

MEDICINE SAFETY: TAKE CARE





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EXECUTIVE SUMMARY

MEDICATION-RELATED HOSPITAL ADMISSIONS



EXTENT OF PROBLEM

- 250,000 hospital admissions annually are a result of medication-related problems
- Annual cost \$1.4 billion
- 400,000 additional presentations to emergency departments are likely to be due to medication-related problems
- 50% of this harm is preventable

AFTER HOSPITAL DISCHARGE



- 3 in 5 hospital discharge summaries where pharmacists are not involved in their preparation have at least one medication error
- For 1 in 5 people at high risk of readmission, timely provision of the discharge summary did not occur
- Only 1 in 5 changes made to the medication regimen during hospital admission were explained in the discharge summary
- Over 90% of patients have at least one medication-related problem post-discharge from hospital

RESIDENTIAL AGED CARE



- 98% of residents have at least one medication-related problem
- Over half are exposed to at least one potentially inappropriate medicine

COMMUNITY



- 1 in 5 people are suffering an adverse medication reaction at the time they receive a Home Medicines Review
- 1.2 million Australians have experienced an adverse medication event in the last 6 months
- Almost 1 in 4 older people prescribed medicines cleared by the kidneys are prescribed an excessive dose

MEDICATION SAFETY IN AUSTRALIA

Use of medications is the most common intervention we make in health care, which means that problems with medicine use are also common.

Problems with medication can occur at any time during their use, including when the decision is made to use a medicine, during dispensing, and while using the medicine. In this report we detail the extent of harms in Australia as a result of medicine use. The main types of harm include hospital admissions due to medicines and adverse events. We estimate the number of hospital admissions

due to medicines, the number of emergency department attendances due to medicines, and present the extent of adverse events in the community setting. We also identify the extent of medication-related problems after discharge from hospital and for residents in aged care. We conclude by highlighting some of the opportunities where pharmacists can play a role in minimising these harms.



MEDICATION-RELATED HOSPITAL ADMISSIONS



250,000 hospital admissions annually are a result of medication-related problems. The annual costs for Australia are \$1.4 billion



An additional 400,000 presentations to emergency departments are likely to be due to medication-related problems



50% of this harm is preventable



There have now been 16 separate Australian studies since 1988 providing estimates of the extent of medication-related hospital admissions (See Figure 1, Appendix Table 1).

The most recent studies were published in 2014¹ and 2017.² One study, conducted on a randomly selected set of 400 patients presenting at the emergency department, estimated that 15% of admissions were associated with an adverse medication event, of which 54% were definitely avoidable.¹ The rate is more than double previous studies assessing medication-related admissions via the emergency departments, which were published in 1993 and 1995.⁴ This may indicate a greater rate of problems as people use more medicines now than in the earlier 1990s, however, the study did not report whether the adverse events were the cause of admission or an associated factor with admission.

The second study was conducted amongst a convenience sample of patients aged 65 years and over with unplanned admissions to medical wards.² Of the 1,008 admissions reviewed, 19% were considered to have an adverse drug reaction as a cause of or contributor to admission. High rates of preventability were reported, with

For those admitted to hospital due to adverse drug reactions, 50% had a single reaction, 30% had two adverse reactions, and 15% had three or more adverse reactions. In 70% of cases, the adverse reactions were due to multiple medicine use

87% considered preventable. Of the people hospitalised with adverse reactions, many were suffering from multiple adverse reactions, with 32.5% having two adverse reactions and 15% having three or more adverse reactions.

In 70% of cases the adverse reactions were due to multiple medicine use.² Patients admitted due to adverse reactions were at high risk of readmission due to an adverse reaction, with a follow-up study showing 13% of patients were readmitted with a hospital admission due to an adverse reaction in the 12 months following their first admission due to an adverse reaction.⁵

FIGURE 1: Results of previous studies assessing medication-related hospital admissions in Australia

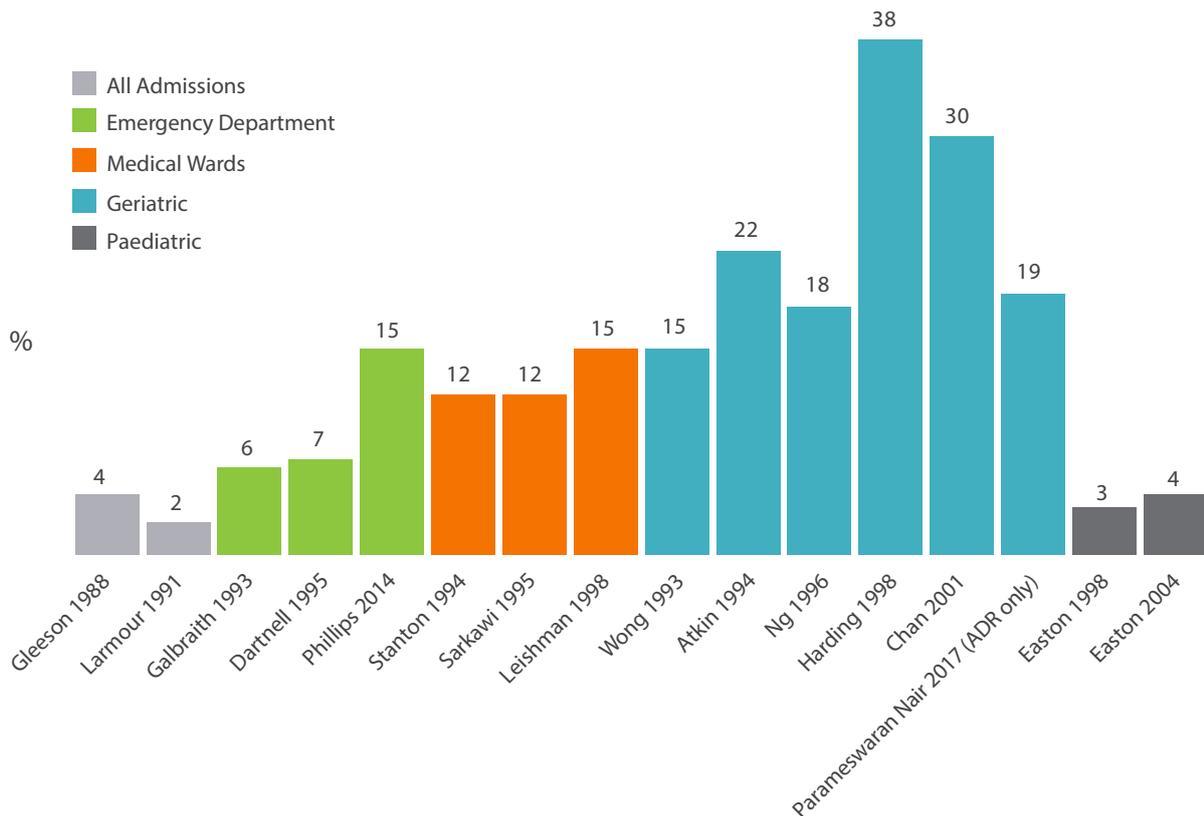


TABLE 1: Estimates of medication-related hospital admissions and emergency department attendances

	Median estimate from Australian medication-related hospital admission studies	Public hospital admissions	Private hospital admissions	Total
All admissions (n=2) ^{11,12}	2.5%	164,675	110,650	275,325
Emergency admissions (n=3) ^{1,4,13}	7%	196,021	16,728	212,749
Emergency admissions (n=3) based on emergency department presentations	7%	169,260	11,675	180,935
Medical admissions (n=3) ^{14,15,16}	12%	323,321	121,316	444,637
Emergency admissions in the elderly (n=6) ^{2,17-20}	20.5%	227,470	20,693	248,163
Emergency attendances (not admitted) (n=1) ³	8.6%	462,852	3,192	466,044

* (See Table A:3 for denominator derivations)

Two other studies have reported hospital admissions associated with adverse medicine reactions based on the reports of adverse events coded in the hospital record,^{6,7} with one showing 1.8% of hospital admissions had an adverse reaction due to medicines coded, which is similar to previous estimates using the same method.⁸ This coding includes both adverse events that caused admission and adverse events that occurred during admission. Neither study reported the results stratified by adverse events that contributed to the admission and those that occurred during admission.^{6,7}

To put these results in context it should be noted that there were 11 million hospital admissions in Australia in 2016–2017; of which 4.6 million occurred in patients aged 65 years and over.⁹ Assuming 2.5% of all hospital admissions are medication-related and the average cost per hospital stay is \$5,500,¹⁰ this amounts to:

- 250,000 medication-related hospitalisations per annum (Table 1); with
- total costs of \$1.375 billion.

Among people 65 years and over with medical or surgical admissions, 55% were on a potentially inappropriate medicine and 6% of all admissions were due to the potentially inappropriate medicine

Other Australian studies, while not enabling estimates of the extent of medication-related hospital admissions, also highlight problems with medicines at the time of hospital admission. One study assessing potentially preventable medication-related hospital admissions used an indicator set that had been validated by Australian clinicians who had indicated that the medication-related problems were recognisable, had foreseeable adverse outcomes, and the causes of the adverse outcomes were identifiable and controllable.²¹ The study found that in one quarter of cases there was suboptimal care prior to hospital admission among potentially preventable medication-related hospital admissions.²²

The use of potentially inappropriate medicines as a contributor to hospital admission has also been identified in a number of Australian studies. One study showed that among people 65 years and over with medical or surgical admissions, 55% were on a potentially inappropriate medicine and 6% of all admissions were due to the potentially inappropriate medicine. Potentially inappropriate medicines are not the only type of medication-related problem that can cause hospital admission, so this study underestimates the overall rate of medication-related hospital admissions in this population.²³

A similar study in patients aged 65 years and over who were admitted to hospital for at least four days also assessed the use of potential inappropriate medicines by the same criteria.²⁴ It also assessed the prevalence of potential prescribing omissions. It found 40% of people were on potentially inappropriate medicines and 63% had potential prescribing omissions at the time of admission. The study did not report the proportion of people who suffered an adverse event as a result of the potentially inappropriate medicines; however, it did find that 33% of potential inappropriate medicines were associated with a possible adverse

clinical outcome.²⁴ A Western Australian study using linked administrative data, and using a slightly different set of potentially inappropriate medicines, found that 15% of all unplanned hospital admissions in persons taking potentially inappropriate medicines was due to the potentially inappropriate medicines.^{25,26}

Among patients with poor renal function, at the time of their admission 16% were on a contraindicated medicine and 21% were on an inappropriate dose

One further study provides evidence that dosing of medicine in patients with poor renal function is also a contributor to hospital admissions in Australia. Among patients aged 40 years and over with either hypertension and/or diabetes mellitus and poor renal function (a creatinine clearance of 60ml/min or less), 32% were on a medicine that required renal adjustment or was potentially nephrotoxic at the time of admission, 16% were on a contraindicated medicine and 21% were inappropriately dosed.²⁷



MEDICATION-RELATED **PROBLEMS AFTER HOSPITAL DISCHARGE**



3 in 5 hospital discharge summaries where pharmacists are not involved in their preparation have at least one medication error



Over 90% of patients have at least one medication-related problem post-discharge from hospital



Changes to medication during hospital stay are common, with some studies showing up to 90% of people may experience a change to their medicines.^{28,29} Without medication reconciliation at discharge, there is a high chance that there will be errors on the discharge medication list.

A 2013 study conducted in a general practice setting examined the discharge summaries from 49 admissions for 38 patients.³⁰ Fifty-seven percent of discharge summaries were typed; 13% were difficult to read due to illegible handwriting or poor quality due to faxing or scanning. Complete lists of discharge medication were included in only 24% of the summaries received; 44% of the summaries contained no medication details. Only 21% included complete copies of radiology or pathology tests. These findings suggested that GPs experienced significant problems with missing medication information in the handover process.

Another study conducted in 2010 in a 900-bed metropolitan teaching hospital in Brisbane assessed the completeness and timeliness of the discharge summaries for a consecutive sample of medical inpatients aged 50 years and older who had also had a previous hospitalisation in the last six months.³¹ A computer-generated printed discharge summary was used. Timely discharge summary completion was documented for 169 (80.9%) of the 209 discharges and discharge medication reconciliation by a pharmacist occurred for 169 (80.9%) of the discharges. Thus, for 1 in 5 people at high risk of readmission, timely provision of the discharge summary did not occur.

For 1 in 5 people at high risk of readmission, timely provision of the discharge summary did not occur

A study conducted in a 350-bed teaching hospital in Sydney compared paper-based discharge summaries used prior to 2012 with those produced using a new 'medical (electronic) discharge summary and discharge medications protocol'.³² The study provided insight into the extent of medication-related changes occurring in hospital that are explained in the discharge summary.³²

On average, only 1 in 5 changes made to the medication regimen during hospital admission were explained in the discharge summary

A retrospective audit of discharge summaries from the general hospital population included 162 paper and 177 electronic discharge summaries. There were 1,236 medication changes identified that had occurred during hospital stay for patients with paper discharge summaries and 1,237 for patients with electronic discharge summaries; 80% of the changes were addition or discontinuation of medicines. Explanations for the medication changes in the discharge summary was limited; only 37% of additions and 28% of dose changes were explained when electronic summaries were used, with even less explanations found in the paper summaries.

Further, less than 15% of medication discontinuations or frequency changes were explained when either electronic or paper discharge summaries were used.

This study also assesses the completeness of the medication orders with regards to the completeness of the frequency, route and dose fields. Of the 1,352 medication orders on paper summaries, 7.3% had an incomplete frequency field, 3.1% had an incomplete route field and 1.4% had an incomplete dose field, while of the 1,771 medication orders in electronic discharge summaries assessed, 0.1% had an incomplete dose field, 6.5% had an incomplete frequency field and 0.4% had an incomplete route field.

A randomised controlled trial conducted in a major metropolitan referral hospital in Melbourne provides data on the prevalence of medication errors in hospital electronic discharge summaries.³³ Patients received normal care (control group) with discharge summaries completed by medical officers or discharge summaries with medication management plans completed by a pharmacist (intervention group). Of the 431 control group patients who received standard medical discharge summaries during the study period, 265 (61.5%) received summaries in which at least one medication error was identified. Of the 401 patients in the intervention group, 60 patients (15%) who received discharge summaries completed by pharmacists had a summary that included at least one error, which was significantly lower than the control group. For the control group discharge summaries with at least one error, there were 36 (13.6%) that were judged to have an error of high severity and 12 (4.5%) had errors of extreme severity. This was lower in the intervention group with 5 (8%) judged to have an error of high severity and 1 (2%) found to have an error of extreme severity.

Of the patients who received standard medical discharge summaries, 61.5% received summaries with at least one medication error.

One further study, while not providing estimates of the extent of the problem, does highlight the potential problems due to medicines post-discharge with regards to risk of falls.³⁴ The study was undertaken in a population admitted to hospital with a fall and found that among individuals discharged on medicines that increase falls risk there was a 70% increased chance of having a subsequent fall within 2 months of discharge.

One study provided some insight into people's perspectives of medication-related problems after discharge from hospital.³⁵ People aged 50 years and above taking five or more prescription medicines who had been recently admitted to

hospital with a minimum stay of 24 hours were included in the survey. Of the 506 participants from across Australia, 174 (34.4%) reported at least one medication-related problem. Of those reporting medication-related problems, 83 (47.7%) reported unwanted effects from medicines, 54 (31.0%) reported being given different medicines after leaving hospital, 48 (27.6%) experienced confusion about their medicines and 26 (14.9%) reported being unaware of changes to their medicines.

Research showed 93% of patients discharged from a cardiology unit had at least one medication-related problem

The extent of medication-related problems was reported in a randomised controlled trial evaluating the effectiveness of a pharmacist discharge service.³⁶ Of the 183 patients included in the trial, 92 patients received the intervention which included medication counselling, in-depth interview and medication review at the time of hospital discharge. The majority of patients (96%) had medication-related problems with an average of 8.5 causes of medication-related problems per patient. The most commonly identified cause of medication-related problems were indication not treated/missing therapy (12%), precaution needed with use of the medicine (11%), medicine not the most safe/effective treatment (8%) and dose too high (7%). The frequency of patients with medication-related problems in the immediate post discharge time period found in this study is similar to previous Australian research that showed 93% of patients discharged from a cardiology unit had at least one medication-related problem post-discharge.³⁷

Two studies provide information about the prevalence of use of potentially inappropriate medications for older people following discharge from hospital. A prospective observational cohort study of older people with high-care needs discharged from hospital to a community-based Transition Care Program was conducted at six sites in Queensland and South Australia in 2009-2010.³⁸ Of 347 patients included, 41 (11.8%) were taking

at least one potentially inappropriate medication following discharge. Potentially inappropriate medicines were defined as the subset from the Beers Criteria where the recommendation to avoid use was strong, where the quality of the evidence was classified as moderate or high, or where exposure to the medicines was above the recommended maximum daily dose.

A retrospective cohort study of medication regimens at discharge among patients aged 65 years and older who were admitted to the

general medical units was conducted to examine medication regimen complexity and potentially inappropriate medications.³⁹ Of the 100 patients included, 42% were prescribed at least one potentially inappropriate medication at discharge, as defined by Beers Criteria. Of 42 patients having at least one potentially inappropriate medication, only five (12%) had a separation summary that addressed the issues related to the potentially inappropriate medications.



MEDICATION-RELATED PROBLEMS WITHIN RESIDENTIAL AGED CARE



Over 90% of residents in aged-care facilities have at least one medication-related problem



As many as 80% are prescribed potentially inappropriate medicines

In the previous report of medication safety in Australia⁴⁰ it was reported that 96% of residents in aged-care facilities had at least one medication-related problem, with an average of three medication-related problems per resident.⁴¹

A 2014 study retrospectively assessed the medication-related problems identified by pharmacists in residential medication management reviews (RMMR) for 847 aged-care residents, between August 2011 and December 2012.⁴² Overall, 98% of the residents had at least one medication-related problem identified by the pharmacist during the RMMR, with an average of 3.2 problems per person. Harm associated with the medicine-related problems and preventability was not assessed in the study. The study assessed the prevalence of inappropriate prescribing of renally cleared medicines in residents with chronic kidney disease (estimated glomerular filtration rate eGFR of 60 ml/min or less).⁴² The eGFR was available for 323 of the 847 aged residents who had an RMMR, and 172 of them had chronic kidney disease. Sixteen percent of the residents with chronic kidney disease (n=28) were prescribed an inappropriate dose of a renally cleared medicine for their level of renal function. The percentage is likely an underestimate of the problem because eGFR may be overestimated in older people with low body mass index.

Another study assessed the prevalence of use of potentially inappropriate medicines using the 2015 Beers criteria, among a cohort of 533 aged care residents, most of whom had dementia or cognitive impairment.⁴³ Based on medicine use



in 2015, 81% of residents were exposed to at least one potentially inappropriate medicine. The most common potentially inappropriate medicines dispensed were long-term (>8 weeks) proton pump inhibitors (42% of residents), benzodiazepines (38%) and antipsychotics (31%). Harm associated with potentially inappropriate medicine use was not assessed in the study. Prior reviews of medication safety have reported the prevalence of potentially inappropriate medicine use in the aged care population at between 40 and 50%.⁴⁰ The 2015 Beers criteria for potentially inappropriate medicine use included additional medicines as potentially inappropriate in the elderly, which may explain some of this difference.

The use of potentially inappropriate medicines in residents of aged-care facilities has been shown to increase their risk of hospitalisation. A Western Australian study assessed the risk of unplanned hospital admissions and the use of potentially inappropriate medicines, as defined by the 2003 Beers criteria, among residents of aged care.⁴⁴ Between 1993 and 2005, there were 20,525 unplanned hospital admissions amongst high-care aged-care residents. Fifty three percent of people in the study who received high-care services in aged-care facilities were taking a Beers criteria medicine at the time of their unplanned admission. Overall, 17% of the unplanned admissions were attributed to the potentially inappropriate medicine.

DOSE ADMINISTRATION AIDS

Most aged-care facilities use dose administration aids (DAAs) to administer medicines to residents and since the last medication safety report,⁴⁰ there have been two new studies that assessed the prevalence of packing errors in DAAs. Both studies audited the accuracy and suitability of medicines packed into blister pack or sachet style DAAs for aged-care facility residents; the first study provided baseline information on the prevalence of packing errors and the second study provided follow-up information on the prevalence of packing errors after a quality improvement intervention to reduce packing errors.

The baseline study found issues with the packing of medicines in more than 1 in 10 DAAs.⁴⁵ Between November 2010 and May 2011 a convenience

17% of unplanned hospital admissions in persons living in aged-care facilities who are taking potentially inappropriate medicines are due to the inappropriate medicine

sample of 3,959 DAAs for 1,757 residents in 49 nursing homes were audited by research pharmacists. Overall, the audit identified 684 incidents in 457 DAAs for 416 residents. Twelve percent of the DAAs audited (457/3,959) had one or more incidents identified. The most common type of incident was unsuitable re-packing of a medicine into the DAA, accounting for half of the 684 incidents identified. The incident rate was similar for the different types of DAA packing. Of the 2,920 blister pack DAAs that were audited, 306 (11%) had one or more incidents identified. Of the 1,039 sachet DAAs audited, 151 (15%) had one or more incident identified.

The potential health consequences of these packing incidents were assessed in the follow-up study, where the researchers also conducted an intervention to reduce DAA incidents and re-audited DAAs after the intervention to determine whether incidents had reduced.⁴⁶ Forty-five of the 49 aged-care facilities involved in the first audit were included in a follow-up audit, which was conducted between September 2012 and January 2013 and included 2,389 DAAs for 983 residents. The follow-up audit identified 770 incidents in 502 DAAs for 407 residents. Despite the intervention to reduce DAA incidents, the overall prevalence of packing incidents increased to 21% in the follow-up audit. The proportion of DAAs with an incident that was considered likely to have major or catastrophic consequences was 4%.



MEDICATION-RELATED PROBLEMS IN THE COMMUNITY



1 in 5 people are likely to be suffering an adverse medication reaction at the time they receive a Home Medicines Review



On average, four medication-related problems are detected for each person who has a Home Medicines Review



There are now 11 Australian studies that have published analyses of the extent of medication-related problems among persons living in the community who have received Home Medicines Review services (Figure 2).^{37,47-57}

These studies consistently show that at the time a person receives a Home Medicines Review they are experiencing four medication-related problems, the majority of which are resolvable. The majority of studies have reported the type of medication-related problem as a proportion of all

problems rather than as a proportion of the people, however, three studies have reported the percent of people experiencing an adverse drug reaction at the time of the review, with one undertaken in the community finding 19% were experiencing an adverse reaction,⁵² one among persons living in rural areas finding 21% were experiencing an adverse reaction⁴⁷ and the other among persons attending a memory clinic or aged-care clinic reporting 26% were suffering an adverse medication reaction.⁵⁸

One further study highlighted the problems related to medicines that require adjustment or should be used with caution in persons with poor renal function.⁴⁸ The study audited records of medication reviews among older persons living in the community or aged care and found there was evidence of inappropriate prescribing in 28% of people who were prescribed medicines that are cleared by the kidneys. Of these, 81% were prescribed an excessive dose, while 19% were prescribed a contraindicated therapy.⁴⁸

Four prior surveys (2003–2012, Figure 3) conducted by the Bettering Evaluation And Care of Health (BEACH) Program found that between 8.5 and 11% of people seeing a general practitioner (GP) reported experiencing an adverse medication event in the previous 6 months.^{40,59}

Two recent BEACH surveys (2014–15 and 2015–16) repeated data collection on this topic. In the 2014–15 survey, data from 390 general practitioners and 11,477 patients were included. Of the 7,426 patients taking at least one continual medication, 11% reported they had experienced an adverse event due to medicine use in the prior 6 months. In all, the doctors classified 9.3% as severe adverse events, while 5.9% resulted in hospital admission, and 4.3% were treated at an emergency department without hospitalisation.⁶⁰ In the following year (2015–2016), data were

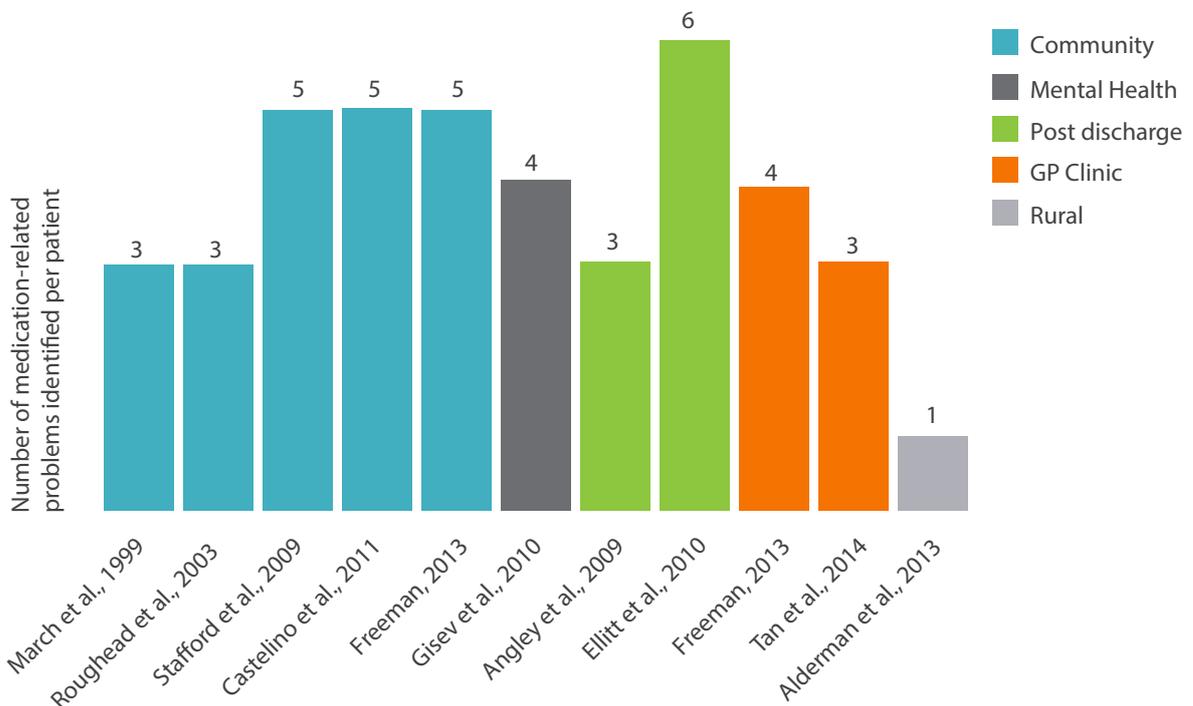
available from 363 general practitioners and 10,667 patients. Of the 7,253 patients taking at least one continual medication, 11% of patients reported they had experienced an adverse event due to medicine use in the prior six months. In total, 6.8% were classified by the doctors as severe adverse events, 5% reported a hospital admission as a consequence of the adverse medication event, and 2.3% were treated at an emergency department without hospitalisation.⁶¹

Almost 1 in 4 older people prescribed medicines cleared by the kidneys are prescribed an excessive dose

When taking into account results of the more recent surveys (2011–2016), the percentage of people attending general practice who had experienced an adverse medication event in the previous six months remained consistent at 11% (Figure 3). The surveys have consistently shown that 5% of the adverse events required hospitalisation (Figure 3).

There seems to be no data available assessing the frequency in which patients present to community pharmacists with medication-related problems.

FIGURE 2: Number of medication-related problems per patient identified in Home Medicines Review



Two small Australian studies reported similar levels of adverse medicine events in general practice.^{62,63} One study assessed the integration of pharmacists in 15 general practice sites in Western Sydney.⁶² Of the 493 patient consultations performed by the pharmacist over 6 months, 11% of patients experienced an adverse medication event. In addition, almost all patients (94%) had at least one medication-related problem, with an average of 2.3 medication-related problems per person. The second study trialled use of a global trigger tool to screen medical records for potential adverse events within 5 general practices in South Australia.⁶³ The study included patients aged 75 years or older who had attended the practice three or more times within 6 months. Among the 273 records reviewed, 6% of patients experienced adverse medication events. The rate of adverse medication events in this study is likely underestimated because patient records were only reviewed if there was a 'positive' trigger based on a list of 10 triggers on the global trigger tool.

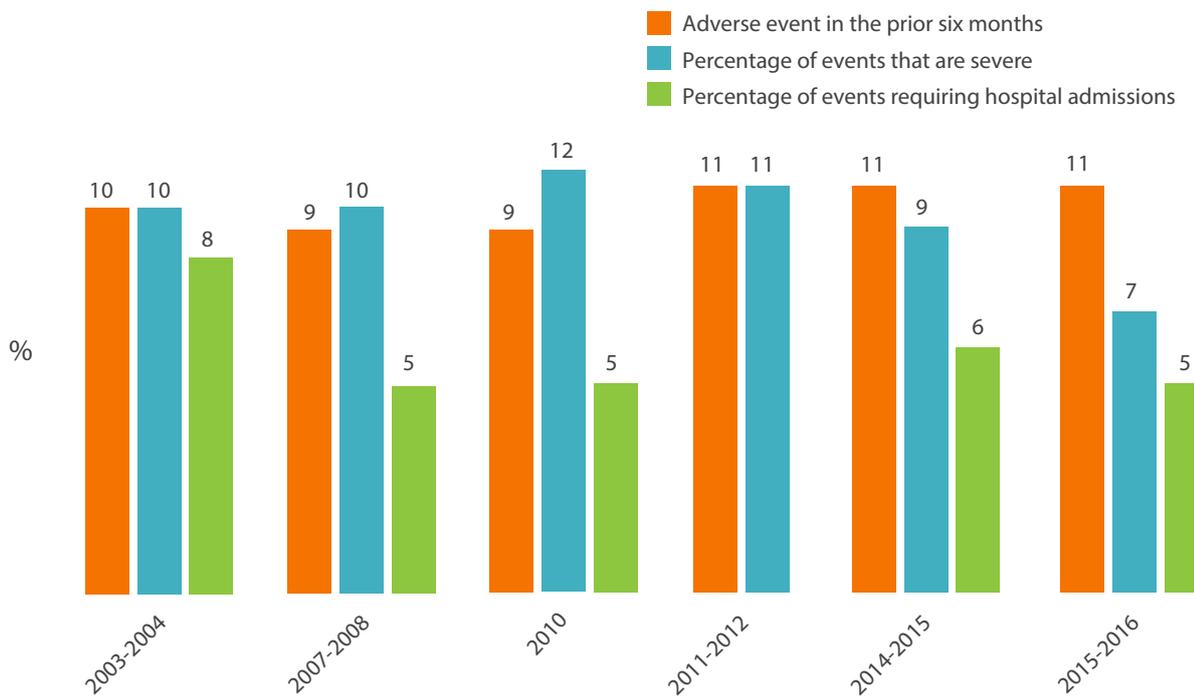
4 in 10 older Australians living in the community are prescribed at least one potentially inappropriate medicine

To put these results in context, 16 million patients saw a GP in 2016–17.⁶⁴ Two-thirds of patients visiting their GPs take at least one continual medication and 11% experienced adverse medication events in the past 6 months. This equates to almost 1.2 million Australians experiencing an adverse medication event in the past 6 months.

Use of potentially inappropriate medicines is also common in the community; three previous studies reported up to 50% of older people in the community are prescribed potentially inappropriate medicines.^{65–67} A more recently published study assessed use of potentially inappropriate medicines using administrative claims data of 251,305 Western Australians aged 65 years or older.⁶⁸ Over the 13-year study period (1993–2005), 75% of people were on at least one potentially inappropriate medicine (defined using the Beers Criteria); with an average of two different potentially inappropriate medicines per person. The annual prevalence of potentially inappropriate medicine at the study end (2005) was 40%.

1.2 million Australians have experienced an adverse medication event in the previous six months

FIGURE 3: Percentage of people experiencing adverse medication event in the prior six months, percentage considered severe and percentage requiring hospital admissions



ROLE OF PHARMACISTS

Pharmacists have significant potential to reduce the number of medication-related hospital admissions and adverse medication events in Australia.

National implementation of the My Health Record means clinical biomarkers including renal function, liver function, electrolytes and INR results will be available to pharmacy practice. The Australian Health Survey showed 11% of Australians 65 to 74 years and 30% of those 75 years and over had abnormal renal function (Table 2),^{69,70} while one Australian study auditing medication review notes found that in one-quarter of cases people on medicines cleared by the kidney received excessive doses.⁴⁸ This does lead to harm, with the Australian study of adverse reactions causing hospital admission showing that renal disorders were a contributor to 44% of the hospital admissions due to adverse reactions.² Use of My Health Record will enable pharmacists to proactively monitor dosages according to renal function, potentially reducing medication-related hospital admissions.

There is also potential to significantly reduce the proportion of admissions that are due to adverse reactions through proactive monitoring. The 2017 Tasmanian study showed 19% of unplanned admissions in the elderly were due to adverse reactions, and that in 56% of cases this occurred in a patient with a previous history of an ADR,

and in just under 50% of cases, the cause was due to multiple medicines.² Access to the complete medication history, which My Health Record will enable, will provide pharmacists with the opportunity to proactively intervene to both document and reduce the adverse reactions, with improved documentation leading to less use of contraindicated therapy and the availability of the complete medication history enabling better detection of multi-medicine interactions.



TABLE 2: Proportion of Australians with abnormal kidney and liver biomarkers^{69,70}

	25–34 years	35–44 years	45–54 years	55–64 years	65–74 years	75 years and over
Kidney disease biomarkers						
eGFR Abnormal (<60 mL/min/ 1.73 m ²)	0	0	0	1	11	30
Presence of albuminuria (Albumin Creatinine Ratio (ACR))	5	5	6	7	13	23
Liver disease biomarkers						
Abnormal Alanine aminotransferase (ALT)	12	13	14	12	8	2
Abnormal Gamma glutamyl transferase (GGT)	10	11	13	21	17	16

The frequency of medication-related problems at discharge and post discharge highlights the need for medication reconciliation and medication review in the immediate post-discharge phase. The Melbourne study showed that pharmacists completing medication management plans significantly reduced medication errors in the hospital discharge summaries.³³ It is worth noting that pharmacists are the first health professional a patient sees after leaving hospital (within 5 to 7 days, compared to within 7 to 21 days for GPs).⁷¹ The availability of discharge summaries within My Health Record will provide the opportunity for pharmacists to proactively prevent and resolve medication-related problems post-discharge with medication reconciliation and review.

There is also the need to integrate pharmacists into aged-care facilities given the high prevalence of medication-related problems that occur in this setting. While no Australian studies reported the rates of adverse medication events in aged care, an international study suggests that the rate of adverse medication events in aged care is between 7 and 28 adverse events per 100 resident months.⁷² Pharmacists can also play an important role in improving care for aged-care residents during transitions of care. Eleven percent of older people discharged from hospital are discharged to aged care.⁷³ Discharge summaries and pathology reports (e.g. renal function) will be available on My Health Record and the presence of pharmacists within aged-care facilities will ensure timely medication reconciliation and review.

Within the community as many as 1.2 million Australians experience an adverse medicine event. There is significant potential for pharmacists to assist in identifying and reducing the number of people living with adverse medication events via proactive monitoring for adverse events after a person first starts a new medicine and at the time a person presents for their first repeat prescription after starting a new medicine. My Health Record will provide the opportunity to improve recording of allergies and adverse medication events, and allow access to clinical biomarkers such as renal function, which will facilitate appropriate dosing and thus prevention of adverse events.

Proactive engagement of pharmacists has the potential to significantly reduce the number of adverse medication events in Australia

Medication-related problems remain a serious health issue for Australia. Proactive engagement of pharmacists has the potential to significantly reduce the number of medication-related hospital admissions and adverse medication events in Australia due to their place in the healthcare system, the frequency with which they have patient contact, developments in health infrastructure, including My Health Record, and the availability of digital tools to support medication management.

SEARCH STRATEGY

Evidence from 2013 to present (September 2018) for Australian data on medication safety was identified from the following databases:

Medline (including Pubmed), Embase, Ovid Emcare and Joanna Briggs Institute (JBI) Database. Criteria for inclusion of studies are that the studies address adverse drug events; adverse drug reactions or medication incidents as a result of the therapeutic prescribing, dispensing and or administration of medication. The literature was restricted to studies in the Australian healthcare setting.

SEARCH RESULTS

The literature search of the electronic database identified 440 (Medline), 2,051 (Embase), 429 (Ovid Emcare) and 150 (Joanna Briggs Institute) papers. All titles and abstracts were screened by one author; full text articles were screened by all authors.

SEARCH TERMS

MEDLINE

Database: Ovid MEDLINE(R) ALL <1946 to October 1, 2018>

Search Strategy:

- 1 Medication Reconciliation/ or Medication Errors/ (12904)
- 2 Diagnostic Errors/ or Medical Errors/ (50858)
- 3 Safety Management/ (18970)
- 4 "Quality of Health Care"/ (67617)
- 5 "Drug-Related Side Effects and Adverse Reactions"/ (28807)
- 6 Quality Assurance, Health Care/ (54243)
- 7 Patient Safety/ (15220)
- 8 patient* safety.mp. (36509)
- 9 medication* safety.mp. (1813)
- 10 adverse drug event*.mp. (3346)
- 11 adverse drug react*.mp. (18585)
- 12 medica* incident*.mp. (289)
- 13 medica* mishap*.mp. (54)
- 14 medica* mistake*.mp. (211)
- 15 medica* misadventure*.mp. (110)
- 16 drug misadventure*.mp. (15)
- 17 drug* toxicity.mp. (5129)
- 18 medication related harm*.mp. (36)
- 19 medication related incident*.mp. (19)
- 20 medication related problem*.mp. (407)
- 21 medication reporting system*.mp. (0)
- 22 pharmaceutical reporting system*.mp. (0)
- 23 medic* prescri* error*.mp. (64)
- 24 drug* prescri* error*.mp. (17)
- 25 prescri* error*.mp. (977)
- 26 medica* dispensing error*.mp. (23)
- 27 drug* dispensing error*.mp. (15)
- 28 dispensing error*.mp. (262)
- 29 medication* administra* error*.mp. (310)
- 30 drug* administra* error*.mp. (108)
- 31 administra* error*.mp. (836)
- 32 medication* related admission*.mp. (8)
- 33 drug related admission*.mp. (47)
- 34 Patient Transfer/ (7469)
- 35 medic* review*.mp. (2562)
- 36 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 (274351)
- 37 INCIDENCE/ (234415)
- 38 PREVALENCE/ (257797)
- 39 rate*.mp. (2756246)
- 40 Drug Substitution/ (2882)
- 41 therapeutic shift*.mp. (15)
- 42 brand substitution*.mp. (24)
- 43 generic substitution*.mp. (510)
- 44 37 or 38 or 39 or 40 or 41 or 42 or 43 (3092353)
- 45 Australia/ or Australian Capital Territory/ or New South Wales/ or Northern Territory/ or Queensland/ or South Australia/ or Tasmania/ or Victoria/ or Western Australia/ or Australia.mp. or Victoria.mp. or Tasmania.mp. or New South Wales.mp. or Queensland.mp. or Australian Capital Territory.mp. or Australia*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (184765)
- 46 36 and 44 and 45 (1125)
- 47 limit 46 to yr="2013 -Current" (440)

APPENDIX

TABLE A:1: Medication-related hospital admissions or readmissions: Australia 1988–2018

	Total admissions reviewed	Total medicine related	TYPE OF MEDICINE RELATED ADMISSION			
			Adverse drug reaction	Non-compliance	Over-dose	Other
All hospital admissions assessed						
Carroll et al., 2003 ⁸	50,712	643 (1.27%)	643 (1.27%)	N/A	N/A	N/A
Gleeson 1988 ¹¹	947	34 (3.6%)	34 (3.6%)	N/A	N/A	N/A
Larmour et al 1991 ¹²	5,623	136 (2.4%)	90 (1.6%)	5 (0.09%)	40 (0.7%)	1 (0.02%)
Admissions via Emergency Department assessed						
Galbraith 1993 ³	751	48 (6.4%)	Unknown	Unknown	7 (0.9%)	Unknown
Dartnell et al 1996 ⁴	965	68 (7%)	26 (2.7%)	15 (1.6%)	13 (1.3%)	14 (1.5%)
Phillips et al. 2014 ¹	400	59 (15%)				
Admissions to Medical Wards assessed						
Sarkawi & Daud 1995 ¹⁴	419	49 (11.7%)	21 (5%)	12 (2.9%)	14 (3.3%)	2 (0.5%)
Stanton et al.1994 ¹⁵	691	81 (11.7%)	21* (3%)	10* (1.4%)	26* (3.8%)	11* (1.6%)
Leishman & Vial 1998 ^{a16}	217	33 (15.2%)	10 (4.6%)	8 (3.7%)	11 (5.1%)	4 (1.8%)
Unplanned readmissions assessed						
Blackbourn 1991 ⁷⁴	180	29 (16%)	12 (6.7%)	14 (7.8%)	1 (0.6%)	2 (1.1%)
Hewitt 1995 ⁷⁵	131	46 (35%)	29 (22%)	1 (0.8%)	0	16 (12.2%)
Greenshields et al., 1997 ⁷⁶	63	17 (27%)	unknown	unknown	unknown	unknown
Stowasser et al., 2000a ⁷⁷	28	9 (32.1%)	unknown	unknown	unknown	unknown
Paediatric admissions assessed – medical only excluding oncology						
Easton, 1998 ⁷⁸	1,682	58 (3.4%)	10 (0.6%)	29 (1.7%)	10 (0.6%)	9 (0.5%)
Easton et al 2004 ⁷⁹	2,933	127 (4.3%)	29 (1.0%)	38 (1.3%)		

TABLE A:1: Medication-related hospital admissions or readmissions: Australia 1988–2018 (Cont)

	Total admissions reviewed	Total medicine related	TYPE OF MEDICINE RELATED ADMISSION			
			Adverse drug reaction	Non-compliance	Over-dose	Other
Geriatric admissions via emergency departments assessed						
Ng 1996 ¹⁷	172	31 (18%)	18 (10.5%)	5 (2.9%)	1 (0.6%)	7 (4.1%)
Atkin et al 1994 ¹⁸	217	48 (22.1%)	41 (18.9%)	5 (2.3%)	1 (0.5%)	1 (0.5%)
Wong et al. 1993 ¹⁹	245	49 (20%)	35 (14.3%)	13 (5.3%)	1 (0.4%)	N/A
Wong et al. 1993 ¹⁹	541	81 (15%)	61 (11.3%)	19 (3.5%)	1 (0.2%)	N/A
Harding, 1998 ²⁰	16	6 (37.5%)	4 (25.0%)	1 (6.25%)	0	1 (6.25%)
Chan et al., 2001 ⁸⁰ (>=75 years)	240	73 (30.4%)	32 (13.3%)	9 (3.8%)	1 (0.42%)	31 (12.9%)
Parameswaran Nair et al., 2017 ² >65 years	1,008	191 (18.9%)				
Cardiac patients admitted to the coronary care unit or medical wards						
Lee & Oldenburg 1993 ⁸¹	112	37 (33%)	14 (12.5%)	11 (9.8%)	0	12 (10.7%)
Emergency department attendances						
Galbraith 1993 ³ (adults)	594 (not admitted)	51 (8.6%)	8 (1.3%)			
Easton 2003 ⁸² (paediatrics)	8,601 (includes admissions)	280 (3.2%)	118 (1.4%)			
Hendrie et al., 2007 ⁸³	3,332 (includes admissions)	45 (1.4%)	45 (1.4%)			

N/A = Not assessed

* = only definite or probable drug-related admissions reported

(all other results report definite, probable or possible drug-related admissions)

1 = medical and respiratory wards and endocrinology unit

a = assessed by medical file review and examination of medication changes

TABLE A:2: Preventability of adverse medicine events associated with hospitalisation or admissions due to medication-related problems

		Total number of medicine-related problems or admissions	Percentage considered definitely avoidable	Percentage considered probably or possibly avoidable	Percentage considered probably not or definitely unavoidable
Parameswaran et al., 2017 ²	Geriatric admissions	328	87.2%		
Phillips et al., 2014 ¹		72	54.2%	11.1%	34.7%
Easton et al., 2004 ⁷⁹	Paediatric admissions	81	46.9%		30.9%
Easton-Carter et al., 2003 ⁸²	Paediatric emergency department attendances	187	51.3%		36.9%
Chan et al., 2001 ⁸⁰	Geriatric admissions	73	53.4	23.3	23.3
Lau et al., 2004 ⁸⁴	Hospital Oncology ADRs	454	1.6%	46.1%	53.4%
Dartnell et al 1996 ⁴	General admissions	55*a	5%	60%	35%
Sarkawi et al, 1995 ¹⁴	Medical admissions	35*	23%	46%	31%
Easton 1998 ⁷⁸	Paediatric admissions	48*+	#	67%	29%
Ng 1996 ¹⁷	Geriatric admissions	31	3%	29%	68%

* - overdose excluded # - category not used + - 2 cases unassessable

Note: estimates of adverse drug event preventability in the community from one study were 23%.⁸⁵



TABLE A:3: Derivation of overall estimates of medication-related hospital admissions and emergency department attendances in Australia 2016–2017

	Median estimate from Australian medication-related hospital admission studies	Public hospital admissions	Private hospital admissions	Total
Denominator data (Source AIHW Hospital statistics 2016-17) ⁹	Admissions	6,587,000	4,426,000	11,013,000
	Emergency admissions	2,800,301	238,970	3,039,271
	Admissions from emergency department attendances	2,418,000	166,780	2,584,780
	Medical admissions	2,694,343	1,010,967	3,705,310
	Admissions in persons 65 years and over	2,580,483	2,018,849	4,599,332
All admissions (n=2) ^{11,12}	2.5%	164,675	110,650	275,325
Emergency admissions (n=3) ^{1,4,13}	7%	196,021	16,728	212,749
Emergency admissions (n=3) emergency department presentations as the denominator	7%	169,260	11,675	180,935
Medical admissions (n=3) ^{14,15,16}	12%	323,321	121,316	444,637
Emergency admissions in the elderly (n=6)* ^{2,17-20}	20.5%	227,470	20,693	248,163
Emergency attendances (not admitted) (n=1) ³	8.6%	462,852	3,192	466,044

*Assume 43% of all public admissions are emergency and 5% of all private are emergency: consistent with estimates for all ages
 Note: Carroll et al., 2003 excluded from derivation as relied on routine administrative coding only



REFERENCES

1. Phillips AL, Nigro O, Macolino KA, et al. Hospital admissions caused by adverse drug events: an Australian prospective study. *Australian health review: a publication of the Australian Hospital Association*. Feb 2014;38(1):51–57.
2. Parameswaran Nair N, Chalmers L, Bereznicki BJ, et al. Adverse Drug Reaction-Related Hospitalizations in Elderly Australians: A Prospective Cross-Sectional Study in Two Tasmanian Hospitals. *Drug Saf*. Jul 2017;40(7):597–606.
3. Galbraith K. *Is there a role for a clinical pharmacist in the emergency department?* Melbourne: Victorian College of Pharmacy Monash University; 1993.
4. Dartnell JG, Anderson RP, Chohan V, et al. Hospitalisation for adverse events related to drug therapy: incidence, avoidability and costs. *The Medical Journal of Australia*. Jun 3 1996;164(11):659–662.
5. Parameswaran Nair N, Chalmers L, Bereznicki BJ, Curtain CM, Bereznicki LR. Repeat Adverse Drug Reaction-Related Hospital Admissions in Elderly Australians: A Retrospective Study at the Royal Hobart Hospital. *Drugs Aging*. Oct 2017;34(10):777–783.
6. Du W, Pearson SA, Buckley NA, Day C, Banks E. Diagnosis-based and external cause-based criteria to identify adverse drug reactions in hospital ICD-coded data: application to an Australia population-based study. *Public Health Research & Practice*. Apr 27 2017;27(2).
7. Zhang H, Du W, Gnjjidic D, Chong S, Lancsar E, Glasgow N. Trends in adverse drug reactions related hospitalisations over 13 years in New South Wales, Australia. *Intern Med J*. Oct 3 2018.
8. Carroll R, McLean J, Walsh M. Reporting hospital adverse events using the Alfred Hospital's morbidity data. *Australian Health Review*. 2003;26(2):100–105.
9. Australian Institute of Health and Welfare. *Admitted patient care 2016–17: Australian hospital statistics. Health services series no. 84. Cat. no. HSE 201*. Canberra 2018.
10. Australian Institute of Health and Welfare. *Hospital resources 2016–17: Australian hospital statistics. Health services series no. 86. Cat. no. HSE 205*. Canberra 2018.
11. Gleeson CA. *Adverse drug reactions causing hospital admissions*. Sydney, University of Sydney; 1988.
12. Larmour I, Dolphin RG, Baxter H, Et al. A prospective study of hospital admissions due to drug reactions. *Aust J Hosp Pharm*. 1991;21:90–95.
13. Galbraith K. *Is there a role for a clinical pharmacist in the emergency department?* Melbourne, Victorian College of Pharmacy; 1993.
14. Sarkawai H, Daud TM. *A study of drug induced illness as a contributor to hospital admissions*. Adelaide: Royal Adelaide Hospital; 1995.
15. Stanton LA, Peterson GM, Rumble RH, Cooper GM, Polack AE. Drug-related admissions to an Australian hospital. *J Clin Pharm Ther*. Dec 1994;19(6):341–347.
16. Leishman S, Vial JH. Drug related admissions to the Royal Hobart Hospital. Paper presented at: Australian Society of Clinical and Experimental Pharmacology (ASCEPT) 1998.
17. Ng D. *Adverse medication-related events and unplanned admissions to an acute care general teaching hospital*. Adelaide, University of South Australia; 1996.
18. Atkin PA, Finnegan TP, Ogle SJ, Et al. Prevalence of drug-related admissions to a hospital geriatric service. *Aust J Ageing*. 1994;13:17–21.
19. Wong ME, Ioannides-Demos LL, Li SC, Et al. Drug-related hospital admissions of geriatric patients. *Aust J Hosp Pharm*. 1993;23:75.
20. Harding AM. A snapshot of admissions to an acute medical unit for the aged. *Aust J Hosp Pharm*. 1998;28:359–360.
21. Caughey GE, Kalisch Ellett LM, Wong TY. Development of evidence-based Australian medication-related indicators of potentially preventable hospitalisations: a modified RAND appropriateness method. *BMJ Open*. Apr 28 2014;4(4):e004625.
22. Caughey GE, Kalisch Ellett LM, Goldstein S, Roughead EE. Suboptimal medication-related quality of care preceding hospitalisation of older patients. *The Medical Journal of Australia*. Sep 7 2015;203(5):220 e221–227.
23. Ni Chroinin D, Neto HM, Xiao D, et al. Potentially inappropriate medications (PIMs) in older hospital in-patients: Prevalence, contribution to hospital admission and documentation of rationale for continuation. *Australas J Ageing*. Dec 2016;35(4):262–265.

24. Manias E, Kusljic S, Lam DL. Use of the Screening Tool of Older Persons' Prescriptions (STOPP) and the Screening Tool to Alert doctors to the Right Treatment (START) in hospitalised older people. *Australas J Ageing*. Dec 2015;34(4):252–258.
25. Price SD, Holman CD, Sanfilippo FM, Emery JD. Impact of specific Beers Criteria medications on associations between drug exposure and unplanned hospitalisation in elderly patients taking high-risk drugs: a case-time-control study in Western Australia. *Drugs Aging*. Apr 2014;31(4):311–325.
26. Price SD, Holman CD, Sanfilippo FM, Emery JD. Association between potentially inappropriate medications from the Beers criteria and the risk of unplanned hospitalization in elderly patients. *Ann Pharmacother*. Jan 2014;48(1):6–16.
27. Doody HK, Peterson GM, Watson D, Castelino RL. Retrospective evaluation of potentially inappropriate prescribing in hospitalized patients with renal impairment. *Curr Med Res Opin*. Mar 2015;31(3):525–535.
28. Mant A, Rotem WC, Kehoe L, Kaye KI. Compliance with guidelines for continuity of care in therapeutics from hospital to community. *Medical Journal of Australia*. Mar 19 2001;174(6):277–280.
29. Stowasser DA, Collins DM, Stowasser M. A randomised controlled trial of medication liaison services - Patient outcomes. *Journal of Pharmacy Practice & Research*. 2002;32(2):133–140.
30. Belleli E, Naccarella L, Pirota M. Communication at the interface between hospitals and primary care: A general practice audit of hospital discharge summaries *Australian Family Physician*. 2013;42:886–890.
31. Mudge AM, Shakhovskoy R, Karrasch A. Quality of transitions in older medical patients with frequent readmissions: opportunities for improvement. *European Journal of Internal Medicine*. Dec 2013;24(8):779–783.
32. Lehnbohm EC, Raban MZ, Walter SR, Richardson K, Westbrook JI. Do electronic discharge summaries contain more complete medication information? A retrospective analysis of paper versus electronic discharge summaries. *Health information management: Journal of the Health Information Management Association of Australia*. 2014;43(3):4–12.
33. Tong EY, Roman CP, Mitra B, et al. Reducing medication errors in hospital discharge summaries: a randomised controlled trial. *The Medical Journal of Australia*. Jan 16 2017;206(1):36–39.
34. Bennett A, Gnjidic D, Gillett M, et al. Prevalence and impact of fall-risk-increasing drugs, polypharmacy, and drug-drug interactions in robust versus frail hospitalised falls patients: a prospective cohort study. *Drugs Aging*. Mar 2014;31(3):225–232.
35. Eassey D, Smith L, Krass I, McLachlan A, Brien J-A. Consumer perspectives of medication-related problems following discharge from hospital in Australia: a quantitative study. *International Journal for Quality in Health Care*. 2016;28(3):391–397.
36. Basger BJ, Moles RJ, Chen TF. Impact of an enhanced pharmacy discharge service on prescribing appropriateness criteria: a randomised controlled trial. *Int J Clin Pharm*. Dec 2015;37(6):1194–1205.
37. Ellitt GR, Engblom E, Aslani P, Westerlund T, Chen TF. Drug related problems after discharge from an Australian teaching hospital. *Pharmacy World and Science*. 2010;32(5):622–630.
38. Runganga M, Peel N, Hubbard R. Multiple medication use in older patients in post-acute transitional care: a prospective cohort study. *Clinical Interventions in Aging*. 2014;9: 1453–1462.
39. Chang WT, Kowalski SR, Sorch W, Alderman CP. Medication regimen complexity and prevalence of potentially inappropriate medicines in older patients after hospitalisation. *International Journal of Clinical Pharmacy*. Aug 2017;39(4):867–873.
40. Australian Commission on Safety and Quality in Health Care. Literature Review: Medication Safety in Australia. Sydney: ACSQHC 2013.
41. Nishtala PS, McLachlan AJ, Bell JS, Chen TF. A retrospective study of drug-related problems in Australian aged care homes: medication reviews involving pharmacists and general practitioners. *J Eval Clin Pract*. Feb 2011;17(1):97–103.
42. Gheewala P, Peterson G, Curtain C, Nishtala P, Hannan P, Castelino R. Impact of the pharmacist medication review services on drug-related problems and potentially inappropriate prescribing of renally cleared medications in residents of aged care facilities. *Drugs and Aging*. 2014;31:825–835.
43. Harrison S, Kouladjian O'Donnell L, Milte R, et al. Costs of potentially inappropriate medication use in residential aged care facilities. *BMC Geriatrics*. 2018;18:9.

REFERENCES (Cont)

44. Price S, Holman C, Sanfilippo F, Emery J. Are high-care nursing home residents at greater risk of unplanned hospital admission than other elderly patients when exposed to Beers potentially inappropriate medications? *Geriatrics and Gerontology International*. 2014;14:934–941.
45. Gilmartin J, Hussainy S, Marriott J. Medicines in Australian nursing homes: a cross-sectional observational study of the accuracy and suitability of re-packing medicines into pharmacy-supplied dose administration aids. *Research in Social and Administrative Pharmacy*. 2013;9:876–883.
46. Gilmartin J, Marriott J, Hussainy S. Improving Australian care home medicine supply services: evaluation of a quality improvement intervention. *Australasian Journal on Ageing*. 2016;35(2):E1–E6.
47. Alderman CP, Kong L, Kildea L. Medication-related problems identified in home medicines reviews conducted in an Australian rural setting. *Consult Pharm*. Jul 2013;28(7):432–442.
48. Khanal A, Peterson GM, Castelino RL, Jose MD. Potentially inappropriate prescribing of renally cleared drugs in elderly patients in community and aged care settings. *Drugs Aging*. May 2015;32(5):391–400.
49. Freeman CR, Cottrell WN, Kyle G, Williams ID, Nissen L. An evaluation of medication review reports across different settings. *Int J Clin Pharm*. Feb 2013;35(1):5–13.
50. Freeman C, Cottrell WN, Kyle G, Williams I, Nissen L. Does a primary care practice pharmacist improve the timeliness and completion of medication management reviews? *Int J Pharm Pract*. Dec 2012;20(6):395–401.
51. Tan EC, Stewart K, Elliott RA, George J. Pharmacist consultations in general practice clinics: the Pharmacists in Practice Study (PIPS). *Res Social Adm Pharm*. Jul-Aug 2014;10(4):623–632.
52. Roughead EE, Barratt JD, Gilbert AL. Medication-related problems commonly occurring in an Australian community setting. *Pharmacoepidemiol Drug Saf*. Feb 2004;13(2):83–87.
53. Stafford L, Peterson G, Bereznicki L, et al. Clinical outcomes of a collaborative, home-based postdischarge warfarin management service. *Annals of Pharmacotherapy*. 2011;45:325–334.
54. Castelino RL, Bajorek BV, Chen TF. Retrospective evaluation of home medicines review by pharmacists in older Australian patients using the medication appropriateness index. *Annals of Pharmacotherapy*. Dec 2010;44(12):1922–1929.
55. Gisev N, Bell JS, O'Reilly CL, Rosen A, Chen TF. An expert panel assessment of comprehensive medication reviews for clients of community mental health teams. *Soc Psychiatry Psychiatr Epidemiol*. 2010;45(11):1071–1079.
56. March G, Gilbert A, Roughead E, Qunitrell N. Developing and evaluating a model for pharmaceutical care in Australian community pharmacies. *International Journal Pharmacy Practice*. 1999;7 220–229.
57. Angley M, Ponniah A, Bong J, Padhye V, Shakib S, Spurling L. *Implementing and evaluating a parallel post-discharge home medicines review model* Canberra 2010.
58. Elliott RA, Woodward MC. Medication-related problems in patients referred to aged care and memory clinics at a tertiary care hospital. *Australasian Journal on Ageing*. Sep 2011;30(3):124–129.
59. Miller GC, Valenti L, Britt H, Bayram C. Drugs causing adverse events in patients aged 45 or older: a randomised survey of Australian general practice patients. *BMJ Open*. Oct 10 2013;3(10):e003701.
60. Britt H, Miller GC, Henderson J, et al. General practice activity in Australia 2014–15. General practice series no. 38. Sydney Sydney University Press; 2015.
61. Britt H, Miller GC, Henderson J, et al. General practice activity in Australia 2015–16. General practice series no. 40. Sydney: Sydney University Press; 2016.
62. Benson H, Lucas C, Kmet W, Benrimoj SI, Williams K. Pharmacists in general practice: a focus on drug-related problems. *Int J Clin Pharm*. 2018;40(3):566–572.
63. Hibbert P, Williams H. The use of a global trigger tool to inform quality and safety in Australian general practice: a pilot study. *Australian Family Physician*. 2014;43(10):723–726.
64. Australian Bureau of Statistics. Patient Experiences in Australia: Summary of Findings, 2016–17. 2018; <http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/4839.0~2016-17~Main%20Features~Key%20findings~1>. Accessed 17 October, 2018.

65. Roughead EE, Anderson B, Gilbert AL. Potentially inappropriate prescribing among Australian veterans and war widows/widowers. *Internal Medicine Journal*. Jun 2007;37(6):402–405.
66. Beer C, Hyde Z, Almeida OP, et al. Quality use of medicines and health outcomes among a cohort of community dwelling older men: an observational study. *British Journal of Clinical Pharmacology*. Apr 2011;71(4):592–599.
67. Castelino RL, Hilmer SN, Bajorek BV, Nishtala P, Chen TF. Drug Burden Index and potentially inappropriate medications in community-dwelling older people: the impact of Home Medicines Review. *Drugs & Aging*. Feb 1 2010;27(2):135–148.
68. Price SD, Holman CD, Sanfilippo FM, Emery JD. Are older Western Australians exposed to potentially inappropriate medications according to the Beers Criteria? A 13-year prevalence study. *Australasian Journal on Ageing*. Sep 2014;33(3):E39–48.
69. Australian Bureau of Statistics. Australian Health Survey: Biomedical Results for Chronic Diseases, 2011–12. 2013; <http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/4364.0.55.0052011-12?OpenDocument>. Accessed 21 September, 2018.
70. Chadban SJ, Briganti EM, Kerr PG, et al. Prevalence of kidney damage in Australian adults: The AusDiab kidney study. *Journal of the American Society of Nephrology: JASN*. Jul 2003;14(7 Suppl 2):S131–138.
71. Roughead EE, Kalisch LM, Ramsay EN, Ryan P, Gilbert AL. Continuity of care: when do patients visit community healthcare providers after leaving hospital? *Internal Medicine Journal*. 2011;41(9):662–667.
72. Tenhunen ML, Smithers B, Tucker B. Identifying Medication-Related Adverse Drug Events in Nursing Facilities in East Texas. *Consult Pharm*. 2016;31(8):436–439.
73. Australian Institute of Health and Welfare. Movement between hospital and residential aged care 2008–09. 2013; <https://www.aihw.gov.au/reports/aged-care/movement-between-hospital-and-residential-aged-car/contents/table-of-contents>. Accessed 24 September, 2018.
74. Blackburn J. Re-admission to Fremantle Hospital. Part II - drug-related re-admissions. *Fremantle Hospital Drug Bulletin*. 1991;15:13–16.
75. Hewitt J. Drug-related unplanned re-admissions to hospital. *Aust J Hosp Pharm*. 1995;25:400–403.
76. Greenshields W, Odgers C, Wing LMH. Drug related unplanned hospital re-admissions audit. Paper presented at: Society of Hospital Pharmacists (SHPA) Australian Federal Conference 1997; Adelaide.
77. Stowasser DA, Staatz CE, Stowasser M, Et al. Identifying drug-related re-admissions: Is there a better way of assessing the contribution of adverse medication events? *Aust J Hosp Pharm*. 2000;30:47–53.
78. Easton KL, Parsons BJ, Starr M, Brien JE. The incidence of drug-related problems as a cause of hospital admissions in children. *Med J Aust*. Oct 5 1998;169(7):356–359.
79. Easton KL, Chapman CB, Brien JA. Frequency and characteristics of hospital admissions associated with drug-related problems in paediatrics. *Br J Clin Pharmacol*. May 2004;57(5):611–615.
80. Chan M, Nicklason F, Vial JH. Adverse drug events as a cause of hospital admission in the elderly. *Intern Med J*. May-Jun 2001;31(4):199–205.
81. Lee A, Oldenburg B. A survey of patients with cardiac disease: risk factors for admissions. *Aust J Hosp Pharm*. 1993;23:104–108.
82. Easton-Carter KL, Chapman CB, Brien JE. Emergency department attendances associated with drug-related problems in paediatrics. *J Paediatr Child Health*. Mar 2003;39(2):124–129.
83. Hendrie J, Sammartino L, Silvapulle MJ, Braitberg G. Experience in adverse events detection in an emergency department: nature of events. *Emerg Med Australas*. Feb 2007;19(1):9–15.
84. Lau PM, Stewart K, Dooley M. The ten most common adverse drug reactions (ADRs) in oncology patients: do they matter to you? *Support Care Cancer*. Sep 2004;12(9):626–633.
85. Miller GC, Britth HC, Valenti L. Adverse drug events in general practice patients in Australia. *Med J Aust*. Apr 3 2006;184(7):321–324.



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250,000 hospital admissions annually are a result of medication-related problems. The annual costs for Australia are \$1.4 billion