An accurate medication history potentially reduces the risk of adverse drug events such as interactions or inadvertent ceasing of essential medications. Obtaining such a history in an emergency department (ED) can be challenging, and patients’ own medications (POM), if available, may give the earliest indication of the drug regimen taken before presentation. The label on each medication container provides information such as the name, strength and the frequency with which it is to be taken. POM may be particularly valuable when there are communication barriers, and after hours, when community records are unavailable.

In this study, we aimed to determine whether regular medications taken routinely before admission are more accurately prescribed on the hospital medication chart when POM are brought to the ED with the patient. If having these medications available in the ED is associated with improved prescribing, an intervention should be initiated to encourage patients and paramedics to bring POM to hospital.

METHODS

This observational study was conducted in the ED at Austin Hospital (Austin Health), a metropolitan mixed department serving adults and children, with about 51 000 presentations and an admission rate of 31% in 2006 (Michael Yeoh, Director of Quality and Audit, Austin Health, personal communication). Austin Health and Monash University ethics committees approved the study. As data were collected for routine care, patient consent was not required.

Patients were recruited to the study if they were brought to the ED by ambulance between 13 and 31 March 2006 (inclusive), were aged 18 years or older, taking four or more regular medications, admitted to the hospital ward. Discrepancies (potential errors) identified were discussed with the admitting unit to determine the prescriber’s intention. Deliberate changes to pre-admission medication regimens were not considered to be errors. To minimise bias associated with intentionally vigilant prescribing, medical staff were not made aware of the study.

One ED pharmacist collated and de-identified admission medication charts, medication histories and details of POM brought in. An independent pharmacist, not involved in the patient’s clinical care, completed a standardised data collection form. The ED pharmacist who was involved in the patient’s care checked these forms and any errors were corrected after discussion.

Medications were considered “brought in” if the patient’s regular medications were...
brought in by ambulance, including labelled packs, medications in dose administration aids with a backing card outlining the regimen, and loose strips of identifiable tablets. Medications taken pro re nata (PRN), meaning “as needed”, were not assessed. If a list was brought in, without the actual medications, the medications were considered “not brought in”.

One ED pharmacist and the independent pharmacist worked separately to categorise and assign significance to the prescribing errors; then, together, they discussed inconsistencies to achieve consensus. Prescribing errors were classified as:
• wrong drug (another medication was intended);
• indication not treated (omission);
• unnecessary treatment (commission — charting a medication the patient was not taking or no longer taking);
• wrong dosage;
• wrong frequency;
• wrong formulation; and
• wrong route of administration. 8

Each error was assessed as being of minimal, moderate or high significance. Errors of minimal significance were defined as those from which the patient was unlikely to suffer significant adverse events (eg, omission of vitamins, calcium supplements, aperients); errors of moderate significance were those from which the patient was likely to experience a medical adverse event (eg, omission of regular analgesia, eye drops for glaucoma, regular inhaled medications, and antiplatelet therapy); and errors of high significance were those involving medications of low therapeutic index or associated with potentially severe adverse events (eg, omission or other error in prescribing warfarin, insulin, strong regular analgesics, and β-blockers).

The main outcome measure was the percentage of medications taken before presentation that were correctly prescribed on admission when POM were brought in with patients arriving by ambulance to the ED compared with when they were not. We estimated that prescribing error rates were about 10% when POM were brought in with patients, and 20% when they were not. To detect this difference, at least 219 regular medications were required in each group (level of significance, \( P < 0.05 \); power, 0.8). The \( \chi^2 \) test (with Yates correction) was used to compare proportions. EpiCalc 2000 (version 1.02; Brixton Health, Llanidloes, UK) was used for data analysis.

**RESULTS**

Of 748 patients brought in by ambulance to the Austin Hospital ED from 13 to 31 March 2006, 100 fulfilled our selection criteria and were recruited into the study (Box 1). No patients were referred to a pharmacist prior to the medication chart being written. Box 2 shows baseline characteristics of the 100 patients. Prescribing accuracy increased when POM were brought in compared with when...
they were not. A total of 151 admission prescribing errors were identified. Among the 428 POM that were brought to the ED, 56 errors occurred (13.1%); among the 372 regular medications taken by patients for whom POM were not brought in, 95 errors occurred (25.5%). Therefore, 86.9% of medications taken before admission were correctly charted when medications were brought in, and 74.5% of medications were correctly charted when they were not (difference in percentages, 12.4%; 95% CI, 6.7%–18.0%; P < 0.001).

All, some, or none of patients’ regular medications were brought in for 30%, 37% and 33% of patients, respectively. Paramedics were often able to bring in POM for patients in high-acuity triage categories, or those transported from a public place, relative or friend’s home or doctor’s clinic. The most prevalent error type was omission, occurring on 61 occasions (Box 3). Most prescribing errors were of moderate significance (Box 4). One medication (insulin) that was brought in was lost, requiring redispensing before discharge.

**DISCUSSION**

Bringing POM to the ED with patients arriving by ambulance was associated with almost half as many prescribing errors on admission medication charts compared with when POM were not brought in. This suggests that bringing POM to the ED may assist in improving prescribing accuracy.

Omissions were the most prevalent errors, and this is consistent with findings of previous studies. Medications that were not in tablet form were commonly omitted, including injections (particularly of insulin) and eye drops for glaucoma, highlighting that questions about such medications are routinely required during history taking. Another common error was prescription of wrong dosages; these were commonly charted for inhalers and cardiovascular medications.

For about two-thirds of patients (67%), paramedics brought in all or some medications. and it is notable that even patients in high-acuity triage categories, or those transported from a public place, relative or friend’s home or doctor’s clinic, often arrived with their medications.

If paramedics are to bring POM to EDs routinely, some procedural issues need to be managed. The risk of losing POM in transit or in hospital must be minimised. To achieve this, medications must not be sent back home before discharge as having these

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### 3 Nature and number of the 151 prescribing errors identified

<table>
<thead>
<tr>
<th>Error category</th>
<th>Occurrence (%; 95% CI)</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wrong drug</td>
<td>6 (4.0%; 1.6%–8.8%)</td>
<td>Irbesartan (irbesartan with hydrochlorothiazide intended); omeprazole (esomeprazole intended)</td>
</tr>
<tr>
<td>Indication not treated (omission)</td>
<td>61 (40.4%; 33.0%–49.0%)</td>
<td>Aspirin, diazepam, eye drops for glaucoma, glycercyl trinitrate patch, insulin, simvastatin, warfarin</td>
</tr>
<tr>
<td>Unnecessary treatment (charting a medication the patient was not taking or no longer taking)</td>
<td>17 (11.3%; 6.9%–18.0%)</td>
<td>Amlodipine, darbepoetin alfa, diltiazem, hydrochlorothiazide, levetiracetam, pantoprazole</td>
</tr>
<tr>
<td>Wrong dosage</td>
<td>43 (28.5%; 22.0%–36.0%)</td>
<td>Methotrexate (15 mg weekly charted, 7.5 mg weekly intended); protamine insulin (70 units charted, 60 units intended)</td>
</tr>
<tr>
<td>Wrong frequency</td>
<td>20 (13.2%; 8.5%–20.0%)</td>
<td>Diclofenac (nocte charted, bd intended); gemfibrozil (tds charted, bd intended); gliclazide modified-release tablets (mane charted, bd intended)</td>
</tr>
<tr>
<td>Wrong formulation</td>
<td>4 (2.6%; 0.9%–7.1%)</td>
<td>Carbamazepine (previously taking controlled-release formulation, immediate-release formulation prescribed)</td>
</tr>
</tbody>
</table>

*bd = twice daily. tds = three times daily. mane = morning. nocte = at night.

### 4 Occurrence and examples of prescribing errors of differing levels of significance

<table>
<thead>
<tr>
<th>Significance of error</th>
<th>Occurrence (%; 95% CI)</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimal</td>
<td>39 (25.8%; 19.0%–34.0%)</td>
<td>• Omission of alendronate 70 mg orally weekly.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Omeprazole charted when esomeprazole was intended.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Fluticasone/salmeterol inhaler 250/25 μg was charted as 250/50 μg.</td>
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<tr>
<td></td>
<td></td>
<td>• Mixtard insulin (Novo Nordisk) charted as 12 units, patient was on 10 units.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Folic acid dose charted as 2.5 mg orally daily, patient was on a dose of 7.5 mg.</td>
</tr>
<tr>
<td>Moderate</td>
<td>110 (72.8%; 65.0%–80.0%)</td>
<td>• Oxycodone 5 mg orally tds was charted for a patient presenting with sciatica; the patient was taking 15 mg orally bd before admission. Naproxen slow-release 1000 mg orally daily was also omitted in the same patient.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Gliclazide 40 mg orally mane was charted; the patient was taking 30 mg of a modified-release formulation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Omission of a lunchtime dose of aluminium hydroxide in a patient with renal disease.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Long-term therapy with prednisolone 5 mg orally bd charted as 5 mg orally mane.</td>
</tr>
<tr>
<td>High</td>
<td>2 (1.3%; 0–5.0%)</td>
<td>• Methotrexate was charted as 15 mg weekly when the dose before admission was 7.5 mg. One dose of 15 mg was given in hospital before the error was amended. If this dose had been continued after discharge, it could have harmed the patient.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Omission of warfarin used to manage the risk of stroke associated with atrial fibrillation.</td>
</tr>
</tbody>
</table>
available at the time of hospital discharge can be of great assistance for many reasons, including educating patients about changes made in hospital and disposing of medications that the patient should no longer take. Many EDs currently use distinctive bags to store POM, and this may minimise the risk of medications being lost.\textsuperscript{14}

One paramedic station in New South Wales has increased the number of patients arriving at their local ED with their own medications. Paramedics store a blood pressure sphygmomanometer in a large, clear, zip-locked bag, which is then placed inside the case of a portable resuscitator. As paramedics always carry both pieces of equipment, the plastic bag serves both as a reminder to bring patients’ medications to hospital, and as a receptacle in which to transport them.\textsuperscript{15}

Having POM available in hospital has a number of other advantages beyond improving prescribing accuracy. It provides an opportunity to assess appropriate medication storage and to check issue and expiry dates, which are important for medications such as glyceryl trinitrate tablets, eye drops, adrenaline (eg, EpiPen Auto-Injector; CSL, Melbourne, Vic) and insulin. Techniques or difficulties using inhaler and insulin devices can also be assessed. Cases of multiple brands of the same medication being taken concurrently can be detected and POM containers and their contents may provide clues about adherence to dosing regimens. Having POM available in EDs may also reduce delays in administering doses, especially after hours.

A comprehensive medication history is more likely when multiple sources of information are used\textsuperscript{16,17} in conjunction with active communication with the patient or carer involved in the medication. POM should be used as prompts for patients to articulate their usual routine of medication administration.

Our study has a number of limitations. A medication history taken by the ED pharmacist was considered accurate, forming the “gold standard” against which discrepancies on medication charts were compared. It is not possible to prove the accuracy of the medication histories, but care was taken to minimise error.

Most eligibility criteria could be determined from the electronic ED admissions database. The exception was whether patients took four or more regular medications before presentation. The fact that 88 patients who met all other eligibility criteria were not asked the number of regular medications they were taking may have introduced some selection bias, as it was not possible to determine whether these patients differed from those who were included in the study. Most of these patients presented after 20:00 and were discharged from the ED before 08:00, outside the hours when an ED pharmacist was available to prospectively identify potentially eligible patients. Finally, this was a single-site study involving two clinical pharmacists, which may limit external validity.

In conclusion, the significant reduction in prescribing errors on the hospital admission medication charts of patients admitted through the ED when POM were brought in with the patient compared with when POM were not brought in suggests that bringing POM to hospital should become a part of paramedics’ standard procedures, wherever possible. A promotional campaign to encourage paramedics to bring POM to hospital is indicated.

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COMPETING INTERESTS

None identified.

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REFERENCES


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