Title page

Title:

Accuracy of information sources used to determine the best possible medication history when patients present to the emergency department.

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Contributions:

All authors designed the protocol, were involved with data analysis and drafted the manuscript, HC collected all data and wrote the initial draft of the manuscript.

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Accuracy of medication information sources compared to the best possible medication history for patients presenting to the emergency department.

Abstract:

Objective: To assess the accuracy of medication information sources available for adult patients presenting to the Emergency Department (ED), compared to a best possible medication history (BPMH).

Methods: This prospective observational study was undertaken in the ED of a major tertiary-referral teaching hospital. A convenience sample of consecutive adult patients taking ≥ 1 regular medication were included. A BPMH was ascertained using patient/carer interviews, where available, and confirmed with ≥ 1 other source. For residential care facility (RCF) patients, the RCF medication chart and at least one other source were used. Information sources compared with the BPMH were: community pharmacy dispensing history, patient's own medications (POM), patient's medication list (PML), general practitioner (GP) letter, medications stored in and labelled on dose administration aids (DAAs), and the RCF chart. Number of discrepancies/patient for each source was determined by comparing medications and dose regimens to those documented in the BPMH.

Results: 455 patients (median age 71 years) took a median of six 'regular' and two 'as required' medications. The median number (range) of discrepancies/patient for regular medication names and dosages were; RCF chart 0 (0-3), DAA contents 2.0 (0-9), PML 2.5 (0-16), DAA medications label 3.0 (0-7), community pharmacy history 3.0 (0-19), GP letter 3.0 (0-18), and POM 4.0 (0-16). Overall, 40.4% of discrepancies were deemed 'moderate' or 'high' clinical significance. Omission errors accounted for 55.6% of discrepancies.

Conclusions: A combination of sources is essential to determine the BPMH. RCF charts provided the most accurate information. Other sources had 2-4 regular medication related discrepancies/patient.

Keywords

Emergency Department; Health information management; Pharmaceutical preparations;
Quality assurance, healthcare.

Introduction

Adverse medication events (AMEs) are a significant cause of morbidity and mortality worldwide.¹⁻³ A significant proportion of AMEs are caused by errors in medication management as patients move from one medical care setting to another.^{2, 4, 5} While an error can occur at any step of the medication use process, over one quarter of prescribing errors that occur when patients are admitted to hospital originate from an inaccurate medication history.^{3, 6} These errors may result in failure to provide patients with their essential regular medications, failure to identify medication-related causes for the presentation, or adverse interactions between newly prescribed and regular medications.

Medication history taking is essential at the community-hospital interface for safe and effective medical practice.⁴ There is no way to know with certainty the exact medication regimen a patient was taking prior to presentation to the emergency department (ED). This is why the internationally recognised concept of the Best Possible Medication History (BPMH) is recommended as best practice.^{7, 8} The BPMH is a comprehensive medication history documented by a healthcare professional using a systematic process. It is more comprehensive and accurate than the routine primary medication history and includes all prescribed and non-prescribed medications actually taken by the patient. The patient and/or carer are interviewed wherever possible and this history is verified using one or more additional sources of information.^{3, 7-10} If a patient or carer interview is not possible, at least two other sources should be used to identify a BPMH. The generation of a BPMH is an iterative process that requires clinical acumen and detailed medication knowledge to determine when to continue to seek further sources of information for verification.

Although this systematic process for identifying a BPMH is considered best practice, barriers to achieving this in the ED include rapid patient turnover, lack of access to primary care records, and patients' communication difficulties.^{11, 12} Consequently, prescribers in ED often base decisions on a cursory history from a single source of information. The purpose of this study was to highlight the inherent pitfalls of using any single source of medication information, in isolation, to identify a medication history. In a recent national multi-centre study of ED patients, 73% of patients were taking one or more regular medications and 41% were taking five or more prior to presentation.¹³ This highlights the relevance of this study to a substantial number of ED patients.

We hypothesized that no single source of medication information available to ED clinicians can be considered universally reliable. This study aimed to assess the accuracy of medication names and dosages provided by each information source available for adult patients presenting to ED compared to the reference standard BPMH documented by an experienced hospital pharmacist. The nature and potential significance of any discrepancies were assessed. The sources examined were the actual patient's own medications (POM), patient's medication list (PML), general practitioner (GP) letter, medications stored in and labelled on dose administration aids (DAAs; packaging systems such as blister packs and sachets that organise solid doses according to when they should be taken),¹⁴ the community pharmacy dispensing history, and residential care facility (RCF) charts. These sources are readily accessible by hospital clinicians and are commonly used to verify an admission medication history.¹⁵

Methods

This prospective, observational study was conducted in the ED of a metropolitan tertiary-referral teaching hospital with an annual ED census of over 80,000 patients. Data were collected from 5th February to 26th May 2016, primarily between 0800 and 2000, Monday to Friday. Some data were collected on weekends. This project was approved by the hospital's Human Research Ethics Committee.

Consecutive adult patients presenting to ED taking one or more regular medications prior to presentation were included. Patients were excluded if they had significant medical illness as determined by ED staff (e.g. pain, shock, sepsis), where no carer or other medication information were available, or if a BPMH was already compiled by the ED pharmacist.

The BPMH was defined as the 'reference standard' medication history against which other information sources were compared. A BPMH was obtained by a qualified pharmacist (also a medical student, investigator HC), who had completed her BPMH validation according to national standards.¹⁶ A systematic series of questions were asked of the patient or carer about 'regular' and 'as required' medications taken immediately prior to presentation, using a pre-determined interview checklist.¹⁵ The patient or carer was prompted by any available lists, medications, GP letters or DAAs. If an informed interview was not possible, at least two alternative information sources were used. For RCF patients, the BPMH was determined from the RCF chart and at least one other source (often the community pharmacy history).

The pharmacist continued to seek information from further sources of information until she was confident in the quality of the documented BPMH to inform optimal, safe patient care. For example, a patient with no communication difficulties taking only one medication where

the patient interview and the PML provided a consistent picture, then further information sources were generally not sought. If the patient was taking a more extensive regimen and there were inconsistencies between the patient interview and other available sources, the pharmacist would continue seeking out information sources until she was confident that the documented BPMH was as accurate a characterisation of the medications taken prior to presentation as possible. This procedure for identifying a BPMH is consistent with international best practice as outlined in the World Health Organisation's Medication Reconciliation Standard Operating Procedure.⁷

The BPMH was compiled using clinical acumen, and the combination of resources available in ED. If there was any doubt about a patient's medications, their regular community pharmacy was also contacted to obtain a dispensing history for at least the preceding six months. For patients attending multiple pharmacies, attempts were made to contact each pharmacy. The POM, PML, GP letter, DAA, RCF chart and community pharmacy records were subsequently examined for accuracy, where available. Other resources used to determine the BPMH, but not evaluated for accuracy, included hospital dispensing records and previous discharge summaries. Whilst discharge summaries can be a valuable source of information, they were not evaluated for accuracy in this current project because the hospital had introduced new software and intervention projects were ongoing to improve the accuracy of these documents.

Patient characteristics that may impact medication complexity and the ability to identify a BPMH were documented using a structured audit tool, including demographic details, triage category and patient's ability to verbally communicate. Patient communication difficulties were determined subjectively, in collaboration with ED staff.

The main outcome measures were a) the percentage of patients with one or more discrepancies pertaining to regular medication names and dosages between the specific information source and the BPMH and b) the number of discrepancies per patient who had that specific information source available. Secondary outcomes included the nature and significance of discrepancies identified. A discrepancy was any mismatch in medication information between an individual source and the BPMH. These included listing the wrong medication, dose, frequency, form or route, as well as errors of omission (where an information source omitted a medication that the patient was taking), and commission (where an information source suggested a medication was taken, but it was not). Medications without a dosage or frequency were also considered discrepancies. Whilst important, assessment of allergy status accuracy was beyond the scope of this project.

Discrepancies were classified as ‘low’, ‘moderate’ and ‘high’ clinical significance using a published risk classification matrix¹⁵ that considered the probability and consequences of an adverse event. For commission errors, this assessment was based on the assumption that the medication was administered for at least seven days where it should not have been. For omissions, significance was assigned according to the potential for harm if clinical decisions were made without knowledge that the patient had been taking the particular medication. Significance ratings were independently assigned by two senior ED pharmacists not involved in the patient’s care using the risk classification matrix.¹⁵ Differences in assessments of significance between the two pharmacists were resolved through consensus.

An Australian ED study found that 87% of GP referral letters contained at least one regular medication discrepancy.¹⁷ In order to have 95% confidence that this proportion will be ± 3 -

4% of the GP letter proportion, 283-502 patients needed to be enrolled. A sample size of approximately 400 patients was estimated to provide sufficient precision in obtaining discrepancy data for the various sources of medication information.

Descriptive statistics were used to report most data. The median number of discrepancies/patient for each information source was calculated. The Chi² test was used to compare proportions and Kruskal-Wallis test was used to compare the number of discrepancies per patient who had the different sources accessed. SPSS for Windows statistical software (version 23.0, SPSS Inc., Chicago, Illinois, USA) was used for all analyses (level of significance 0.05).

Results

Four hundred and fifty-five patients met the inclusion criteria and were recruited into the study (figure 1). Included patients took a median of six 'regular' and two 'as required' medications (table 1). Most patients were elderly and one-third had communication difficulties. Approximately one-third of patients were transferred to the short stay unit, one third were discharged home, and 40% were admitted to an inpatient ward.

A patient or carer interview was one source that informed the BPMH in 411 (90.3%) patients. The remaining 44 (9.7%) patients had communication difficulties and did not have a carer available to interview; 39 (88.6%) of these patients presented from a RCF.

At least two information sources were available to derive the BPMH for 94.1% of patients. Of these, three sources were used for 29.6% patients and four or more sources were used for 13.3% patients. Where the BPMH was unable to be verified using at least two sources, these patients were excluded from further analysis (5.9% of patients).

The community pharmacy was the most accessed source of information, being accessed for 58.2% of patients. This was followed by POM, PML, and the GP letter. The PML was written by the patient or carer in 37.8% cases, with the remainder being compiled by health professionals. Forty-eight patients brought their DAAs into ED. Of these, 62.5% and 37.5% were packed by the community pharmacy and patient/carer, respectively. All DAAs packed by community pharmacies had a backing label attached, while only 72.2% of the DAAs packed by the patient/carer were labelled. The RCF chart was evaluated in 39 (8.6%) patients.

The proportion of RCF medication charts with one or more discrepancies related to the regular medications was significantly less than for other sources of information as outlined in table 2, ($p < 0.01$). There were significant differences in the median number of discrepancies/patient related to both 'regular' and 'as required' medications for individual sources ($p < 0.01$). When considering all types of discrepancies related to regular medication names and dose regimens, RCF charts had the lowest median number of discrepancies/patient, followed by the medications stored in DAAs, the PML, medications labelled on DAAs, community pharmacy history, and GP letter (table 3). The POM had the greatest number of discrepancies/patient, due to omission errors and available medications not being in packaging labelled with prescribed doses. Errors of omission were the most common type of discrepancy for all sources, except the RCF chart. Thirty-six percent and 22.9% of discrepancies on the GP letter and community pharmacy history, respectively, related to medications no longer taken by the patient (commission errors).

For 'as required' medications, the median number of discrepancies/patient with the specific information source available (and range) were: RCF chart 0 (0-3), PML 2.0 (0-7), GP letter 2.0 (0-8), community pharmacy history 2.0 (0-10), DAA contents 2.0 (1-11), POM 2.0 (0-12) and DAA medications label 2.5 (1-6).

Overall, 36.7% and 3.7% were of moderate and high significance, respectively, while 59.6% of discrepancies were of low significance (figure 2). The proportion of regular medication discrepancies for a given source that were of 'high' significance was lowest for the community pharmacy history (2.0%) and highest for the label and packed contents of the DAAs (11.2% and 10.8%, respectively). Examples of high significance medications that

would be missed using the DAA label or packed contents to identify the BPMH included omission of mycophenolate or Lantus® and Novomix® insulin.

Discussion

Overall, no single information source accurately reflects the medications taken prior to ED presentation. This study has implications for how clinicians approach medication history taking in fast-paced EDs. The accuracy of the informed interview was not included in the analysis due to the abundant literature already supporting its use as a cornerstone to identifying the BPMH^{3, 9, 10, 18} and the difficulty in undertaking the interview without the patient or carer using ‘props’ such as their lists and own medications.

Apart from the patient/carers interview, the community pharmacy dispensing history was the most accessed information source, being used for more than half of patients. This was not higher, possibly because some of our data were collected outside of usual pharmacy hours. The POM was the next most accessed source, although it was only available for 42.4% patients. The POM can be a valuable resource, particularly in the setting of communication difficulties or after-hours presentations.

The RCF chart had the lowest number of discrepancies/patient for both regular and ‘as required’ medications. The most common discrepancy for RCF charts was the absence of a dose or frequency, followed by omission errors. These errors may reflect the quality of RCF medication chart transcription or the fact that the RCF chart and the prescription provided to the community pharmacy are not usually one and the same. When an RCF patient is brought to ED, the RCF chart should be sought by ED staff if not sent with the patient, as it is a reliable information source for the majority of RCF patients.

The PML was most often affected by errors of omission. These omissions often included over-the-counter (OTC) medications and periodic medications that patients do not need to

remember to take daily. In addition, the PML frequently listed medication names without the dosing regimen, or included medications that patients were no longer taking.

Omission errors were the most common discrepancy associated with DAAs brought into the ED. Approximately 1 in 10 discrepancies between the BPMH and the DAA label and medications packed in the DAA were of 'high' significance. DAAs only facilitate packing of medications presented in oral, solid dosage forms.^{14, 19} Some significant discrepancies include omission of variable dose warfarin, fentanyl patches and injections such as epoetin alfa and insulin. Notably, most DAA labels do not provide an accurate list of variable dose and 'as required' medications.

For the community pharmacy history, omission errors were the most common discrepancy, followed by commission errors. Where we found that the community pharmacy records were fully accurate for regular medications for 12.5% of patients, overseas, the accuracy was found to be 17-25%.^{20, 21} Fitzsimons et al. reported that the community pharmacy history was most likely to be affected by errors of commission, largely due to lack of up-to-date information and patient non-compliance.²⁰ In the Fitzsimons study, 92.5% of patients visited a single pharmacy.²⁰ While we did not directly examine this, anecdotally, it is very common for Australian consumers to attend multiple community pharmacies for prescription medications. This would increase the likelihood of omission errors. Moreover, as OTC medications and complementary medicines are not recorded on the pharmacy dispensing system, their use may have a significant impact on the accuracy of the community pharmacy history.²⁰

Regarding GP letters, our findings are similar to a multi-centre Australian study that found 87% of GP lists contained one or more discrepancies related to regular medications.¹⁷ In

contrast, another Australian study found 58% of GP lists correctly identified the medication name and dose for prescribed medications.²² We found that medication histories obtained from the GP letter had a similar proportion of omission and commission errors. The proportion of commission errors was higher than for any other information source. Potential reasons for inaccuracies in GP medication lists include infrequent medication review by GPs, and poor communication between primary and secondary care.^{17, 21}

POM had the highest number of discrepancies/patient, largely due to patients not bringing their entire regimen to ED and medications being brought in without their original labelled packaging. Nonetheless, POM are important as patients or caregivers who use their physical medications as a prompt provide a more accurate medication history.²⁰ A previous study also demonstrated a significant decrease in hospital admission prescribing errors when POM were brought into the ED by paramedics.²³

Limitations:

The reliability of our results is strengthened by the rigorous approach used to ascertain the 'reference standard' comparator medication history. However, our study has important limitations. It was conducted in a single ED. Although we minimised selection bias by attempting to recruit consecutive patients, only a limited number of patients were recruited outside of usual pharmacy hours, several patients were discharged from ED before they could be recruited and medically and psychiatrically unstable patients were often excluded if they did not have a carer available in the ED to assist with identifying information sources. Therefore, the patients enrolled may not reflect the entire ED patient population. In addition, we were unable to evaluate the true outcomes of each discrepancy as it would be unethical to allow these to translate to prescribing errors. For less widely available sources of information, the 95% confidence intervals around the percentage of patients with one or more regular medication discrepancies are broad. Despite this, our data still clearly demonstrate that no single source of information is universally reliable to determine a medication history.

Conclusions

Our findings support the recommendations of peak bodies internationally to use multiple sources in order to acquire a reliable medication history. No single information source accurately reflects the medications patients take prior to ED presentation. Discrepancies between sources reflect the complexity of the medication reconciliation process. The RCF chart provided the most accurate information for both 'regular' and 'as required' medications. The DAA contents and label had the highest proportion of 'high' significance discrepancies for 'regular' medications.

An informed patient or carer interview must be a priority to confirm the medication history from any source. Patients should be empowered to take greater accountability for their own medications. Information sharing needs to be improved across the continuum of care. Health professionals should be proactive about keeping accurate medication lists for their patients, while implementation of the national electronic health record may also improve continuity of care. Future research should investigate methods to improve the availability of information sources, as well as factors affecting their accuracy.

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Table 1: Baseline patient characteristics

Parameter	Number (n = 455)
Age, years, median (IQR)	71 (27)
Gender, male, n (%)	229 (50.3)
Australasian Triage Scale, n (%)	
• Category 1 or 2	93 (20.4)
• Category 3	246 (54.1)
• Category 4	109 (24.0)
• Category 5	7 (1.5)
Number of 'regular' medications, median (IQR)	6 (5)
Number 'as required' medications, median (IQR)	2 (2)
Number of patients with communication difficulties (medical or language reasons), n (%)	146 (32.1)
Disposition from ED, n (%)	
• Home/other	134 (29.5)
• Short stay unit	137 (30.1)
• Ward	184 (40.4)

Table 2. Accuracy of medication information sources for ‘regular’ medications compared to the Best Possible Medication History (BPMH)

Information source	Patients with this information source, with 1 or more discrepancies compared to BPMH	
	Number of patients	% (95% Confidence Interval)
Community pharmacy dispensing records (n=264)	231	87.5 (82.8 – 91.1)
Patient’s own medication packaging (n=192)	181	94.3 (89.7 – 97.0)
Patient medication list (n=82)	72	87.8 (78.3 – 93.7)
General Practitioner letter (n=62)	58	93.5 (83.5 – 97.9)
Dose administration aid contents (n=48)	40	83.3 (69.2 – 92.0)
Dose administration aid label (n=35)	31	88.6 (72.3 – 96.3)
Residential Care Facility chart (n=39)	12	30.8 (17.7 – 47.7)

Table 3 – Nature of discrepancies between each information source and the BPMH for ‘regular’ medications

Discrepancy category	Sources of information evaluated							Totals for discrepancy categories (% of each discrepancy category)	Examples*
	Community pharmacy (n = 264)	POM (n = 192)	PML (n = 82)	GP letter (n = 62)	DAA contents (n = 48)	DAA labelled (n = 35)	RCF chart (n = 39)		
Omission error, n (%) [†]	497 (55.3)	519 (60.9)	102 (37.4)	88 (36.0)	99 (89.2)	77 (78.6)	4 (28.7)	1386 (55.6)	Amiodarone and rivaroxiban omitted from GP letter (H)
Commission error, n (%) [†]	206 (22.9)	23 (2.7)	44 (16.1)	87 (35.5)	0 (0)	4 (4.1)	0 (0)	364 (14.6)	Moxonidine POM brought in, patient no longer taking (M)
No dose or frequency provided, n (%) [†]	50 (5.6)	224 (26.2)	66 (24.2)	23 (9.4)	0 (0)	8 (8.1)	7 (50.0)	378 (15.1)	Lantus Solostar (insulin) no directions (22 units daily intended) (M)
Wrong dosage, n (%) [†]	62 (7.0)	43 (5.0)	27 (9.9)	24 (9.8)	3 (2.7)	3 (3.1)	1 (7.1)	163 (6.5)	Levetiracetam 500mg twice daily listed, on 1g twice daily (M)
Wrong frequency, n (%) [†]	55 (6.1)	42 (4.9)	23 (8.4)	16 (6.5)	8 (7.2)	5 (5.1)	1 (7.1)	150 (6.0)	Frusemide 40mg daily listed (twice daily intended) (M)
Wrong drug, n (%) [†]	25 (2.8)	2 (0.2)	7 (2.6)	5 (2.0)	0 (0)	0 (0)	0 (0)	39 (1.6)	Ramipril listed, actually taking irbesartan (M)
Wrong formulation, n (%) [†]	3 (0.3)	1 (0.1)	4 (1.5)	2 (0.8)	1 (0.9)	1 (1.0)	1 (7.1)	13 (0.52)	Metformin immediate release listed (slow release intended) (L)
Wrong route, n (%) [†]	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	N/A
Total discrepancies for each source, n (% of total number of discrepancies) [‡] [95% CI]	898 (36.0) [34.1 – 38.0]	854 (34.3) [32.4 – 36.2]	273 (10.9) [9.8 – 12.3]	245 (9.8) [8.7 – 11.1]	111 (4.5) [3.7 – 5.4]	98 (3.9) [3.2 – 4.8]	14 (0.6) [0.3 – 1.0]	2493 (100)	-
Median number of discrepancies/patient, n (range)	3.0 (0-19)	4.0 (0-16)	2.5 (0-16)	3.0 (0-18)	2.0 (0-9)	3.0 (0-7)	0 (0-3)	-	-

* Significance of the discrepancy – L = Low significance, M=Moderate significance, H = High significance

[†] Column percentages; [‡] Row percentages

POM – actual patient’s own medication, PML – patient medication list, GP – general practitioner, DAA – dose administration aid e.g. blister-pack, sachet system or compartmentalised box, RCF – residential care facility.

Figure 1: Patient recruitment flowchart

Figure 2: Clinical significance of discrepancies for each information source for ‘regular’ medications

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