








## Original Research

# Pharmacy student-assisted medication reconciliation: Number and types of medication discrepancies identified by pharmacy students

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### Abstract

**Background:** Medication reconciliation aims to prevent unintentional medication discrepancies that can result in patient harm at transitions of care. Pharmacist-led medication reconciliation has clear benefits, however workforce limitations can be a barrier to providing this service. Pharmacy students are a potential workforce solution.

**Objective:** To evaluate the number and type of medication discrepancies identified by pharmacy students.

**Methods:** Fourth year pharmacy students completed best possible medication histories and identified discrepancies with prescribed medications for patients admitted to hospital. A retrospective audit was conducted to determine the number and type of medication discrepancies identified by pharmacy students, types of patients and medicines involved in discrepancies.

**Results:** There were 294 patients included in the study. Overall, 72% (n=212/294) had medication discrepancies, the most common type being drug omission. A total of 645 discrepancies were identified, which was a median of three per patient. Patients with discrepancies were older than patients without discrepancies with a median (IQR) age of 74 (65-84) vs 68 (53-77) years (p=0.001). They also took more medicines with a median (IQR) number of 9 (6-3) vs 7 (2-10) medicines per patient (p<0.001). The most common types of medicines involved were those related to the alimentary tract and cardiovascular system.

**Conclusions:** Pharmacy students identified medication discrepancies in over 70% of hospital inpatients, categorised primarily as drug omission. Pharmacy students can provide a beneficial service to the hospital and contribute to improved patient safety by assisting pharmacists with medication reconciliation.

### Keywords

Medication Reconciliation; Students, Pharmacy; Professional Competence; Pharmaceutical Services; Medical History Taking; Hospitalization; Pharmacists; Workforce; Cross-Sectional Studies; Australia

## INTRODUCTION

Medication errors are a significant cause of preventable harm in healthcare systems around the world.<sup>1</sup> Unintentional medication errors are common at transitions of care and occur in up to 70% of patients admitted to hospital.<sup>2-4</sup> To prevent unintentional medication discrepancies at transitions of care, medication reconciliation has been promoted by the World Health Organisation.<sup>1</sup> Medication reconciliation is defined as the process of creating the most accurate list possible of a patient's medications, also called a "Best Possible Medication History", and reconciling this list with currently prescribed medicines on admission, discharge or transfer

from hospital.<sup>5-8</sup> In Australia, medication reconciliation is also part of the National Safety and Quality in Health Service standards for hospital accreditation whereby patients should receive this service within 24 hours of admission.<sup>7</sup> A national study in Australia found that across ten health services 49.5% (n=20,162/42,003) of patients had a medication reconciliation within 24 hours. In this study, medication reconciliation was performed by pharmacists at all sites, and at one site by medical officers and pharmacists indicating that medication reconciliation is primarily conducted by pharmacists in Australia.<sup>8</sup>

The benefits of pharmacist-led medication reconciliation for hospital inpatients are well recognized.<sup>2,8-11</sup> A meta-analysis of 17 interventional studies involving over 21,000 adult patients showed that pharmacist-led medication reconciliation programs reduced adverse drug event related hospital revisits by 67%, emergency department visits by 28% and hospital re-admissions by 19%.<sup>9</sup> Despite clear benefits, many hospitals have reported that they are unable to provide this service to all patients due to workforce limitations and competing priorities for hospital pharmacists.<sup>12,13</sup>

Pharmacy students have been identified as a potential workforce solution to ensure more patients receive medication reconciliation in a timely manner.<sup>12-15</sup> International studies have demonstrated that pharmacy students involved in the medication reconciliation process were effectively able to document a best possible

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medication history during admission and identify discrepancies.<sup>12-16</sup> In the US, one study showed that 11 PharmD students identified 922 discrepancies when conducting medication reconciliation in 330 patients in three hospitals.<sup>14</sup> Furthermore, pharmacy students from the US and Canada have also been shown to obtain more accurate medication histories than fully trained nurses and physicians.<sup>13,15</sup> Even though strong evidence to support PharmD students to conduct medication reconciliation exists, it is unclear if these results can be reproduced with undergraduate Bachelor of Pharmacy (BPharm) students in Australia. Embedding such training into the undergraduate BPharm programs would not only assist pharmacists, but also provide valuable experience for students to ensure they meet the competency standards for pharmacists in Australia.<sup>17</sup>

The aim of this study was to evaluate the number and types of medication discrepancies identified by undergraduate pharmacy students when patients are admitted to hospital and to compare patient characteristics that had medication discrepancies to those that did not have medication discrepancies.

## METHODS

Ethics approval was obtained from Sydney Local Health District Ethics Review Committee. Approval number: 2019/ETH07525.

### Study setting

This was a retrospective audit evaluating medication discrepancies identified by fourth year undergraduate pharmacy (Bachelor of Pharmacy) students from August to November 2019 while on placement at an Australian tertiary metropolitan hospital. A total of 22 students attended the hospital for one day each week, over four weekdays, for a 10-week period to obtain best possible medication histories and identify discrepancies in patients admitted to hospital. The students received orientation, training and completed a competency assessment at their host university prior to the placement. Students worked in pairs under the supervision of a registered, clinical pharmacist. Participating wards included all adult, inpatient wards except the intensive care unit, haematology ward and the mental health unit. Different wards were allocated a pair of students for one day each week and the geriatrics ward for two days each week. Patients interviewed by students were selected by the supervising pharmacist from adult, inpatients admitted to their ward as part of their routine clinical work. Selection criteria were used to identify patients that would benefit most from medication

reconciliation (Online appendix – Table 1).<sup>7</sup>

Pharmacy students were trained to document a structured progress note in the electronic medical record. This included the best possible medication history, obtained from at least two sources, and any discrepancies identified with currently prescribed medicines. A discrepancy was defined as a mismatch between the medication history and medications prescribed on admission.<sup>3,6</sup> If any issues or errors were identified by the pharmacists, the notes were modified by the pharmacist, otherwise they were authorised by the pharmacists without modification. Documentation by students, including that it was written by a pharmacy student, became a permanent document in the electronic medical record.

### Data collection

Participants included in the data collection were patients with a progress note documented by pharmacy students during the placement period. Online Appendix – Figure 1 includes selection criteria for participants in the study. The process for data collection involved generating a report which extracted all progress notes written by pharmacy students from the electronic medical record. This was done by the electronic medicines management pharmacist at the hospital. The data in this report was able to determine if a pharmacist had authorised or modified the note. Exclusion criteria were patients with progress notes modified by a pharmacist and patients that had a best possible medication history documented prior to admission medications being prescribed. Progress notes modified by a pharmacist were excluded because modified progress notes replace the original student entry and it was not possible to determine what was documented by the student and what modifications were made by the pharmacist. Therefore, it was unknown how much input the pharmacists had into these notes. As the aim of the study was to evaluate what students identified, only notes that did not have modification by a pharmacist were included. Progress notes that were not authorised by a pharmacist were also excluded as they may reflect incomplete medication histories conducted by the students due to lack of time. Patients with a best possible medication history documented prior to admission medications being prescribed were excluded because identification of discrepancies by students could not be completed without prescribed medications.

Data collection involved independent review of all progress notes by two pharmacy students, who were not part of the placement, and a pharmacist to ascertain the number and types of discrepancies identified for each patient. If there

Table 1. Demographics of patients with and without medication discrepancies

	All patients n=294	With discrepancies n=212	With no discrepancies n=82	p-value
Age, median (IQR)	72 (62-83)	74 (65-84)	68 (53-77)	0.001
Age ≤ 50, (%)	36 (12%)	20 (9%)	16 (20%)	0.018
Age 51-60, (%)	28 (10%)	16 (8%)	12 (15%)	0.063
Age 61-70, (%)	64 (22%)	47 (22%)	17 (21%)	0.789
Age 71-80, (%)	69 (23%)	49 (23%)	20 (24%)	0.817
Age 81-90, (%)	74 (25%)	61 (29%)	13 (16%)	0.022
Age 91-101, (%)	23 (8%)	19 (9%)	4 (5%)	0.242
Female, number (%)	133 (45%)	102 (48%)	31 (38%)	0.111
Number of medicines, median (IQR)	9 (5-11)	9 (6-13)	7 (2-10)	<0.001



Table 2. Number of patients per admitting specialty, number (%) of patients with discrepancies and median number of discrepancies per patient

Admitting Specialty	Number of patients	Number (%) of patients with discrepancies <sup>c</sup>	Median (IQR) number of discrepancies per patient
Medical	195	142 (73%)	3 (1 - 4)
Geriatric medicine	80	67 (84%)*	3 (2 - 5)
Cardiology	28	20 (71%)	2.5 (2 - 4)
Gastroenterology	28	17 (61%)	1 (1 to 3)
Thoracic medicine	21	15 (71%)	2 (1 - 3)
Other <sup>a</sup>	15	10 (67%)	2.5 (1 - 5)
Renal medicine	10	9 (90%)	3 (3 - 5)
Drug & alcohol	9	2 (22%)*	2.5 (2 - 3)
Rheumatology	4	2 (50%)	3 (3 - 4)
Surgical	99	70 (71%)	3 (1-4)
Cardiothoracic surgery	27	25 (93%)*	3 (2 - 4)
Upper GIT	20	11 (55%)	2 (2 - 4)
Colorectal surgery	17	14 (82%)	2.5 (1 - 4)
Liver transplant	12	7 (58%)	4 (3 - 5)
Renal transplant	7	3 (43%)	1 (1 - 2)
Other <sup>b</sup>	7	3 (43%)	2 (2 - 3)
Orthopaedics	5	3 (60%)	3 (2 - 4)
Vascular surgery	4	4 (100%)*	3 (1 - 5)
Total	294	212 (72%)	3 (1 - 4)

<sup>a</sup>. Other includes medical specialties with ≤3 patients emergency medicine, general medicine, haematology, infectious diseases, neurology, psychiatry and urology.  
<sup>b</sup>. Other includes surgical specialties with ≤3 patients neurosurgery, ENT, head & neck surgery and melanoma/surgical oncology.  
<sup>c</sup>. % based on number of patients per admitting specialty.  
\* $p < 0.05$  for chi square test when comparing proportion of patients with discrepancies by admitting specialty compared to different specialties.

was any uncertainty by the students classifying the discrepancies this was referred to the investigating pharmacist. If there was still uncertainty the investigating pharmacist discussed with the other investigating pharmacists. Each discrepancy was classified by type using the medication discrepancy taxonomy (MedTax).<sup>6</sup> The Anatomical Therapeutic Chemical (ATC) code was identified for each medicine involved in discrepancies to determine the therapeutic categories (1<sup>st</sup> level) and subgroups (2<sup>nd</sup> level) commonly associated with medication discrepancies.<sup>18</sup>

In addition, patient demographic data were collected including age, gender, number of medicines and admitting specialty.

#### Data analysis

Descriptive analyses were conducted on the data collected including the number of patients with discrepancies, number and type of discrepancies and therapeutic categories of medicines involved. Statistical analysis of patient demographic data was performed using the Chi Square test and Mann-Whitney test to compare patients with and without medication discrepancies. Data analyses were completed using Microsoft Excel (Version 16.41).

## RESULTS

A total of 404 patients had progress notes documented by pharmacy students during the placement period. Of these, 316 were authorised by a supervising pharmacist without modification and included in the study. There were 32 patients with progress notes modified by a pharmacist (9%,  $n=32/348$  of all notes authorised by pharmacists), 55 where authorisation by a pharmacist could not be identified and one with a note marked in error, these were excluded. Identification of discrepancies could not be completed in 21

of the 316 patients as no admission medicines had been prescribed prior to completion of the best possible medication history. One entry was duplicated so these were also excluded resulting in 294 patients included in the study.

The median (IQR) age of patients included in the study was 72 (62 – 83) years, 45% ( $n=133/294$ ) were female and the median (IQR) number of medicines taken prior to admission was 9 per patient (5 – 11). The median (IQR) age was higher for patients with discrepancies compared to patients without discrepancies, 74 (64 – 84) vs 68 (53 – 77) years ( $p=0.001$ ). The median (IQR) number of medicines was also higher for patients with discrepancies, 9 (6 – 13) vs 7 (2 – 10) medicines ( $p < 0.001$ ). There was no statistically significant difference between the gender of patients with discrepancies compared to those with no discrepancies (Table 1).

All but two admitting specialties, urology and head and neck surgery, were found to have patients with at least one discrepancy. Overall, the proportion of patients with discrepancies for medical and surgical specialties was similar, 73% ( $n=142/195$ ) vs 71% ( $n=70/99$ ) ( $p=0.7$ )

Table 3. Types of discrepancies identified by pharmacy students ( $n=645$ )

Type of discrepancy	n (%)
Drug omission	393 (60.9)
Discrepancy in the dose	138 (21.4)
Discrepancy in the time of administration	28 (4.3)
Name of the drug	28 (4.3)
Drug commission/addition	27 (4.2)
Discrepancy in the dose for or route of administration	10 (1.6)
Therapeutic class substitution	9 (1.4)
Allergy or intolerance	6 (0.9)
Drug duplication	4 (0.6)
Other	2 (0.3)

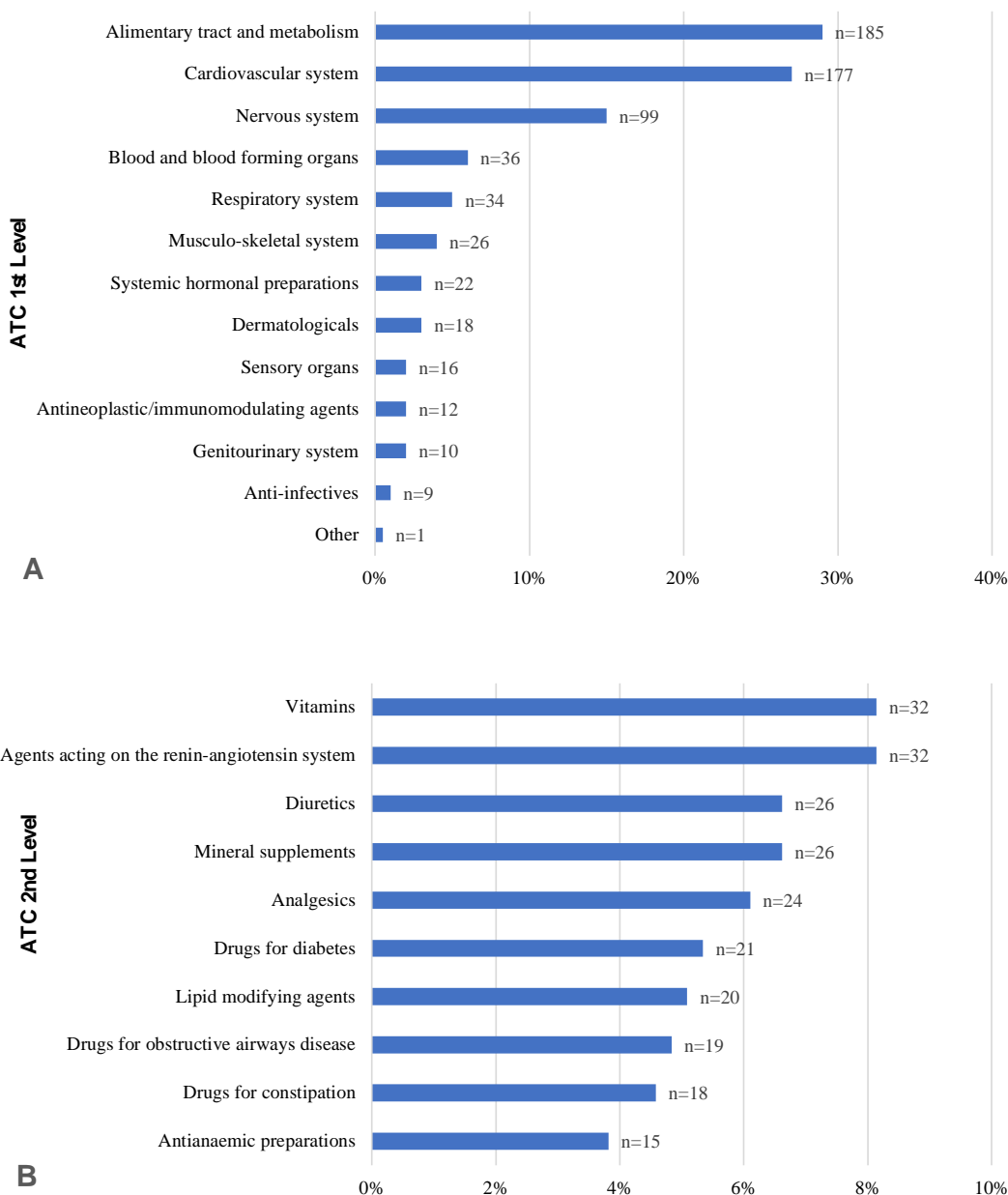


Figure 1. (A) Anatomical Therapeutic Chemical categories 1<sup>st</sup> level of medicines involved in discrepancies (n=645), (B) Top 10 Anatomical Therapeutic Chemical categories 2<sup>nd</sup> level of medicines involved in drug omission (n=393)

respectively. Geriatrics (84%, n=67/80) and cardiothoracic surgery (93%, n=25/27) had the highest number and proportion of patients with discrepancies (Table 2).

Pharmacy students identified discrepancies in 72% (n=212/294) of patients. A total of 645 discrepancies were identified with a median of three discrepancies per patient. The most common type of discrepancy was drug omission which accounted for 60.9% (n=393/645) of total discrepancies. Other types of discrepancies identified are shown in Table 3. Drug omission was defined as omission of home medications. Medicines used in the alimentary tract and metabolism and for treatment of conditions associated with the cardiovascular system (ATC 1<sup>st</sup> level) were the most common and together accounted for nearly 60% (n=362/645) of all discrepancies (Figure 1). The two most common therapeutic groups (ATC 2<sup>nd</sup> level) involved in drug

omission were agents acting on the renin-angiotensin system and vitamins (Figure 1).

## DISCUSSION

This study found that 72% (n=212/294) of patients with a best possible medication history by pharmacy students had medication discrepancies with a median of three discrepancies per patient. This highlights the ability of pharmacy students to identify discrepancies and demonstrates their value in assisting pharmacists with medication reconciliation. These results support other studies where pharmacy students have been involved in the medication reconciliation process. Similar to our results, a US study found that pharmacy (PharmD) students identified discrepancies in 75% of patients with a median of two discrepancies when conducting medication

reconciliation.<sup>14</sup> Another study showed pharmacy students identified at least one medication discrepancy in 78% (n=3162/4070) of patients admitted to hospital with an average of 2.3 discrepancies per patient.<sup>19</sup> In addition, of the progress notes documented by pharmacy students, 316 out of 404 were authorised by a supervising pharmacist without modification. This indicates that the documentation by Australian pharmacy students was appropriate and met the standard of the supervising pharmacists in most cases. Further research identifying what aspects of the pharmacy students' work required modification by a pharmacist will assist in improving pharmacy students' involvement in the medication reconciliation process.

Discrepancies identified by pharmacy students mainly included drug omissions and medicines involved in the alimentary tract and cardiovascular system. This is similar to a study in China of clinical pharmacist trainees that found the most common type of discrepancy was drug omission (40%, n=40/98) and that medicines associated with the alimentary tract and cardiovascular system accounted for 71% (n=70/98) of discrepancies.<sup>20</sup> Although the majority of discrepancies are unlikely to have significant clinical impact, errors involving the alimentary tract, such as drugs for diabetes, and cardiovascular drugs have the potential to lead to more serious adverse events.<sup>20</sup> Furthermore, it has been found that an estimated third of drug omission discrepancies identified from admission medication histories have the potential to result in moderate or severe clinical deterioration.<sup>3</sup> Hence, the clinical impact of pharmacy student assisted medication reconciliation may be substantial. Future studies should assess the clinical relevance of medication discrepancies identified by pharmacy students to evaluate their impact on patient care.

This study also identified that both surgical and medical specialties would benefit from pharmacy student conducted best possible medication histories. Our results are similar to another Australian study that showed there was no difference in number of discrepancies identified when conducting medication reconciliation between medical and surgical units.<sup>21</sup> In particular, our study showed that geriatrics and cardiothoracic surgery had a higher proportion of patients with medication discrepancies than other specialties and may benefit the most from having pharmacy students conduct medication histories.

#### Limitations

Some limitations in this study should be considered when interpreting the results. For instance, medication discrepancies were defined as a mismatch between the best possible medication history and medicines prescribed on admission. This means that all discrepancies were documented and coded in this study regardless of their appropriateness. Consequently, the number of discrepancies includes both intentional and unintentional discrepancies. Unintentional errors identified by pharmacy students are likely to be significantly less than intentional errors.<sup>10,20</sup> Although this difference is clinically important, pharmacy students were trained in this program to identify discrepancies, regardless if they were intended or not. This model was chosen as supervising pharmacists did not want students assuming if discrepancies were intentional or

unintentional without further discussion with them. Hence, students only documented the best possible medication history and the data reflects their impact to the workflow, instead of the whole patient journey. Also, due to the retrospective nature of this study, we could not reliably determine if the discrepancy was intentional or not.

Approximately 9% (n=32/348) of progress notes were modified by the supervising pharmacist. It was not possible to determine what modifications were made so these notes were excluded from the study. This small number is unlikely to affect the validity of the results however is a limitation of the study because these modifications could indicate errors made by pharmacy students.

Further, selection criteria were used to identify patients who would most benefit from medication reconciliation. Hence, pharmacists may have chosen more complex patients for pharmacy students to review so the patients included in this study may not be representative of the hospital's patient population. However, this would also support that pharmacy students are able to conduct medication reconciliation for high-risk patients with complex medication regimens and provide a substantial benefit for the hospital.

#### CONCLUSIONS

Pharmacy students identified medication discrepancies in over 70% of hospital inpatients, with most discrepancies being drug omission. Patients admitted under geriatrics and cardiothoracic surgery had more discrepancies than other specialties although discrepancies were found across nearly all specialties. This study supports that pharmacy students are able to contribute to improved patient care by assisting pharmacists with medication reconciliation.

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#### CONFLICT OF INTEREST

The authors have no conflicts of interest to declare that are relevant to the content of this article.

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