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CLINICAL RESEARCH

Medication reconciliation: Predictors of risk of unintentional medication discrepancies in the cardiology department

Conciliation des traitements médicamenteux : facteurs associés aux divergences non intentionnelles en service de cardiologie

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KEYWORDS
Medication reconciliation;
Clinical pharmacy;
Drug prescription;
Patient admission

Summary
Background. — Medication reconciliation is a powerful formal process to decrease medication errors, but it has proved to be complex and time consuming.
Aims. — To describe the frequency and types of medication discrepancies (between previous treatment and medication order at admission), and to identify predictors of unintentional medication discrepancies (UMDs).
Methods. — This interventional study was carried out in the cardiology department of a French teaching hospital. Medication reconciliation was conducted at admission to the cardiology department over 1 month in 2016 by trained pharmacists for: (1) determination of best possible medication history using multiple sources; (2) comparison with the patient's admission medication order and identification of discrepancies; and (3) classification of discrepancies (intentional/unintentional) with the physician. Associations between UMDs and various factors were examined.

Abbreviations: BPMH, Best Possible Medication History; CI, Confidence Interval; ICU, Intensive Care Unit; UMD, Unintentional Medication Discrepancy.

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Results. — Overall, 100 patients were included (mean age 67.6 ± 16.7 years; 56 men). The reconciliation process identified 544 drug discrepancies, 77 of which were UMDs; these occurred in 42 patients. The most common UMD type was omission (70.1%). Inability to speak French ($P = 0.007$), low educational level ($P = 0.004$), admission to a non-intensive care unit ($P = 0.019$), two or more co-morbidities ($P = 0.001$) and eight or more drugs on the admission order ($P = 0.004$) were significantly associated with UMDs. Educational level remained significantly and independently associated with UMDs in a multivariable analysis after adjustment for factors that were statistically significant in the univariate analysis.
Conclusions. — This study highlights the high risk of medication discrepancies and the factors associated with UMDs. Our results allowed us to identify patients who should receive priority medication reconciliation in a cardiology department.

MOTS CLÉS
Conciliation médicamenteuse ;
Pharmacie clinique ;
Ordonnances de médicaments ;
Admission du patient

Résumé
Contexte. — La conciliation des traitements médicamenteux permet de diminuer les erreurs médicamenteuses, mais ce processus formel s'avère complexe et chronophage.
Objectifs. — Décrire la fréquence et le type de divergences (entre le traitement avant l'hospitalisation et la prescription à l'admission), identifier les facteurs de risque de divergence non intentionnelle.
Méthodes. — La conciliation a été réalisée à l'admission des patients dans le service de cardiologie d'un centre hospitalo-universitaire français, pendant un mois en mars 2016 par des pharmaciens formés : (1) réalisation du bilan médicamenteux optimisé ; (2) comparaison avec la prescription médicamenteuse à l'admission et identification des divergences ; (3) caractérisation des divergences (intentionnelles/non intentionnelles) avec le clinicien. Les associations entre divergences non intentionnelles et les caractéristiques des patients ont été analysées.
Résultats. — Chez les 100 patients inclus (âge moyen 67,6 ± 16,7 ans; sexe-ratio (H/F) 1,3). La conciliation a identifié 544 divergences, dont 77 non intentionnelles chez 42 (42 %) patients. La plus fréquente était l'omission (70 %). Les facteurs associés à la présence de divergences non intentionnelles sont: ne pas parler français ($P = 0,007$), faible niveau d'éducation ($P = 0,004$), admission en hospitalisation conventionnelle (VS soins intensifs) ($P = 0,019$), ≥ 2 comorbidités ($P = 0,001$) et ≥ 8 médicaments ($P = 0,004$). Le niveau d'étude demeure significativement associé après ajustement sur les facteurs statistiquement significatifs de l'analyse univariée.
Conclusions. — Notre étude nous a permis de mettre en évidence l'importance des divergences et les facteurs associés. Nous pouvons désormais sélectionner les patients chez qui la conciliation médicamenteuse est à réaliser en priorité en cardiologie.

Background

Medication error can be defined as a failure in the treatment process that leads to, or has the potential to lead to, harm to the patient [1]. In line with the frequently cited quotation—''to err is human''—medication errors occur frequently in hospitals. Not all such errors cause harm, but in 1993, medication errors were estimated to cause approximately 7000 deaths in the USA [2]. Furthermore, they accounted for 1/131 outpatient deaths and 1/854 inpatient deaths [3]. Medication errors can occur at all stages of the medication management process, i.e. prescription, transcription, dispensing and administration [4]. Importantly, many of these events occur at transitions in care. Nearly half of the medication errors reported in hospitals are estimated to occur at admission to or discharge from a clinical unit or hospital, and nearly 30% are estimated as being potentially harmful to the patient [5—7].

Up to 67% of adults admitted to hospital have at least one unintentional medication discrepancy (UMD). Up to 27% of all prescribing errors detected in hospitalized patients can be attributed to discrepancies in medication histories at the time of admission [8]. Left unresolved, they may lead to adverse events during the hospital stay or after discharge from hospital.

The strategy of medication reconciliation can reduce medication errors during transitional care by identifying UMDs through better communication between healthcare professionals and patients [9]. The World Health Organization defines medication reconciliation as the ''formal

process in which health care professionals partner with patients to ensure accurate and complete medication information transfer at interfaces of care'' [10].

Medication reconciliation has been acknowledged by several international patient safety organizations — such as The Joint Commission [11] and the World Health Organization [10] — as important for achieving medication safety. However, implementation of the process faces several possible pitfalls, such as hospital organization and staff availability [12,13]. Medication reconciliation should be performed during the first 24 hours after admission, and is time consuming (up to 30 minutes per patient) [14]. Moreover, medication reconciliation should be carried out by dedicated pharmacists, as they have been shown to be more efficient at this task than physicians [15].

As resources are limited, patients at higher risk of reconciliation errors should be identified, and patients at higher risk of UMDs should be given priority for medication reconciliation. The present study was therefore designed to describe the frequency and type of UMDs at admission to a cardiology department, and to identify predictors of UMD risk.

Methods

Setting and participants

This prospective, observational, single-centre study was conducted at Saint-Antoine Hospital, an 800-bed university teaching hospital in Paris, France. Medication reconciliation at admission was conducted in the cardiology department — composed of an intensive care unit (ICU) (10 beds) and a hospital ward (30 beds) — over a 1-month period (18 February to 18 March 2016). The process for admission medication reconciliation was retroactive. The study was registered with the *Agence nationale de sécurité du médicament et des produits de santé* (the French national drug agency) (No. 2016-A00120-51).

A pilot study was conducted in January 2016 to validate the process of reconciliation and the tools (i.e. questionnaire, file and medication reconciliation form [Supplementary data, Fig. A.1]) developed for the patient interviews.

All patients admitted to the cardiology department were considered eligible for the study. Patients who were scheduled to be discharged on the same day or were unable to undergo the intervention were not included.

Medication reconciliation process

A team of three students and one pharmacy resident received training in how to take a 'best possible medication history' (BPMH), including a description of the tools and procedures for data collection; they applied the standardized method described by French authorities [16]. The first step of the medication reconciliation process at hospital admission was to obtain the BPMH, which includes a thorough history of all regular medication (prescribed and non-prescribed) taken before admission [8]. The BPMH was compiled from various sources of information, i.e. patient/family interview, medication packages, previous medical records, contact with physicians (general practitioner or specialist), contact with community pharmacies and pharmaceutical records [17]. The BPMH is a record of medication information, which includes medication name, dose, frequency and route of administration of medications; it is a 'snapshot' of the patient's actual medication use [10].

A structured form was used to guide the patient interviews and to record the answers. The interview with the patient was conducted at the patient's bedside by the reconciliation team, to obtain their current medication regimens (drug names, doses, routes, frequencies and administration). The reconciliation team also asked explicitly about painkillers, sleep medications, eye drops, inhalers, transdermal patches, injectable drugs, dermatological creams, antibiotics, vitamins, herbal drugs and nutritional supplements, drugs for stomach ache or constipation and the contraceptive pill, as recommended by scientific societies [10,18,19].

The reconciliation team systematically asked the patient for their public health insurance card. This card allows to access to the pharmaceutical record if created by the community pharmacy. The pharmaceutical record lists all medicinal products provided to each patient over the last 4 months (21 years for vaccines, 3 years for biological drugs) [20]; this includes both medicinal products prescribed by a physician and those advised by a pharmacist.

The reconciliation team systematically contacted relevant community pharmacies by telephone to obtain the latest medication orders.

The BPMH was established within the 24-hour period following admission (or 48—72 hours if the patient was admitted on a Friday or Saturday).

After data collection, the reconciliation team compared the BPMH with the patient's admission medication order; any difference was considered to be a discrepancy. Discrepancies were classified as omissions of medication, extra medications or differences in dose, frequency or pharmaceutical form. Every medication discrepancy was reviewed by the pharmacy resident and the physician in charge of the patient, and was classified as an intentional or unintentional discrepancy. Medications added, changed or discontinued intentionally by a prescriber were classified as intentional discrepancies. In the case of an unintentional discrepancy, the physician had the opportunity to make appropriate medication changes.

Data collection

Sociodemographic characteristics, hospitalization data and clinical characteristics were collected. For each reconciliation process, the sources used and the numbers and types of discrepancies were collected using a standardized form. The reconciliation team recorded the time spent collecting the data and completing the form.

Statistical methods

Categorical variables are reported as counts, percentages and 95% confidence intervals (CIs); quantitative variables as means and standard deviations. The associations between

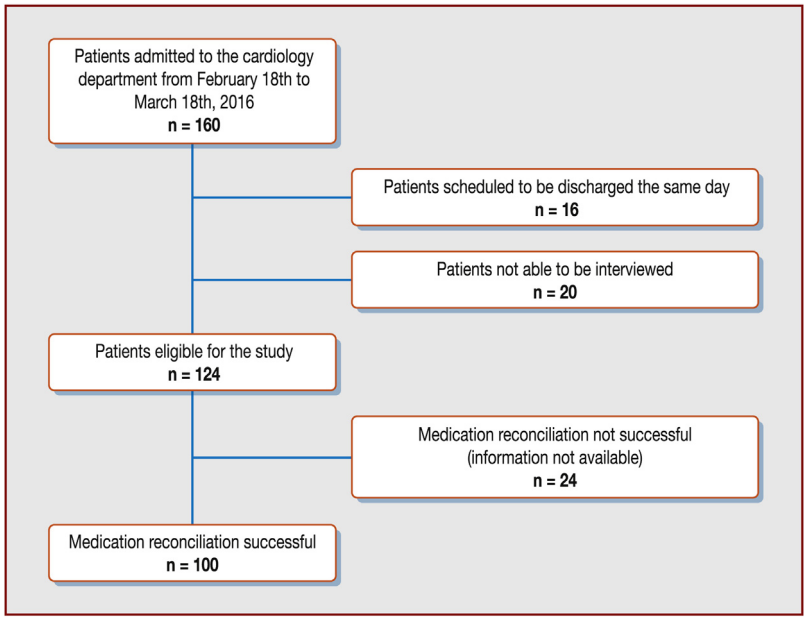

Figure 1. Study flow chart.

UMDs and patient characteristics were assessed using logistic regression in univariate and multivariable analyses. Interactions were assessed systematically. Analyses were performed using R software, version 0.99.893 (© 2009—2016 RStudio, Inc., Boston, MA, USA). *P* values < 0.05 were considered to be significant.

Results

Demographic and clinical characteristics

During the 1-month study, 160 patients were admitted to the hospital's cardiology department. Sixty patients were excluded from the study: 16 were discharged < 24 hours after admission; the reconciliation team could not interview 20 patients (ongoing medical examination or patients not in their room at least two times) and no other sources of information could be consulted; and no medication information was found for 24 patients (Fig. 1). The reconciliation team performed a mean (range) of 4.5 (2—8) medication reconciliations per weekday.

Patient demographic and clinical characteristics are provided in Table 1.

Reconciliation process

Sources of information for the BPMH

The sources of information used to create the BPMHs are described in Table 2. Pharmacists consulted a mean (range) of 2.7 (2—5) information sources per patient to obtain the BPMH. The distribution of the 100 medication reconciliations according to information sources used to create the BPMH is presented in Fig. 2. The most accessible source of information was the patient and/or their family (93 patients). Among these, 84 (90.3%) provided information about their treatment during the interview, 26 (28.0%) had their prescriptions, 19 (20.4%) brought their medication packages and 49 (52.7%) had their public health insurance card.

Through the 49 public insurance cards obtained, the pharmaceutical records provided information about treatment for 23/49 patients (46.9%) (26 pharmaceutical records were not created by the community pharmacy).

Community pharmacies were contacted for 66 patients; they provided previous medication orders for 83.3% of these 66 patients. For the other 34 patients, contact information for the community pharmacy was not obtained or the patient did not have a regular community pharmacy.

Duration of the reconciliation process

The duration of the reconciliation process was < 30 minutes for 25 patients, 30—60 minutes for 38 patients and > 1 hour for 37 patients.

Discrepancies

A total of 746 prescribed medications were analysed among the 100 patients, and 544 discrepancies were observed. After discussion with hospital physicians, 467 discrepancies (85.8%) were flagged as intentional and 77 (14.2%) as unintentional. Among the 467 intentional discrepancies, 367 (78.6%) were not documented in the medical record by the physician: 184 started medications (50.1%); 118 stopped medications (32.2%); and 65 changed medication (dose, timing or forms) (17.7%). There were 85 patients (85.0%) with at least one undocumented intentional discrepancies.

The distribution of the 77 UMDs among the 100 patients is presented in Fig. 3. There were 58 patients without any UMDs, 26 patients with one UMD and 16 patients with two to seven UMDs. The types of UMD are described in Fig. 4. Omission of medication (70.1%) was the most frequent type of UMD, followed by a wrong dose (24.7%). Among the dose errors, 12/19 (63.2%) were cases of underdosing and 7/19 (36.8%) were cases of overdosing.

Table 1 Patient characteristics ($n = 100$).

Demographic characteristics	
Age (years)	67.6 ± 16.7 (27–95)
Men	56/100 (56.0)
French-speaking	96/100 (96.0)
Socioprofessional category (missing data, $n = 4$)	
Retirees	59/96 (61.5)
Other people without professional activity	11/96 (11.5)
Senior managers	10/96 (10.4)
Employees	8/96 (8.3)
Workers	4/96 (4.2)
Company directors	3/96 (3.1)
Intermediate professionals	1/96 (1.0)
Residence	
Home	95/100 (95.0)
Care/retirement home	5/100 (5.0)
Living alone (missing data, $n = 1$)	58/99 (58.6)
Educational level	
Primary	28/84 (33.3)
Secondary	25/84 (29.8)
Tertiary	31/84 (36.9)
Hospitalization-related data	
Admission to hospital ward	53/100 (53.0)
Admission to ICU	47/100 (47.0)
Admission to cardiology unit	
Emergency admission	64/100 (64.0)
Transfer from another unit	24/100 (24.0)
Scheduled hospitalization	12/100 (12.0)
Clinical characteristics	
Co-morbidities	
0	9/100 (9.0)
1	31/100 (31.0)
2	36/100 (36.0)
≥ 3	24/100 (24.0)
Drugs prescribed at admission[a]	7.5 ± 3.9 (1–17)
1–4	26/100 (26.0)
5–7	22/100 (22.0)
8–10	29/100 (29.0)
9–17	23/100 (23.0)

Data are expressed as mean ± standard deviation (range) or number/number with data (%). ICU: intensive care unit.
[a] On the admission medication order.

Table 2 Information sources used by the reconciliation team when eliciting information.

Sources of information	Information obtained/sought (%)
Patient/family interview	84/93 (90.3)
Prescriptions brought by patient/family	26/93 (28.0)
Medication packages brought by patient/family	19/93 (20.4)
Pharmaceutical records (through public health insurance card)	23/49 (46.9)
Prescriptions obtained from a community pharmacy	55/66 (83.3)
Medical records	52/87 (59.8)
General practitioner	2/2 (100)

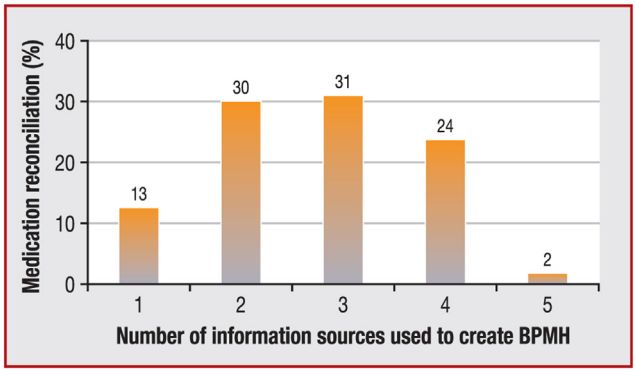

Figure 2. The distribution of medication reconciliation according to number of information sources used to create the best possible medication history (BPMH).

The three most common pharmacological classes involved in UMDs according to the Anatomical Therapeutic Chemical classification systems were: the nervous system (17/77, 22.1%); the cardiovascular system (15/77, 19.5%); and the alimentary tract and metabolism (14/77, 18.2%). Most UMDs concerned tablets or capsules (53/77, 68.8%), followed by ophthalmic forms (8/77, 10.4%).

Factors associated with UMDs

Factors associated with UMDs are presented in Fig. 5. Inability to speak French ($P = 0.007$), low educational level ($P = 0.004$), admission to a hospital ward (rather than an ICU) ($P = 0.019$), two or more co-morbidities ($P = 0.001$) and eight or more drugs on the hospitalization prescription at admission ($P = 0.004$) were statistically associated with UMDs in the univariate analysis. Age, route of admission to the cardiology unit (emergency, transfer from another unit or scheduled hospitalization), socioprofessional category and living alone were not associated with UMDs.

Educational level remained significantly and independently associated with UMDs after adjustment in the multivariable analysis for factors that were statistically significant in the univariate analysis ($P < 0.05$).

Discussion

This observational non-interventional study reveals a substantial rate of UMDs in patients admitted to a cardiology ward. At least one UMD was identified in 42.0% of patients. Among 746 prescribed medications, 544 discrepancies were observed, 77 (14.2%) of which were flagged as unintentional. The most common UMD was omission (54/77, 70.1%).

The study also reveals an important number of undocumented intentional discrepancies identified in 85.0% of patients. These discrepancies are not medication errors, but may lead to medication errors in future medical care.

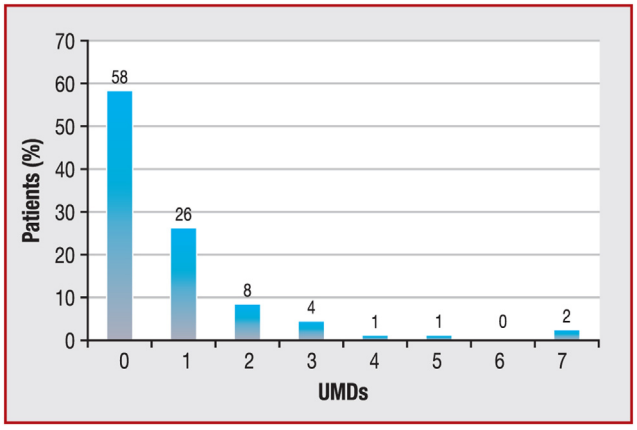

Figure 3. The distribution of 77 unintentional medication discrepancies (UMDs) among 100 patients.

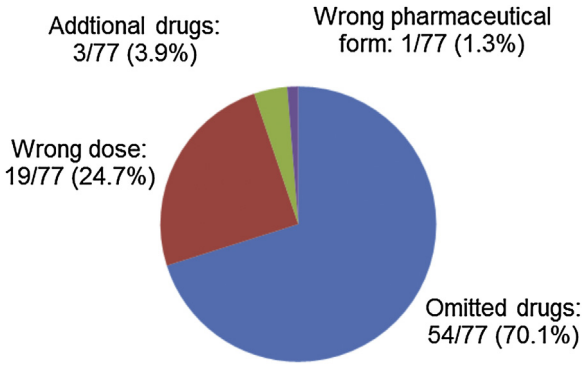

Figure 4. Types of unintentional medication discrepancies.

When they identified undocumented intentional discrepancies, the pharmacist and physician could work to rectify this lack of documentation; proper documentation is required on the medical file to improve transition in care.

We had a need to identify predictors of risk of UMDs. The highlighted factors associated with UMDs were: inability to speak French; admission to the hospital ward (rather than the ICU); low educational level; two or more co-morbidities; and eight or more drugs on the initial prescription. Educational level remained significantly and independently associated with UMDs after adjustment in the multivariable analysis.

Our results showed that 42.0% of patients had one or more UMD; this result is consistent with previous studies, which reported UMD rates of between 17.7% and 53.6% in diverse clinical settings [5,21,22]. These high rates of medication discrepancies at the time of hospital admission advocate close monitoring of drug regimens at this transition in care.

In our study, the most common types of discrepancy were omission of a medication that the patient was taking before

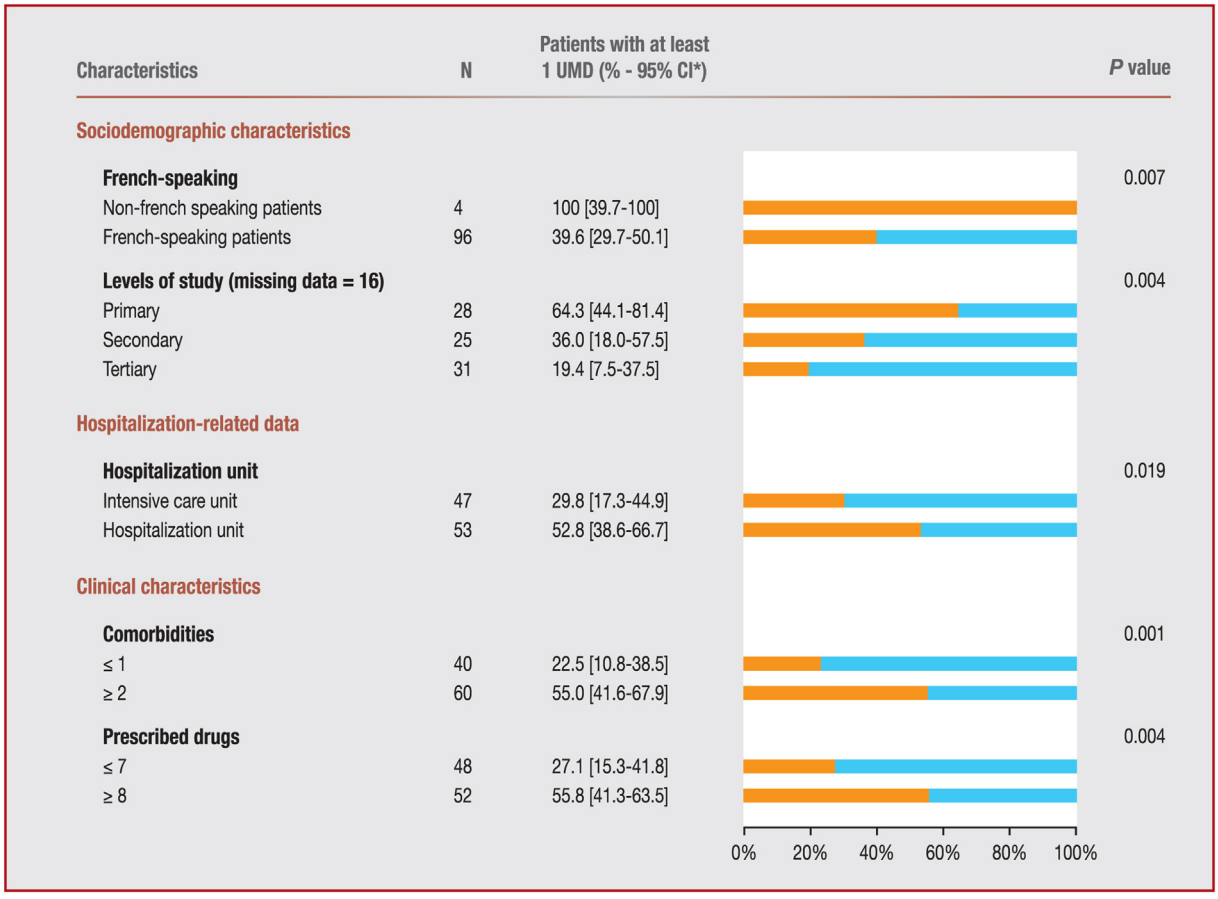

Figure 5. Sociodemographic and hospitalization-related data and clinical characteristics of patients with unintentional medication discrepancies (UMDs). Orange bars represent the percentages of patients with one or more UMD. CI: confidence interval.

admission and wrong dose. These results are in agreement with the literature, where omissions have invariably been reported to be the main cause of divergence, followed by dose modification [5,14,23]. Omission of drugs or modification of dosing in cardiology can cause treatment failure, leading to increased morbidity/mortality both short term (e.g. beta-blockers and anticoagulants) and long term (e.g. statins).

In our study, the most common pharmacological classes involved in UMDs were nervous system, cardiovascular system and alimentary tract and metabolism drugs. These data agree with several studies [14,24,25] not performed in cardiology departments. Drug classes involved in discrepancies do not seem to be related to the ward's medical discipline. Although, for Buckley et al. [26], the criteria for deciding which patients received medication reconciliation on admission included diagnosis/past history of heart failure or acute myocardial infarction, an active order for warfarin and concomitant active orders for aspirin and clopidogrel.

We found that low educational level and inability to speak French were significantly associated with UMDs in the univariate analysis; this is similar to findings from a study that reported that low patient understanding of preadmission medications was associated with UMDs [27]. Further, Gleason et al. prioritized patients with limited English proficiency for the reconciliation process [24]. Moreover, patients who are unable to read are frequently excluded from studies, and hence few data are available for this population.

None of the other sociodemographic variables investigated in the current study (i.e. sex, age, socioprofessional category or living alone) were associated with the presence of UMD at hospital admission. However, other studies have reported that age is associated with the presence of UMDs. For instance, Climente-Marti et al. showed that the risk of UMD increases with advancing age [28], and Unroe et al. showed that age was associated with a higher risk of discrepancies on admission [25]. The lack of a link between age and UMDs in the current study may reflect the advanced age of our population (mean 67.6 years).

The route of admission to the cardiology unit (via emergency, transfer from another unit or scheduled hospitalization) was not significantly associated with UMDs in our study. However, Pourrat et al. reported that patients with planned hospitalizations were less likely to have UMDs than patients with unplanned hospitalizations [22].

Admission to the hospital ward was significantly associated with UMDs, compared with admission to the ICU. Although we were unable to find another study comparing a hospital ward and an ICU, Unroe et al. reported that the proportion of patients with discrepancies on admission differed significantly between three unit types (cardiology department, general medicine and general surgery) [25]. On the contrary, in our study, even if we were not evaluating factors associated with undocumented intentional discrepancies, there are more undocumented intentional discrepancies in the ICU than in the hospital ward. We could assume that ICU physicians have less time to document treatment changes in the medical file. Moreover, many drugs for the chronic treatment of patients are not prescribed during hospitalization in the ICU.

In line with other studies [24,29—31], the number of drugs on the admission order was associated with UMDs in our study. For example, Hellstrom et al. reported that a higher number of drugs at admission was predictive of medication history errors [30]. Gleason et al. also reported that a higher number of prescription medications was a risk factor independently associated with an increased risk of UMDs (odd ratio 1.21, 95% CI 1.14—1.29) [24].

Strengths and limitations

We acknowledge the following limitations to our study. Only one hospital department was involved in patient recruitment. The study was performed in the ICU and hospital ward of a cardiology department, where prescribing practices are similar. Medication reconciliation was not performed for 60/160 patients (patients discharged on the same day, those not able to be interviewed and those with medication information not available). Medication reconciliation could not be achieved for all patients; it would be necessary to have a larger reconciliation team. Furthermore, the use of at least three sources is recommended to establish the BPMH [17,32]. The reconciliation team consulted a mean of 2.7 information sources per patient to obtain the BPMH. Fewer than three sources were used for 43% of medication reconciliations (Fig. 2); this seems insufficient to create a reliable and complete BPMH. The patient is the most used source of information because they are the most accessible (Table 2). However, the patient is not the most reliable source [17]; the information they provide during the interview is often incomplete (missed medication, unspecified dose). Nevertheless, the patient has a main role, because they allow the reconciliation team access to their prescription, their boxes of medication, their insurance card and the name of their community pharmacy. Absence of the patient from the ward at the time of data collection stops access to these other sources. It is difficult to realize medication reconciliation without the patient.

This study also has various strengths. We conducted the admission medication reconciliation process using a standardized method, as described by French authorities. The tools (questionnaire, file and medication reconciliation form) were validated during a pilot study. We did not select patients; all patients admitted were eligible for the study, making our results more generalizable than other studies. The students and pharmacy resident from the reconciliation team received training for the course of patient interviews. Lastly, the study was designed and performed by a structured multidisciplinary team comprising physicians, nurses and pharmacists.

Conclusions

Our study highlights the high risk of UMDs at admission to the cardiology department. However, medication reconciliation at admission is a resource-intensive process. Our study identified patient factors associated with UMDs, and allowed us to identify patients who should receive priority medication reconciliation in a cardiology department.

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Disclosure of interest

The authors declare that they have no competing interest.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.acvd.2018.09.004.

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