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Electronic pharmaceutical record for best possible medication history at preoperative evaluation to prevent postoperative adverse events: a quasi-experimental study

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ABSTRACT

Background Access to reliable data about patient's medications before surgery represents a challenge for reducing the risk of postoperative adverse events (AE) potentially related to preoperative treatment.

Objective To evaluate the impact on AE of a nationwide ambulatory electronic pharmaceutical record (EPR) used by a pharmacist for best possible medication history (BPMH), associated with the preoperative evaluation.

Methods This quasi-experimental comparative interventional study included 750 adult patients with an available EPR, admitted to the preoperative clinic for elective orthopaedic surgery, between April 2014 and April 2017. Data analysis was completed in September 2022. In the intervention group, a pharmacist performed the BPMH using the EPR, before the patient's medical evaluation. In the control group, there was conventional preoperative evaluation. The primary outcome was the number of patients with at least one AE collected by using the trigger tool method, within 30 days after surgery. Secondary outcomes were the number of medications reported in the medical record and the number of patients with at least one documented adverse drug event (ADE) by an independent committee within 30 days after surgery.

Results Of 1924 patients admitted to the preoperative clinic, 750 patients who had a record (39%) were included (153 (41%) men; median age 61 (49–71 and 50–70) years in both groups), 375 in each group. There was a 29% reduction in the proportion of patients with at least one AE in the intervention group (110/374 patients (29%) with 165 AE vs 156/372 patients (42%) with 233 AE) (OR 0.58 (0.43–0.78), p<0.01). There were significantly more drugs reported on the medical record in the intervention group (3 (1–5) vs 2 (1–4), p<0.01). There was no significant difference between the two groups in the number of patients with ADE (71/374 patients (19%) with 96 ADE vs 80/372 patients (22%) with 108 ADE, p=0.44).

Conclusions and relevance A BPMH performed by a pharmacist using a nationwide EPR at the time of preoperative evaluation contributed to reducing AE, potentially preventing harm to patients.

Trial registration number NCT02071472.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Electronic medication reconciliation implementation has been associated with adverse events (AE) and medications errors' reduction in medical, surgical and paediatric units in hospitals.

WHAT THIS STUDY ADDS

⇒ In this quasi-experimental comparative interventional study that included 750 patients at the preoperative evaluation, the intervention (best possible medication history performed by a pharmacist using a nationwide electronic pharmaceutical record (EPR)) reduced the proportion of patients with at least one AE within 30 days after surgery.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The EPR is one digital tool in a larger set of interventions, in which the physicians and pharmacists have a common role in targeting the patients at risk and optimising drug management before surgery.

INTRODUCTION

Preoperative medical evaluation aims to better document medical history, optimise a patient's underlying disease state and medical treatment, either to improve medical condition or to prevent postoperative adverse events (AE) related to treatment.[1] The main objective is to assess the anaesthetic and surgical risk including clinical and drug features likely to interfere with the procedure. Chronic medication and herbal remedies are common in patients undergoing surgery.[2 3] However, access to comprehensive and reliable data concerning the consumption of health products by the patient represents a major challenge. The patient does not systematically know the exact names and dosages of her/his medications, the prescriptions are

not always available, some are over the counter (OTC) medications or non-pharmaceutical products, and some prescriptions happen to be missing (ie, narcotics). An American prospective study evaluated that 1 in 20 perioperative medication administrations included a medication error (ME) and/or an adverse drug event (ADE).[4]

According to the Joint Commission, medication reconciliation, based on best possible medication history (BPMH), is a formal process for creating the most complete and accurate list possible of a patient's current medications and comparing the list to those in the patient record or medication orders. Medication reconciliation is also recognised as an important tool for the prevention of medication discrepancies and subsequent patient harm at care transitions.[5–7] In order to improve the process of medication reconciliation, electronic and digital tools have been evaluated.[8 9] Electronic medication reconciliation implementation has been associated with ADE and ME reduction.[5 10 11] Among electronic systems, the 'Pharmaceutical File' or 'Dossier Pharmaceutique' (DP) is an ambulatory nationwide electronic pharmaceutical record (EPR) implemented by the National Council of the French Chamber of Pharmacists from 2007, which oversees the development of DP services and ensures both its safe use and data protection.[12] This digital tool includes medications (prescribed medications, OTC, complementary and alternative medicines) delivered by community pharmacists over a 4-month period (21 years for vaccines). Hospital pharmacists have access to the DP of hospitalised patients since 2012 in order to improve the quality of the medication history and reconciliation. Community pharmacists were supposed to create a DP for the patients to whom they dispensed medication, with their consent, but this was not systematic. At the time of this study, 95% of community pharmacies were connected to the DP, and in 2016, supposedly 69% of patients in France had a DP. Physicians, nurses or pharmacists and pharmacy technicians can perform medication reconciliation. Pharmacy-led medication reconciliation interventions were found to be an effective strategy to reduce medication discrepancies.[6 13 14] The DP was implemented at the Grenoble Alpes University Hospital in 2012.

The aim of this study was to assess the impact of a medication history performed by a clinical pharmacist using the DP in addition to a standard preoperative evaluation, on AE, after elective orthopaedic surgery.

METHODS

This study was conducted at the 2000-bed Grenoble Alpes University Hospital in France, where 38 000 anaesthesia procedures are performed annually in 64 operating rooms and interventional suites. The Hospital has an electronic health record (EHR).

Study population

All adult patients admitted to the preoperative clinic for an evaluation performed by a physician (an anaesthesiologist in France) before an orthopaedic elective surgery, with an available EPR (DP) and at least one medication prescribed before hospital admission, were eligible for inclusion in the study. Patients under 18 years of age, protected by law, or not speaking French were not included. Orthopaedic surgery was targeted to obtain a population as representative as possible of the general population.

All patients provided signed informed consent to participate in the study. This study follows the Consolidated Standards of Reporting Trials for non-pharmacological trials reporting guideline.

Study design and intervention

This controlled sequential interventional study with quasi-experimental design was conducted between April 2014 and April 2017. Intervention and control periods alternated every 2 weeks (figure 1).

Access to the DP requires a physician's or pharmacist's professional chip card with an associated code, as well as the patient's health insurance chip card. At the time, physicians were unfamiliar with the DP, and most often did not have their cards or codes. That is why we implicated a pharmacist and a pharmacy technician, using the pharmacist's card under supervision.

During intervention periods, a pharmacist interviewed the patients just before the preoperative evaluation, in order to carry out the BPMH, using the patient's DP and other sources of information such as paper prescriptions and information displayed by the patient. The pharmacist gave the medication report to the physician in paper format and recorded it in the patient's EHR. The report was also registered in the electronic case report form.

During control periods (usual care), the collection of information on the health products taken by the patient was carried out by the anaesthesiologist during the consultation scheduled between 2 and 4 weeks before the date of the surgery. In this group, a pharmacy technician performed the BPMH using the DP, after the anaesthesiologist's consultation. The medication report was registered in the electronic case report form but was not given to the anaesthesiologist, unless a major or problem risk was detected.

Data collection

The evaluation of the content of the DP data and the medication history combined with the DP's information was based on the comparison of the data in the electronic case report form and data documented in the medical record by the anaesthesiologist during the consultation. These data were collected at the time of surgery by an investigator (clinical research pharmacist) not involved in the intervention. Patients' data were as follows: age, sex, American Society of Anesthesiology (ASA) score,[15] surgical APGAR score (for Appearance, Pulse, Grimace, Activity, Respiration)[16] and medical history. The ASA score is a metric to determine if someone is healthy enough to tolerate surgery and anaesthesia. The ASA score is a

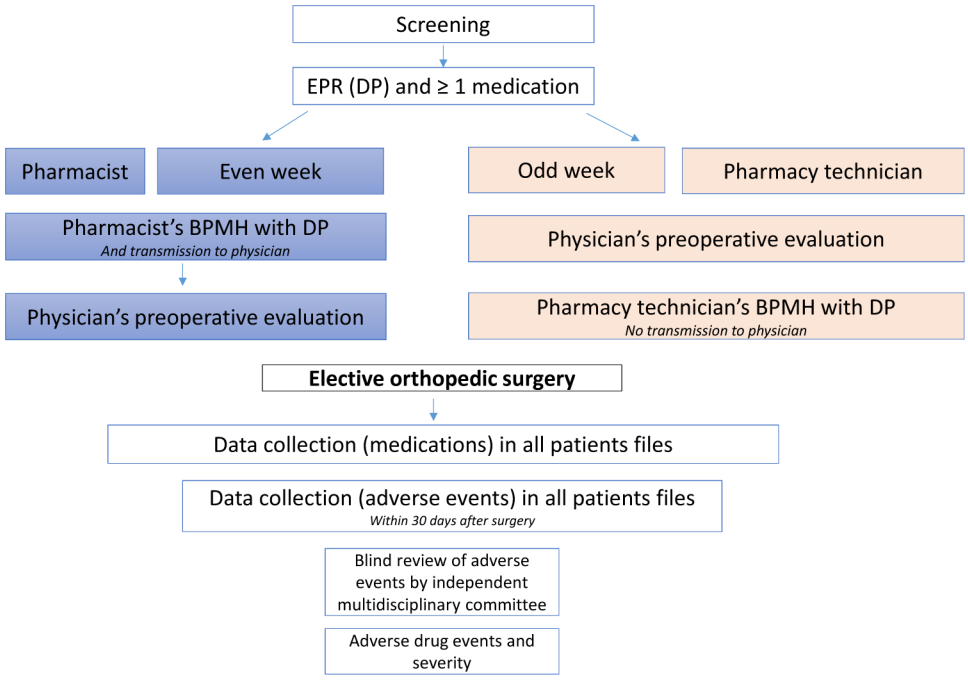

Figure 1 Study protocol.

subjective assessment of a patient's overall health that is based on five classes (I to V): I=Patient is a completely healthy fit patient; II=Patient has mild systemic disease; III=Patient has severe systemic disease that is not incapacitating; IV=Patient has incapacitating disease that is a constant threat to life; V=A moribund patient who is not expected to live 24 hours with or without surgery. The surgical APGAR score is a 10-point scoring system in which a low score reliably identifies patients at risk for adverse perioperative outcomes.

AE occurring in the perioperative period were collected by the investigator from the medical records for a period of up to 30 days after the surgery.

Outcomes

Adverse events, adverse drug events and medication errors

An AE is 'any untoward medical occurrence that may present during treatment with a pharmaceutical product but which does not necessarily have a causal relationship with this treatment'.[17]

An ADE is 'an injury resulting from the use of a drug. Under this definition, the term ADE includes harm caused by the drug (adverse drug reactions and overdoses) and harm from the use of the drug (including dose reductions and discontinuations of drug therapy).' ADE may result from medication errors but most do not.[17]

Medication errors (ME) are 'mishaps that occur during prescribing, transcribing, dispensing, administering, adherence, or monitoring a drug'. Not all errors lead to adverse outcomes or ADE. ME that are stopped before harm can occur are sometimes called 'near misses' or 'close calls'.[17]

The 'trigger tools' method is an objective risk analysis for examining targeted patient records in order to identify avoidable AE.[18] This is a retrospective review of inpatient hospital records using 'triggers' (or clues) to identify potential AE. In this study, all included patients' records were reviewed.

We defined our trigger tools or trigger AE according to usual postoperative events potentially related to drugs. They were defined according to the French guidelines on preoperative management of chronic medications,[19] including high-risk medications interfering with surgery outcomes. These events were then chosen according to those identified in the guidelines, such as the following: anaphylactic shock, cardiovascular events (hypertension, hypotension, tachycardia, bradycardia, arrhythmia), haemostasis disorders (unusual bleeding), neuropsychic disorders (confusion), unusual postoperative pain (Visual Analogue Scale (VAS) >3 and > 30 mg morphine/24 hours), acute kidney injury, hyperkalaemia, hypokalaemia, hypoglycaemia, hyperglycaemia, postoperative infection, hepatic toxicity.

An independent multidisciplinary committee (anaesthesiologist, clinical pharmacist and pharmacologist) retrospectively reviewed all patients' files containing trigger AE. They had access to a complete description of events but were blinded to the group. Each trigger AE was discussed and classified into the following categories: unlikely, possible, probable or proven ADE. A documented ADE was rated when the event was classified as possible, probable or proven. An ADE could result from a ME. The severity of each event was classified using the National Coordinating Council for Medication Error Reporting and Prevention method: no error (A), no errors not reaching the patient (B), errors reaching the patient but causing no harm (categories C–D) and errors causing harm or even death (E–I).[20]

The primary outcome was the number of patients with at least one trigger AE collected by using the trigger tool method within 30 days after surgery. Secondary outcomes were the following: the number of medications reported by the anaesthesiologist in the EHR, the number of patients with a documented ADE over the perioperative period within 30 days after surgery. We also documented the proportion of patients who had a DP at inclusion.

Sample size estimation

In the absence of robust preliminary data concerning the proportion of patients with a potential or documented adverse drug event (ie, primary outcome), we originally estimated the total sample size based on documented ADEs. According to available data,[21–26] we estimated this proportion to be 18% in the control group and 13% in the intervention group, an absolute reduction of 5%. Such an effect required 588 patients per group (1176 in total) to show a statistically significant difference for a two-sided χ^2 test with an alpha risk of 5% and a power of 80%. However, considering slow recruitment due to a lower than anticipated proportion of patients with an active electronic DP (ie, a proportion of 39% screened were actually included), we decided to plan an interim analysis in March 2016, after 526 patients were included. Such analysis revealed a proportion of 62% of patients meeting the primary outcome in the control group and 51% in the intervention group. We thus recalculated the required sample size based on these proportions and assumed an 11% difference between the two groups at the final look. Sample sizes of 338 per group achieve 80% power to detect this difference, when the proportion in the control group is 62%, at a significance level of 0.05 using a two-sided z-test with continuity correction. To account for the inflation of alpha due to this interim analysis, we used the O'Brien-Fleming spending function to determine the test boundaries. This calculation was made with the Stata software.

Statistical analysis

Analyses were performed on the intention-to-treat population. All data handling and analysis were performed by an independent statistician. Results were expressed as mean and SD for normally distributed variables (graphical estimation), median and IQR for non-normally distributed variables, and numbers (percentages). Bilateral Student's t-tests were used to compare normally distributed and Mann-Whitney tests to compare non-normally distributed continuous outcome variables. A χ^2 test compared the frequency of events between the two groups. OR and the 95% CI are given. For all the comparisons, if χ^2 was not applicable, the Fisher's exact test was used. All tests were two-sided and a p value of less than 0.05 was considered significant. Professional statisticians from the public health department of Grenoble Alpes University Hospital performed all calculations on Stata V.15.

The characteristics of the patients at inclusion are presented by group and have been statistically tested for intergroup comparability as the quasi-experimental allocation method studied does not strictly guarantee comparability between groups. The primary outcome was the number of patients with at least one trigger event compared with the χ^2 test and presented with OR and number needed to treat. The search for risk factors for the occurrence of documented ADE was done by univariate analysis. It included all the demographic, clinical and therapeutic characteristics of the patients. Very few missing data were expected for the primary outcome; no specific treatment was applied.

RESULTS

In total, 1924 patients were admitted to the preoperative clinic between April 2014 and April 2017, and 750 were included. In this study, 39% of patients had a DP. The main reasons for non-inclusion were the absence of DP (58%), which had not previously been created by a community pharmacist, no medication at the time of the interview (23%), absence of patient's chip card (10%), patients under 18 years of age (8%) and other reasons (1%). Of the 750 patients included, 4 patients were excluded from the analysis because of absence of primary endpoint, 1 in the intervention group and 3 in the control group (figure 2). Among these patients, 444 (59%) were women, with a median (IQR) age of 61 years (50–70). The intervention and control groups were similar in age, sex, ASA score and medical history (table 1).

Overall, 266 patients (36%) experienced at least one AE. There was a significant reduction of 29% in the number of patients who experienced at least one AE (110 patients (29%) with 165 AE (41%) in the intervention group vs 156 (42%) patients with 233 AE (59%) in the control group) (OR 0.58 (0.43–0.78), p<0.01) (table 2). The number of patients with ADE secondly documented by the independent committee was reduced by 15% but did not statistically differ between the two groups (71 (19%) vs 80 (21%), p=0.39).

The type of AE versus documented ADE (after analysis by the independent committee) by group is provided in online supplemental e-Table S1.

The anaesthesiologist entered more medications in the patient's file in the intervention group (3 (1–5) vs 2 (1–4), p<0.001), in particular more high-risk medications according to the French guidelines (1 (0–3) vs 1 (0–3), p=0.027). The overall number of medications was higher in the control group (5 (2–8) vs 4 (2–7), p=0.015), but there was no difference in the number of high-risk medications (2 (1–3) vs 2 (0–3), p=0.402). The type of drug classes is detailed in online supplemental e-Table S2.

Most ADE were associated with harm, respectively, in the intervention and control groups (72 (76%) vs 23 (24%) and 95 (88%) vs 15 (14%)). There was no significant difference in severity between the two groups, neither on events without harm (A–D) nor on events with harm (E–I) (p=0.15) (table 2). No error occurred which would have required an intervention to sustain life (H)

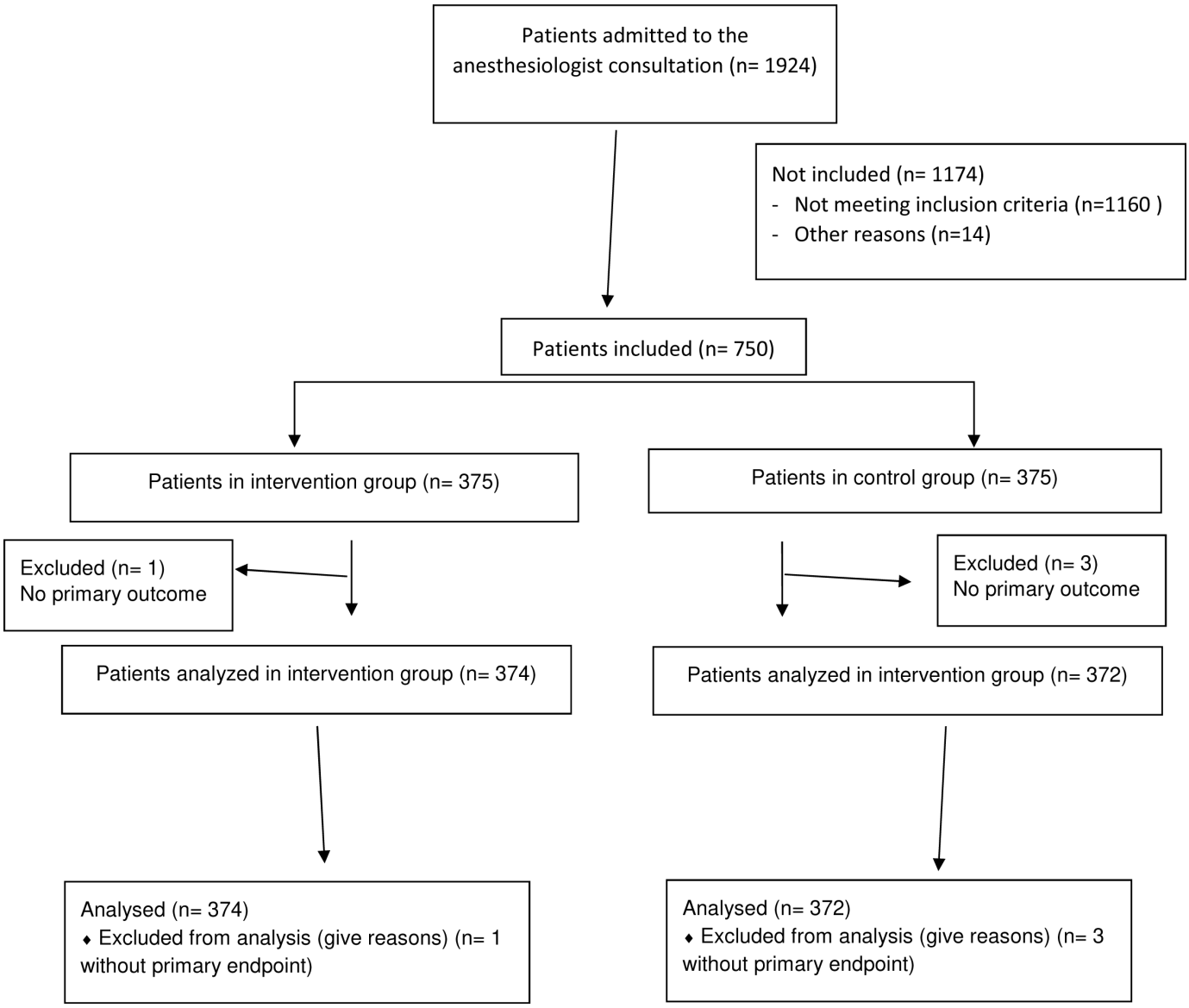

Figure 2 Flow diagram of patients included in the study: Consort—The CONSORT Flow Diagram (consort-statement.org).

nor an error which would have contributed to or resulted in the patient's death (I).

Patients with documented ADE (151 patients) were older (67 (59–75) vs 60 (47–69), p<0.001 and had a superior ASA score (2 (2–3) vs 2 (1–2), p<0.001), which was already present at inclusion. Occurrence of iatrogenic events was more frequent in surgery with lower surgical APGAR scores, that is, higher surgical risks (more bleeding, lower blood pressure, higher heart rate). Patients were more prone to diabetes, hypertension, metabolic disorders, cardiac failure and renal failure. They had a higher number of medications and high-risk medications at the time of medication history (online supplemental e-Table S3).

DISCUSSION

This study showed that the medication history carried out at the preoperative evaluation by a pharmacist using a nationwide EPR was associated with a reduction of AE. The number of patients with at least one AE was reduced in the intervention group by 29%. There were significantly more drugs reported on the medical record in the intervention group but there was no significant difference between the two groups in the number of patients with ADE.

Preoperative polypharmacy is common and associated with adverse outcomes.[3 27] Numerous studies have shown the interest of BPMH and medication reconciliation for geriatric, intensive care, emergency and other medical patients.[5–7 28–30] Fewer have evaluated it in the preoperative period.[31–33]

We evaluated a new collaborative strategy, combining the BPMH performed by a pharmacist, using an original electronic pharmaceutical file and given to the physician. In our study, the medication history using the DP contributed to an increase in the number of medications written

Table 1 Characteristics of the 750 patients enrolled in the intervention and control groups (preoperative period)

	Intervention group	Control group	Total	
	n=375	n=375	N=750	P value
Age, year (median (IQR))	61 (49–71)	61 (50–70)	61 (50–70)	0.54
Sex, male (n, %)	153 (41%)	153 (41%)	306 (41%)	0.99
ASA score (n, %)				
1 and 2	309 (83.5%), n=370	320 (87.7%), n=365	629 (85.6%)	0.10
3 and 4	61 (16.5%), n=370	45 (12.3%), n=365	106 (14.4%)	
Medical history (n, %)				
Cardiovascular disease	166 (44.3%)	145 (38.7%)	311 (41.5%)	0.11
Metabolic disease	105 (28%)	122 (32.5%)	227 (30.3%)	0.18
Neuropsychiatric and nervous system disease	64 (17.1%)	56 (14.9%)	120 (16%)	0.41
Pulmonary disease	32 (8.5%)	30 (8%)	62 (8.3%)	0.78
Infection	19 (5%)	20 (5%)	39 (5%)	0.87
Renal failure	10 (3%)	7 (2%)	17 (2%)	0.45
Progressive cancer	7 (2%)	5 (1%)	12 (2%)	0.55
Liver disease (cirrhosis)	2 (0.5%)	1 (0.25%)	3 (0.4%)	0.62
Type of orthopaedic surgery (n, %)	**n=374**	**n=372**	**N=746**	
Prosthetic surgery	117 (31.3%)	125 (33.6%)	242 (32.4%)	0.51
Arthroscopic surgery	26 (7.0%)	31 (8.3%)	57 (7.6%)	0.48
Others, various*	231 (61.7%)	216 (58.1%)	447 (60.0%)	0.28
Number of medications reported by (median (IQR))				
Physician	3 (1–5), N=369	2 (1–4), N=368	3 (1–5)	<0.001
Physician (high-risk medications according to guidelines)	1 (0–3), N=369	1 (0–3), N=368	1 (0–3)	0.02
Pharmacist or pharmacy technician (using the DP)	4 (2–7), N=374	5 (2–8), N=363	4 (2–7)	0.01
Pharmacist or pharmacy technician (using the DP) (high-risk medications according to guidelines)	2 (1–3), N=374	2 (0–3), N=362	2 (1–3)	0.40

*Material removal, osteotomy, arthrodesis, fracture, biopsy…

in the medical patient file. Particularly, the anaesthesiologists reported more high-risk medications (identified from the French guidelines) in the patient file.

There are very variable results in studies evaluating the impact of electronic medication reconciliation records. A similar trial in the emergency department failed to show ADE reduction,[8 9] while it produced a significant reduction in unintended medication discrepancies (UMD). Other authors showed that an electronic medication reconciliation system reduced potentially inappropriate medication use and associated AE and the time of discharge.[9] Some studies also investigated and showed the positive impact (reduction of UMD) of a preoperative pharmaceutical consultation with a BPMH shared with the anaesthesiologist using the usual software.[34–36] Recently, the increasing availability of EHRs offers an opportunity for pharmacists to further secure clinical pharmacy services and the therapeutic management of patients.[37]

We found that many AE occurred in the postoperative period, potentially attributable to medication, even if some AE (ie, respiratory, cardiovascular) could certainly occur without the use of medication. For example, a 40-year-old patient, seen in consultation prior to his knee osteotomy, presented with unusual postop pain with VAS up to 5 for 24 hours. His DP had indicated that he was on tramadol. The pharmacist using the DP was more likely to notice that some patients were on chronic opioids because they appeared on the DP, while patients sometimes forgot their paper prescription for opioids, which was on a separate secure document. Therefore, the prescriber could potentially underdose postop pain medications. Another example is a 71-year-old patient undergoing total knee replacement surgery, who presented with a haemorrhage requiring transfusion. She had been taking enoxaparin prior to surgery. Most patients were not elderly patients (median age 61 years), with ASA scores 1 and 2 (85%) (no or mild systemic disease). They had few polypharmacy (median of 4 drugs).

In order to minimise surgical risks from medications, drug-related problems have to be identified, resolved and prevented.[38] There is a growing literature about the beneficial effects of Enhanced Recovery After Surgery

Table 2 Adverse events (AE), adverse drug events (ADE), severity and outcomes (postoperative period)

	Intervention group	Control group	Total	P value
Number of patients with ≥1 AE (n, %)	110 (29%) (N=374)	156 (42%) (N=372)	266 (36%) (N=746)	< 0.001
Total number of AE (n, %)	165 (41%) (N' = 398)	233 (59%) (N' = 398)	398 (100%)	< 0.001
Number of patients with ≥1 ADE (n, %)	71 (19%) (N=374)	80 (21%) (N=374)	151 (20%) (N=746)	p=0.39
Total number of ADE	96 (47%) (N" = 204)	108 (53%) (N" = 204)	204 (100%)	p=0.42
Severity of ADE				
A-B-C-D* (no harm) (n, %)	23 (24%) (n" = 95)	15 (14%) (n" = 108)	38 (19%) (n" = 203)	p=0.15
E-F-G-H-I* (harm) (n, %)	72 (76%) (n" = 95)	95 (88%) (n" = 108)	167 (82%) (n" = 203)	
APGAR score (median, IQR)	8 (7–9) (n=350)	8 (8–9) (n=350)	8 (8–9) (n=700)	p=0.16

*National Coordinating Council for Medication Error Reporting and Prevention: A: no error; B: an error occurred but did not reached the patient; C: an error occurred that reached the patient but did not cause patient harm; D: an error occurred that reached the patient and required monitoring or intervention to preclude harm; E: an error occurred that may have contributed to or resulted in temporary harm to the patient and required intervention; F: an error occurred that may have contributed to or resulted in temporary harm to the patient and required initial or prolonged hospitalisation; G: an error occurred that may have contributed to or resulted in permanent patient harm; H: an error occurred that required an intervention to sustain life; I: an error occurred that may have contributed to or resulted in the patient's death.
N', total number of AE; N", total number of ADE; N, total number of patients.

(ERAS) and the value of involving a pharmacist in these programmes.[39–42] Officials in the American College of Clinical Pharmacy, the Perioperative Care Practice and Research Network and ERAS Society have proposed collaborative practice opportunities between key stakeholders in the surgical journey and clinical pharmacists to manage drug therapy problems.[43] In France and in Europe, there is a lack of data.

Strengths and limitations

This is the first study to our knowledge to assess the impact on AE of a nationwide EPR used for BMPH performed at the preoperative evaluation. Most studies focused on unintended medication discrepancies, without accurate evaluation of consequences.[34 35] While there are few recommendations in perioperative medication management, one of the strengths of this study is having relied on recommendations worked out by the French Society of Anesthesia and Intensive Care to establish the list of drugs to be maintained, interrupted or relayed, with regard to the risk of AE linked to the drugs studied. Indeed, this list aimed to minimise postoperative outcomes, that is, AE, related to drug management.

Our study has some limitations. In this study, there was no significant reduction in the documented ADE after examination by the independent committee, maybe due to lack of power for this infrequent secondary endpoint. Indeed, we chose the elective orthopaedic surgery and the patients mostly were not fragile patients, with few polypharmacy. Moreover, the medication history or medication reconciliation should be viewed as a part of the multidisciplinary process to improve medication safety.[6 44 45] Clinical pharmacists can also help prevent medication errors by analysing prescriptions and suggesting optimisation to physicians.[46] A study in the postoperative period showed that pharmacists detected 1975 drug-related problems among 7005 orders,[47] emphasising the need for optimisations. In addition to management of polypharmacy, multidisciplinary optimisation of prescriptions and administration by a team of physicians, pharmacists and nurses is important, through avoidance of missed doses and medications not needed or potentially harmful to patients, and through reduction of drug-drug interactions and unnecessarily large doses in patients having general anaesthesia and surgery.

CONCLUSIONS

This collaborative strategy based on medication history carried out by a pharmacist associated with the preoperative consultation, using nationwide EPR, reduced the number of patients with postoperative AE. There were no differences in ADE between the groups. The control group had better postoperative experiences in the realms of haemostasis and postoperative pain. This intervention contributed to an increase in the number of medications written in the medical record. The DP is one tool in a larger set of interventions, in which the physicians and pharmacists have a common role in targeting the patients at risk and optimising drug management before surgery.

Contributors CC is a clinical pharmacist working in the Anesthesia and Critical Care Departement at the University Hospital of Grenoble Alpes: she participated in data collection, interpreted the results and wrote the manuscript. J-LB is Professor of Biostatistics at the University Grenoble Alpes: he performed the analyses, interpreted the results and revised the manuscript for important intellectual content. BJ-D is a pharmacist and associate professor at the University of Grenoble Alpes; he participated in data collection and revised the manuscript for important intellectual content. ML is a pharmacist, working in the Pharmacovigilance department; she participated in data collection and revised the manuscript for important intellectual content. DS is a statistician at the University of Grenoble Alpes: he performed the analyses, interpreted the results and revised the manuscript for important intellectual content. MR is Professor of Pharmacology; he designed the study, participated in the data analysis, and revised the manuscript for important intellectual content. BA is Professor of Clinical Pharmacy; he was the principal investigator of the study; he designed the study, interpreted the results and revised the manuscript for important intellectual content. SC is a clinical pharmacist and Head of Clinical Pharmacy Department; he revised the manuscript for important intellectual content. PA is Professor of Anesthesia and Critical Care and Head of Anesthesia Department; he designed the study, interpreted the results and revised the manuscript for important intellectual content. PB (guarantor) is Professor of Clinical Pharmacy and Head of Pharmacy Department at the University of Grenoble Alpes: he designed the study, interpreted the results and revised the manuscript for important intellectual content.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Consent obtained directly from patient(s)

Ethics approval This study involves human participants and was approved by Ethical approval was obtained on October 16th 2013 by the Committee for the Protection of Persons (CPP Sud-Est, France; ID RCB – Réf. ANSM : 2013-A00984-41) Participants gave informed consent to participate in the study before taking part.

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