty, patient very agitated and nervous, speaking fast, prominent jugular veins and goiter, RR 100/68 mmHg, heart rate 140/min, irregular, Heart: normal heart sounds. Lung: basal rales. Abdomen: no pathological findings. Pitting edema of the legs. Varicosis, no ulcer.

Prescription charts were independently rated by two blinded consultants from the field of internal medicine according to a checklist comprising the following seven items (see Table 1):

- Discontinue the non-indicated drug from the previously prescribed medication
- Notify the nurses and other doctors of the contra-indicated drug or drug class (Howell and Jones 1993; Leape et al. 1995)
- Provide a realistic and unambiguous dosage for each prescribed drug
- Prescribe optional medication to cover the risk situation for non-authorized medication
- Monitor for severe and common side effects of the medication
- Adjust the fluids and diuretic-dosage according to the fluid status of the patient
- Prescribe thromboembolic prophylaxis/anticoagulation as indicated.

Statistical analysis

Calculations were based on mean rater evaluations. We compared the averages of each group using the χ^2 -test for nominal variables and an ANOVA for continuous variables. Statistical analyses were conducted using JMP 6.0.0 (SAS Institute Inc, Cary, NC, USA).

Results

In the post-hoc power analysis, a difference of 5% could have been detected with $n=41$, $\alpha=.05$, $\sigma=.13$.

The three groups of assessed students did not differ with regard to gender or age ($p>0.29$ in all cases, see Table 3).

Table 3 Student characteristics

Group	1	2	3	
Weeks of internal-medicine clerkship	0	1–4	>5	
N	18	38	18	
Gender	3 m, 15 f	14 m, 24 f	7 m, 11 f	$p=.29$ (χ^2)
Age (mean \pm SD)	25 \pm 2	25 \pm 3	25 \pm 2	$p=.76$ (ANOVA)
Number of prescriptions completed so far	0	0	0	
Distribution of case pairs	A 33% B 44% C 22%	A 34% B 37% C 29%	A 33% B 28% C 39%	

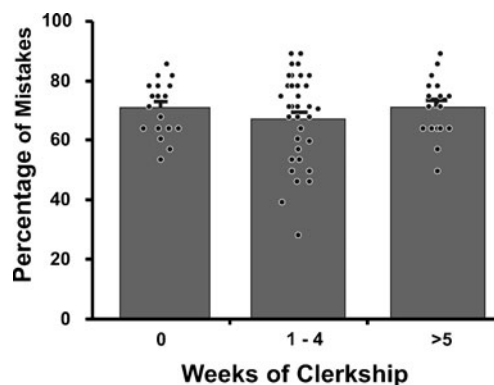


Fig. 1 Comparison of prescription-test results across the three groups with varying levels of experience from previous internal-medicine clerkships. Each dot represents the result of an individual student (derived from the scores assigned from two blinded raters)

In the survey, none of the students reported ever having previously completed a valid or non-valid prescription chart. In the analysis of variance, results of the prescription test did not significantly differ across the three groups with varying degrees of former clerkship experience ($p=.76$, see Fig. 1).

Overall, students failed to solve $69\% \pm 12\%$ of the presented tasks. Group 1, who had never completed an internal-medicine clerkship made $71\% \pm 9\%$ of all possible mistakes, Group 2 with up to four weeks of clerkships made $67\% \pm 15\%$, and Group 3 with more than four weeks of clerkships committed $71\% \pm 10\%$ ($p=.76$) see Fig. 1)

Results for the individual tasks are presented according to group in Table 4.

We additionally analyzed whether previous training and experience had any effect on prescription errors. In these analyses, nurses, paramedics, and physiotherapists were considered to have qualified experience and students who worked as nursing auxiliaries in the hospital without prior training were considered to have unqualified experience.

Students with qualified experience ($n=10$) made $66 \pm 13\%$ of the mistakes, students with unqualified experience ($n=26$) $66 \pm 13\%$, and students without prior experience ($n=38$) apart from the clerkships $72 \pm 11\%$ ($p=.13$).

Discussion

Clerkships constitute an integral part of medical education, although it is not sufficient to simply rely on students systematically practicing skills as intended (Remmen et al. 1999; Lempp et al. 2005; Likic et al. 2009). Given the pivotal importance of patient safety for good clinical practice, correct prescribing represents a key skill that

Table 4 Results for the individual tasks (Mean±SD). Group 1: students without previous clerkships in internal medicine, Group 2: 1–4 weeks, and Group 3: more than four weeks previous clerkship in internal medicine

Nr	Task	Group 1	Group 2	Group 3	All
All	All	71±9%	67±15%	71±10%	69±12%
1	Identify and notify others of contraindication	100±0%	97±8%	100±0%	99±5%
2	Prescribe only indicated drugs	46±27%	49±27%	57±29%	50±28%
3	Prescribe unambiguous and correct dosage	51±31%	42±28%	32±32%	42±30%
4	Prescribe adequate thromboembolic prophylaxis or anticoagulation	83±24%	82±27%	84±26%	83±26%
5	Monitor for common and severe side effects	79±25%	79±27%	93±21%	82±25%
6	Adjust fluids and diuretics to hydration status	58±27%	55±33%	50±31%	55±31%
7	Cover potential risk situations for unauthorized medication	79±30%	67±34%	82±19%	74±30%

should be trained at medical schools. Many medical schools, however, fail to provide specific training in this domain and expect the necessary skills to be acquired during regular clerkships. German Medical Licensing Regulations stipulate only one very general learning objective for the 16-week obligatory clerkships during the third to fifth years of medical training. Students only need to prove that they have completed 16 weeks and do not need to demonstrate what they have done during this period. As a result, clerkships are rather unstructured. Every single fifth-year student in the present study negated our question concerning whether they had previously ever filled in a valid or non-valid prescription chart. We therefore investigated whether exposure to typical situations improves prescribing performance. We constructed paper cases with common scenarios which tend to be associated with medication errors in an inpatient setting in internal medicine - a specialty that probably demands more individual prescriptions than any other. These scenarios included, for example, renal insufficiency (modify drug doses), risk situations for under-medication or non-authorized medication, comorbidities that pose contraindications for certain medication classes, and so on. Since our university hospital is located in a rather small town and also serves as a district hospital, we expected no significant influence of students' choosing to complete their clerkship at the university hospital versus teaching hospital. Neither clerkships in internal medicine nor previous training as a nurse, paramedic, or physiotherapist (there were no pharmacists among study participants) contributed to the acquisition of appropriate prescribing skills, see also (Jaillon 2006; Maxwell et al. 2007). This finding strengthens our hypothesis that, in addition to pharmacological training, prescription training that is conducted by the clinical specialties and which comprises typical medication scenarios should become a fixed component of current medical education. Furthermore, examinations which are more sophisticated than multiple-

choice tests should probably be employed in order to encourage more complex problem solving. Indeed, several studies have shown that structured problem-based training improves medical students' ability to prescribe correctly (de Vries et al. 1995; Boreham et al. 2000; Hassan et al. 2000; Flockhart et al. 2002; Scobie et al. 2003; Al Khaja et al. 2005; Halbach and Sullivan 2005; Garbutt et al. 2006, 2008; Richir et al. 2008a,b; Celebi et al. 2009). In addition, using a prospective and controlled study design, we recently demonstrated that problem-based training with a focus on common prescription errors is able to reduce average error rates by more than 50%, independently of the clinical context (Celebi et al. 2009).

Our findings may help to explain why recently graduated doctors represent the subgroup of medical professionals that is most prone to committing prescription errors (Tobaiqy et al. 2007; Coombes et al. 2008); solely watching other doctors prescribing does not appear to be sufficient when it comes to acquiring reliable prescription skills - it would appear that trainee doctors need to practice these skills for themselves. With respect to patient safety and ensuring good clinical practice among young doctors, specific training modules within medical education would seem warranted.

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Conflict of interests None.

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