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Empfohlene Zitierung / Suggested Citation:
Müller-Bühl, U., Gerold, C., Engeser, P., & Szecsenyi, J. (2008). Changes in drug therapy following hospital discharge for patients in a general practice: a German incident study. *Journal of Public Health*, *17*(3), 217-223. https://doi.org/10.1007/s10389-008-0241-6

J Public Health (2009) 17:217–223
DOI 10.1007/s10389-008-0241-6

ORIGINAL ARTICLE

Changes in drug therapy following hospital discharge for patients in a general practice: a German incident study

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Received: 10 June 2008 / Accepted: 7 October 2008 / Published online: 23 December 2008

Abstract
Objective In primary care, clinically recommended drug medication is often modified after hospitalization. The aim of the study was to examine the frequency and factors associated with GPs changing the hospital drug treatment in a sample of patients discharged from the hospital.
Methods In a prospective study, the prehospital, hospital and posthospital diagnoses and drug treatment of 130 patients consecutively recruited from 15 general practices were recorded over a period of 12 months. The ICD-10 classification was used to compare the data from hospitals and general practices. GPs who changed the hospital drug treatment were interviewed in a semistructured way concerning their reasons for changing.
Results The most frequent diagnoses during and after hospitalization were listed in the ICD-10 chapters 'Diseases of the cardiovascular system' (34.3%) and 'Endocrine, nutritional and metabolic diseases' (18%). Accordingly, the most frequently prescribed drug medication was related to these chapters (47.5% and 15.9%, respectively). Hospitalization led to a significant increase in the number of drugs per patient [prehospital 5.4; hospital 6.6; posthospital 6.7; ($p<0.001$)]. GPs changed the hospital drug recommendations of the discharge letters in 60.7% of the cases. They omitted drugs in 27.6%, replaced prehospital drug medication in 26.3%, changed to other manufacturers in 9.3%, added new drugs in 13.1% and changed the dosage in 4.2% of the cases. Changes in drug medication correlated significantly with the number of drugs and number of diagnoses ($p<0.001$). The most frequently mentioned reason for drug changing by GPs was cost savings (30.3%). But more often they changed drug medication for patient-related reasons (42.4%): 'better individual drug effect' in 18.5%, 'no reasonable indication' in 17.1% and 'not related to adequate diagnosis' in 6.8% of the cases.
Conclusion After hospital discharge, GPs changed more than half of posthospital drug recommendations. Although they believed that economical aspects were the most important reason for their behavior, most drug changes were done for patient-related reasons.

Keywords Hospital discharge · General practitioners · Drug utilization · Out-patient prescriptions

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Introduction

In Germany, as in other industrial countries in Europe and overseas, health administrators of the government try to save health system costs by restriction of drug prescription in family practices. Hereby, the most important instrument to slow down the increase in drug costs is economical awareness of drug prescribing among general practitioners (GP) (Bijl et al. 1998; Hakansson et al. 2001).

However, the combined physician-patient decisions for prescribing or changing drug medication are too complex to reduce to economical aspects. In particular, GPs have to regard various patient-related factors, such as disease-specific indication, patient shared decisions, side effects, drug interactions and so on.

A high percentage of drug changes results at the hospital-general practice interface. Therefore, this topic is particularly suitable for researching the drug prescribing behavior of GPs. Former studies have found that GPs

change hospital written drug medication in 34–82% of discharged patients (Cochrane et al. 1992; Burns et al. 1992; Feely et al. 1999). However, most studies were performed many years ago and lost their actuality through rapid changes in health system government declarations. Moreover, interpretation of the results to Germany is limited, because studies resulted from other countries (US, Great Britain, Switzerland) with modified health systems.

The study was undertaken to examine actual frequencies and reasons for changing drug medication after hospitalization in primary care in Germany. We aimed, in particular, to identify GPs prescribing decisions for changing clinically recommended posthospital drug medication.

Subjects and methods

Sampling

Fifteen primary care practices in Germany participated in this prospective study. All practices consecutively collected posthospital discharge letters for a period of 12 months from January 2004 to January 2005. Patient criteria for inclusion in the study were the presence of a preliminary or final discharge letter of an internal medical ward of a district general hospital and the diagnosis of at least one chronic disease.

Out of a group of 20 GPs involved in educational programs at the University of Heidelberg who were asked to participate in the study, 16 GPs (80%), 2 females and 14 males, took part. The sample represents a diversity of practice size and location (rural, urban). The age of GPs was uniformly distributed (40–50 years, n=5; 50–60 years, n=5; >60 years, n=5).

Data source and statistical analysis

Drug medication and related diagnoses were recorded three times for all included patients. Prehospital data and the actual posthospital data were taken by reviewing practice patient documents prior to referral to the hospital and after discharge. Data from the last GP consulting before the referral and from the first after the discharge were used in each case. Hospital data were recorded from the hospital discharge letter. The frequency of GP drug cancellation, replacement, and dosage alteration was recorded by comparison of the hospital drug recommendations in the discharge letter with the actual drug medication as received from practice patient documents. Drugs for complementary medicine were not considered in this study because they are not listed in the German drug manual.

All diagnoses were coded according to the International Classification of Diseases (ICD-10 2007). For statistical analysis, drug medication (trade name, generic drug, dosage) was filed under the 22 main ICD-10 chapters as listed in the German drug manual (Rote Liste® 2004). If a drug could be assigned to more than one ICD-10 chapter, the chapter for its usual clinical indication was always chosen. For example, hydrochlorothiazide was filed exclusively under chapter 9 (cardiovascular diseases) and not under chapter 18 (symptoms and clinical abnormalities). After recording patients' data in a semistructured interview, GPs who changed the hospital drug treatment were asked about their reasons for changing medication proposed by the hospital. Prior to the study, the structure of the interview was discussed in a focus group.

All statistical procedures were performed with SAS software. Bivariate comparisons for variables were conducted using Pearson's chi-square test and Student's *t* test for categorical and continuous variables. A two-sided *P* value <0.05 was considered to indicate statistical significance. A multivariable logistic regression model was used to obtain the association between variables and drug changing.

Results

A total of 130 patients were enrolled in the study (68 females, 62 males). The mean age was 71 years (range 19–97). The females (75 years, range 24–97) were 7 years older than male patients (68 years, range 19–86). Eighty-three percent of the patients contacted their GP within the first 4 days after discharge from the hospital; 11% of the patients visited the practice after 5–10 days.

Prehospital, hospital, and posthospital diagnosis groups

Summarizing the discharge letters and practice patient documents resulted in 1,503 diagnoses (753 hospital diagnoses and 750 practice patient diagnoses). The number of diagnoses significantly increased with age from 5 in patients <70 years to 6.5 in patients >70 years, but there was no difference between males and females. In the statistical analysis from a total of 22 ICD chapters of the drug manual, only 18 chapters were registered.

The most frequent diagnoses on referral to the hospital were filed under chapter 18, 'Symptoms and clinical and laboratory abnormalities' (females 16.9%, males 8.5%, total 25.4%). Of the patients, 12.3% were registered in chapter 0, 'No diagnosis.' All diagnoses are summarized in this chapter that were not related to one of the other chapters, for example, diagnostic examination, improvement of pharmacological treatment or follow-up procedures. When patients of chapter 18 and 0 were added, a total of 37.7% patients were referred to the hospital without an exactly

described diagnosis (Fig. 1). Second to the most frequent referral diagnoses, 'diseases of cardiovascular system' were listed with 23.8%. Further reasons for referral were 'diseases of the respiratory system' with a frequency of 10% followed by 'diseases of digestive system' with 7.7%. 'Diseases of the musculo-skeletal system' and 'psychological disorders' were not diagnosed for referral to an internal medical ward of hospital.

As a result of hospital stay, diagnoses of chapter 0 completely disappeared after discharge, and the number of diagnoses of chapter 18 decreased from 25.4% to 2.8% (Fig. 1). The ranking of hospital letter diagnoses was now led by diagnoses of chapter 9, 'Diseases of the cardiovascular system' (37.3%), followed by 'endocrine, nutritional and metabolic diseases' (19.5%), 'diseases of digestive system' (8.2%) and 'diseases of respiratory system' (6.2%).

In the posthospital practice document analysis 'diseases of the musculo-skeletal system' and 'psychological disorders' rose to the third and fourth ranking positions. The number of 'diseases of the musculo-skeletal system' increased significantly from 3.9% to 12% ($p<0.05$). Also, 'psychological disorders' were registered significantly more commonly in practices than in hospitals (9.2% vs. 5.8%, $p<0.05$).

Prehospital, hospital, and posthospital drug medication

A total of 2,427 drugs were recorded, on average 6.5 per patient. The hospitalization led to a significant increase of 1.3 drugs per patient ($p<0.001$).

Corresponding to the high frequency of diagnoses, most drugs were prescribed for chapter 9, 'Diseases of cardiovascular system' (47.5%). Similar to the ranking of diagnoses, drug medication follows for treatment of 'endocrine, nutritional and metabolic diseases' with 15.9% and 'diseases of digestive system' with 7.7% (data not shown). Figure 2 depicts a significant increase in the drug number prior to and after hospitalization in the three chapters of most frequently prescribed drugs and additionally in chapter 1 (infectious diseases, i.e., antibiotics). According to the frequency of diagnoses, patients received drugs for treatment of 'diseases of the musculo-skeletal system' and 'psychological disorders' significantly more often in practices than in hospitals.

In the practice setting, only 19.4% of the proposed hospital drug medication was issued unchanged. GPs changed the hospital drug recommendations of the discharge letters in 60.7% of the cases. They omitted drugs in 27.6%, replaced prehospital drug medication in 26.3%, changed to other manufacturers in 9.3%, added new drugs in 13.1% and changed the dosage in 4.2% of the cases (Fig. 3).

Because cardiovascular drugs of chapter 9 were most frequently prescribed and changed; a more detailed listing of its pharmacological subgroups is shown in the table. This indicates that most changes are related to antihypertensive and cardiac drugs. Considering 2,427 recorded drugs and a total of 1,050 posthospital drug changes, an even more detailed portrayal at the level of pharmacological subgroups or even single agents would generate more confusion than providing worthwhile information.

Reasons for drug changing

The most frequent reason for changing clinically recommended drug medication from interviewees was cost savings (30.3%). However, GPs stated 'better individual drug effect' in 18.5%, 'no reasonable indication' in 17.1%, 'use up prehospital prescribed drugs' in 8.1% and 'not related to adequate diagnosis' in 6.8% of the cases. Summarizing these statements, patient-related reasons would be responsible for 42.4% of all drug changes after hospital discharge (Fig. 4).

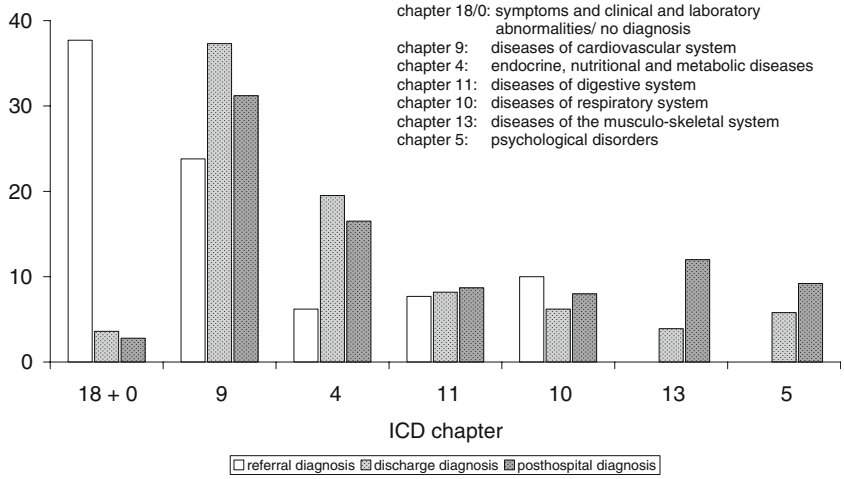

Fig. 1 Ranking of the most frequent referral diagnoses, diagnoses of the discharge letters and the post-hospital practice document diagnoses

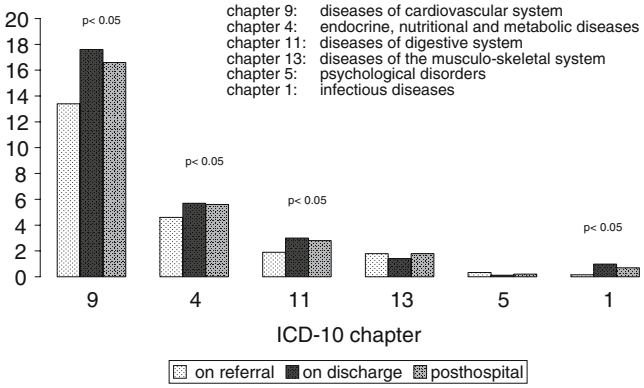

Fig. 2 Drug medication of prehospital practice documents, of the discharge letters, and of posthospital practice documents

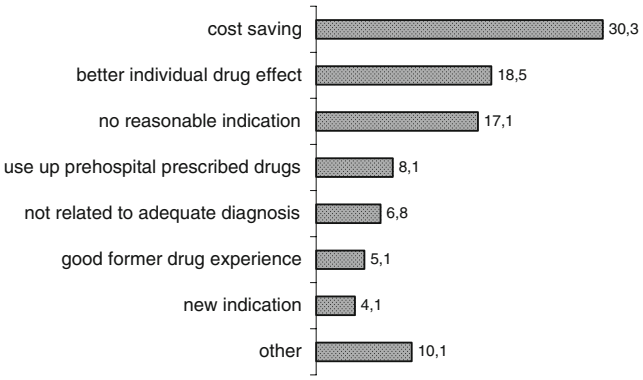

Fig. 4 GPs' reasons for drug changing

We used multivariate analysis to identify patient characteristics associated with drug changing. The following variables were added to the regression equation to adjust the probability of drug changing estimates: age, gender, number of drugs, as well as the number of diagnoses. Regression analysis showed that changes in drug medication correlated significantly with the number of drugs and number of diagnoses ($p<0.001$), but not with patients' age or gender.

Discussion

The International Classification of Primary Care (ICPC) is used in most primary care studies nowadays. The ICPC allows classification of the reasons for encounter from the patient's perspective and the problems and diagnoses from the health-care provider's view. However, the International Classification of Diseases (ICD-10) was chosen for our study, because in Germany the ICD-10 is the standard coding system of the hospitals and practices and therefore suitable for comparing statistics and deduction of both settings.

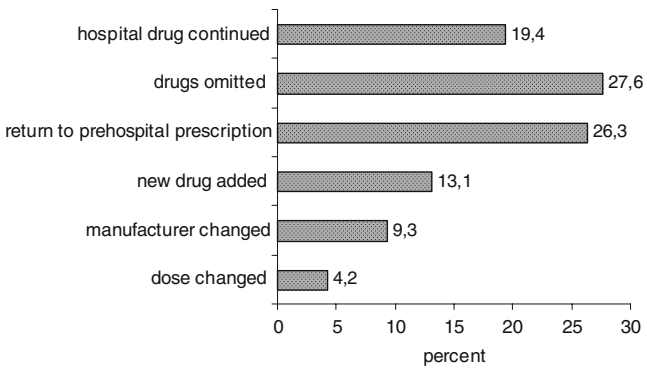

Fig. 3 Frequency of GPs changing the drug after discharge from hospital

A total of 1,503 diagnoses were collected in 18 out of 22 ICD-10 chapters. Despite a nearly identical number of prehospital and posthospital diagnoses, the hospital stay led to a distinct floating of diagnoses within the different ICD-10 chapters. It was not surprising that chapter 18 and chapter 0 containing no exactly described diagnoses or no diagnoses disappeared after hospital discharge, because diagnostic or therapeutic insecurity influenced GPs to refer patients to the hospital. Also, in agreement with numerous primary care studies, cardiovascular diseases, digestive diseases and respiratory disorders were the most frequent diagnosis groups requiring admission to the hospital (Himmel et al. 1996; Lau et al. 1999). Since the discharge letter of an internal medical ward was a criterion of our study, no cases of diseases of the musculo-skeletal system and psychological disorders were listed as the reason for referring a patient to the hospital. However, it is conspicuous that those diagnoses that were significantly more common posthospital were listed in practice patient documents and in hospital discharge letters. Obviously, during a stay in internal medical wards, patients and doctors have less awareness of those complaints and diseases than in primary care practice. Also, in discharge letters little attention was given to diagnoses and nonoral medication of eyes, skin and airways.

To compare the amount and frequency of drug changing during and after hospital stay, patient medication in our study was categorized according to ICD chapters. Hospitalization led to a 22% increase in the number of drugs per patient after discharge. Several surveys investigating changes in prescription at the hospital-general practice interface resulted in a similar increase in drug number after discharge (Himmel et al. 1996; Omori et al. 1991). In a German single practice study, 18% more drugs were prescribed posthospital compared to the time before hospital admission (Himmel et al. 1996). In contrast, in a study of geriatric patients, Nikolaus et al. (1996) described a significantly lower number of drug prescriptions on

discharge compared to admission. However, this study focused on elderly patient problems with polypharmacy and drug non-compliance, and reducing the number of drugs was considered to be a way to prevent patient confusion about the drug regimen.

Prescription of more drugs mostly leads to higher costs. Results of studies in Germany, The Netherlands, Great Britain and Sweden suggest that referral to consultants or hospitals results in higher costs compared to general practice (Feely et al. 1999; Bijl et al. 1998; Hakansson et al. 2001). However, prescribing of not only more but also more expensive drug medication in hospitals must not mean an uneconomic prescribing behavior of hospital physicians. At least a part of the increase in costs may be caused by a change of diagnoses. According to Bijl et al. (1998), referral to a consultant leads in about half of the patients to a change in diagnosis and to a 23% increase in costs. While a higher number and more defined diagnoses may explain an increase in costs on the one hand, on the other hand, certain diseases require more costly medication. For example, inpatient triple eradication therapy is very expensive and must often be continued for some time in the practice setting.

According to the high medical and economic importance, drugs for treatment of cardiovascular diseases in hospitals as well as primary care practices are the most frequently prescribed medication. Within the group of cardiovascular diseases, hypertension and hyperlipidemia are the most common disorders causing chronic drug usage (Katz et al. 1996; Lau et al. 1999; Harder S et al. 1998; Saltman et al. 2005). In our study, cardiovascular drugs were also the superior class of drugs that have been prescribed and changed during and after hospitalization. However, cardiovascular drug changes in many cases are neither caused by guideline adherence nor suggest inappropriate prescribing by GPs. Himmel et al. (2004) found changes of about 30% in antihypertensive and cardiac drugs after hospital admission independent of whether the patient was admitted because of cardiac disease or other medical problem. In a 1-year follow-up study, about 50% of all cardiovascular prescriptions were subject to changes in the choice of preparation (brand-generic) or within classes of similar agents prescribed (Harder et al. 2005). In a study by Katz et al. (1996), treatment changes were almost as common in patients admitted with stable cardiovascular disease as in those requiring rapid drug intervention. GPs' decisions for posthospital changing of cardiovascular drugs in the practice setting possibly could depend on the kind of cardiovascular disease. While antihypertensive agents will more often be changed in patients with heart failure, the treatment regime remained stable 2 weeks after discharge (Scherer et al. 2006).

As expected, hospital admission encouraged an increase in drugs for the treatment of digestive diseases, particularly H_2-receptor antagonists and proton pump inhibitors. According to Nardino et al. (2000), in approximately 50% of admitted patients acid-suppressive therapy is started inappropriately during hospitalization. Sometimes home GPs retain antacid prescriptions after discharge and not rarely it results in acid-suppressive long-term treatment (Zink et al. 2005).

GPs changed the hospital drug recommendations of the discharge letters in more than half the cases. About one third of the interviewees mentioned costs as the most important argument for changing the prescribed drugs. In a German questionnaire study even 58% of GPs stated economical considerations as the most important reason for changing drug medication followed by patient-related reasons in 34% (Roth-Isigkeit and Harder 2005). Numerous reimbursement restrictions of health system facilities might explain these prescription habits of German GPs. In our study, however, when the different patient-related answer categories for GPs' decisions for drug changing were summarized, more than half of all interview answers concerned patient-related reasons. Probably this rate is still higher, because the interview category 'other' contained further patient-related reasons such as patient-shared decisions or me-too prescriptions. GPs considered patient-related

Table 1 Changes of cardiovascular drugs after discharge from hospital, arranged according to pharmacological subgroups (n=481)

	Drugs omitted		Return to prehospital prescription		Hospital drug continued		New drug added		Manufacturer changed		Dose changed	
	n	%	n	%	n	%	n	%	n	%	n	%
Anticoagulants, platelet function inhibitors	35	7.2	14	2.9	15	3.1	4	0.8	2	0.4	0	0.0
Antihypertensive drugs, diuretics	44	9.1	44	9.1	38	7.9	30	6.2	23	4.8	6	1.2
Beta-receptor blockers, calcium channel antagonists, ACE inhibitors	43	9.1	44	9.1	31	6.4	25	5.2	30	6.2	14	2.9
Other cardiac substances, vasoactive agents	12	2.5	10	2.0	13	2.7	3	0.6	1	0.2	0	0.0
Total	134	27.8	112	23.3	97	20.1	62	12.9	56	11.6	20	4.1

reasons obviously as less important for the reason for prescription; in the interview, however, they named appropriate categories more often than cost savings. We do not believe that this explains the low rate of generic drugs prescribed by GPs posthospital in our study, which is probably more due to the currently high acceptance of generic prescribing in hospitals.

It was not the aim of the study to record how often hospital doctors change the medication of GPs. However, at the first posthospital practice encounter, GPs returned to patients' prehospital prescription in 26.3% of cases. There is no detailed information on why they did so, but this should not be misinterpreted as suspicion of medical competence of hospitals. Taking into account the common GPs' interview statements, "better individual drug effect" and "no reasonable indication," it rather seemed to show GPs' very differentiated and individual view of their patients' therapeutic needs. Even in 4.1% of cases, symptoms and ailments obviously required additional newly prescribed drug medication ("new indication").

GPs' drug changes on hospital discharge appeared to be induced not only by principles of rational prescribing, but also most notably by comprehensive knowledge and competence in long-term care of their patients. For example, deficits have been shown concerning guideline implementation of medical heart failure treatment into practice (Peters-Klimm et al. 2008). Armstrong et al. (1996) identified three models explaining the drug prescribing behavior of GPs. Besides traditional agencies of change with an accumulation of evidence-based information, important factors influencing prescribing behavior are therapeutic challenges like successful treatment or conflictual clinical events. Further studies on this topic are necessary to suggest which of these single or combined mechanisms are responsible for GPs' decisions for changing hospital-recommended prescriptions. We feel that the latter two reasons play a particularly important role in the GP's subjective prescription decision.

Our study is limited by the fact that a heterogeneous sample of 15 GPs by chance was recruited, but not in a random manner. However, the age and gender structure of patients and doctors in this study is very similar to that of numerous studies concerning problems of drug medication in primary care practice (Himmel et al. 1996; Cochrane et al. 1992; Burns et al. 1992). Therefore, our findings cannot be considered as representative, but nevertheless characteristic of GP prescribing behavior nationwide.

In conclusion, the data of our study suggest that drug medication is still changed too frequently and extensively at the interface between clinical pharmacology and primary care practice. This situation is unsatisfactory for patients and physicians and may lead to unnecessary and avoidable costs for the health-care system. Better communication between hospital and practicing physicians is easy to postulate, but difficult to realize. The concept of shared care, at present, failed to demonstrate significant benefits for patients apart from improved prescribing (Smith et al. 2007). However, in Germany it is far from reality and difficult to put into practice. Besides improvement in communication between family and hospital doctors via transmission of more detailed information about drug changes to the discharge medication list (Clintborg et al. 2007; Gonski et al. 1993), perhaps more patient information, such as pharmaceutical counseling and better informing of patients concerning their pharmaceutical care plan, might be helpful to reduce posthospital drug prescribing (Al-Rashed et al. 2002; Sorensen et al. 2004). Furthermore, use of modern media like the world-wide web in primary care practices opens up new possibilities for better maintenance of adequate drug treatment after hospital discharge. See Table 1.

Acknowledgement We thank the general practitioners who participated in this study: A. Arends, MD; T. König, MD; B. Hoops, MD; U. Ritter, MD; U. Kneise, MD; R. Barabasch/G. Riedel, MD; R. Leutgeb, MD; P. Engeser, MD; D. Zeise-Süss, MD; A. Wiesemann/U. and T. Wiesemann, MD; B. Musselmann, MD; T. Polzer, MD; St. Bilger, MD; J. Barlet, MD; H.D. Klimm, MD.

Conflict of interest The authors disclose any relevant associations that might pose a conflict of interest.

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