Prevalence of medication-related risk factors among retirement village residents: a cross-sectional survey

Cik Yin Lee[1], Johnson George[1], Rohan A. Elliott[1,2], Kay Stewart[1]

[1]Department of Pharmacy Practice, Centre for Medicine Use and Safety, Faculty of Pharmacy and Pharmaceutical Sciences, Monash University (Parkville Campus), 381 Royal Parade, Parkville VIC 3052, Australia
[2]Pharmacy Department, Austin Health, Melbourne, VIC, Australia

Address correspondence to: K. Stewart. Tel: (+61) 3 9903 9618; Fax: (+61) 3 9903 9629. Email: kay.stewart@pharm.monash.edu.au

Abstract

Background: information on medication use and risk factors among older people residing in retirement villages and their uptake of medication reviews are scant.
Objectives: to identify medication use issues and risk factors for medication-related problems among retirement village residents and to evaluate the uptake of government-subsidised Home Medicines Review (HMR) services in this population.
Design: cross-sectional, mail survey.
Setting: retirement villages in Victoria, Australia.
Participants: members of the Residents of Retirement Villages of Victoria residing in retirement villages (2,116, aged 54–100 years).
Methods: a questionnaire was developed incorporating validated scales and items to measure medication risk, medication adherence, co-morbidity, disability, information on medication use, health and the uptake of HMR services. Questionnaires were mailed to participants for self-completion and returned using reply-paid envelopes.
Results: of the 2,116 respondents (70.7% response rate), 2,006 (94.8%; 95% confidence interval (CI) 93.9–95.7%) reported using prescribed medications. Three or more health conditions were present in 993 (46.9%; 95% CI 44.8–49.0%) respondents. Five or more regular medications were used by 988 (46.7%; 95% CI 44.6–48.8%) respondents. Twelve or more tablets/capsules per day were used by 229 (10.8%; 95% CI 9.5–12.1%) respondents. The use of narrow therapeutic index medications was reported by 264 (12.5%; 95% CI 11.1–13.9%) respondents. Changes to medication regimens in the previous 3 months were reported by 356 (16.8%; 95% CI 15.2–18.4%) respondents. One or more medication-related risk factors were seen in 1,374 (64.9%; 95% CI 62.9–66.9%) respondents. Of these at-risk residents, 76 (5.5%; 95% CI 4.5–6.5%) reported receiving an HMR in the previous 12 months, who were older ($P < 0.001$), were using more medicines ($P < 0.001$) and had greater disability ($P = 0.002$).
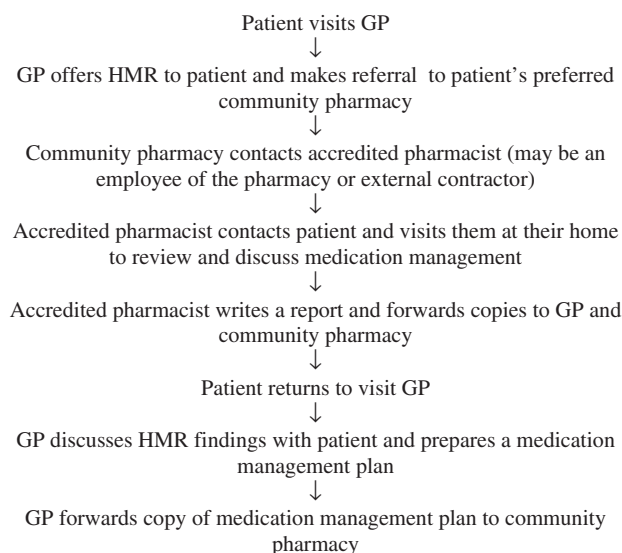**Conclusions:** reasons for the low uptake of medication reviews in retirement village residents despite the high prevalence of medication risk require further investigation.

Keywords: *retirement villages, sheltered housing, older people, medication risk factors, home medicines review, elderly*

Introduction

Retirement villages (similar to sheltered housing in the United Kingdom) provide accommodation for older people who wish to live independently or with limited assistance within a supportive community [1]. Approximately 80,000 Australians reside in retirement villages, and this figure is projected to increase to 300,000 by 2051 [1].

Research on medication use in older Australians living in retirement villages is scant, but a range of medication-related issues and risk factors have been reported in similar populations in the United Kingdom and the United States [2–4]. Multiple chronic health problems, polypharmacy and physiological changes that occur with ageing put many older people at increased risk of adverse medication outcomes [5]. In the only published study of medication use in an Australian re-

581

Patient visits GP
↓
GP offers HMR to patient and makes referral to patient's preferred
community pharmacy
↓
Community pharmacy contacts accredited pharmacist (may be an
employee of the pharmacy or external contractor)
↓
Accredited pharmacist contacts patient and visits them at their home
to review and discuss medication management
↓
Accredited pharmacist writes a report and forwards copies to GP and
community pharmacy
↓
Patient returns to visit GP
↓
GP discusses HMR findings with patient and prepares a medication
management plan
↓
GP forwards copy of medication management plan to community
pharmacy

Figure 1. Steps involved in the HMR process [11].

tirement village population, 41% of residents were using multiple medications, including combinations that could potentially cause drug interactions [6]. However, this study involved only a single retirement village and was conducted nearly 20 years ago. Further research is warranted to explore the nature and extent of medication risk factors among retirement village residents in Australia.

Regular review of medications is part of a quality use of medicines strategy to reduce medication misadventure among people who are at risk [7, 8]. The UK Quality and Outcomes Framework currently includes Medicine Use Reviews (MUR) as part of the primary care framework that aims to optimise medication use and health outcomes for individual patients [8]. In Australia, Home Medicines Review (HMR) is a similar medication management review service that aims to maximise individual patient's benefit from their medication regimen and prevent medication-related problems [7]. HMRs are provided to patients in the community setting. A general practitioner (GP) can initiate an HMR for an at-risk patient by making a referral to an accredited pharmacist to conduct the HMR [9]. There is no charge to the patient, and both the GP and pharmacist are reimbursed by the government for delivering the medication review service [9, 10]. The steps that are involved in a single HMR process are summarised in Figure 1[11]. Uptake of HMRs in the general Australian population has been low — approximately 10% of the eligible general population receive them [12]; the uptake of HMRs in the retirement village population is unknown.

The purpose of this study was to investigate medication use issues and risk factors for medication-related problems among retirement village residents and to assess the uptake of HMRs in this population.

Methods

A cross-sectional survey of retirement village residents in Victoria, Australia was conducted between November 2008 and

January 2009. A four-page, 29-item questionnaire was developed including items on demographics, general health, use of health services, use of medications associated with increased risk of adverse events or drug-related hospitalisations in older people [13–15], and validated scales for measuring co-morbidity (Charlson co-morbidity index) [16], disability (Townsend scale) [17], medication adherence (Morisky scale) [18] and medication risk [Medication Risk Questionnaire (MRQ)] [19]. The Charlson co-morbidity index gives a total co-morbidity score which predicts the mortality rate for a patient who has a range of health conditions, with each health condition scored differently (0, 1, 2, 3 or 6) based on its effect on mortality [16]. A total score of five or more on the Charlson co-morbidity index represents high risk of mortality [16]. The total disability score on the Townsend scale ranges between 0 and 18, with a higher score representing a greater degree of physical disability [17]. The total score on the Morisky scale ranges between 0 and 4, and a score of less than 4 represents nonadherence [18]. Medication risk was assessed using five items of the MRQ that have been consistently associated with an increased risk of adverse medication events [3, 19]. Face and content validity of the questionnaire were reviewed and established by a panel of academics and practising pharmacists ($n = 7$). The questionnaire was pilot tested in a sample of five older people.

The self-completed anonymous questionnaire, plain language statement and reply-paid envelope were sent to all members ($n = 2,442$) of the Residents of Retirement Villages of Victoria (RRVV), along with the RRVV newsletter. RRVV is an organisation representing the needs and interests of residents of retirement villages in Victoria; approximately 10% of retirement village residents in Victoria are members of the RRVV. Additional copies of the questionnaire ($n = 568$) were sent to addresses having two residents according to the RRVV database, giving a total of 3,010 questionnaires. A reminder was sent with the next issue of the newsletter to all RRVV members 6 weeks after the initial mail out. The cut-off date for survey responses was set at 14 weeks after the initial mail out.

The study was approved by the Monash University Standing Committee on Ethics in Research involving Humans.

Statistical analysis

Responses were analysed using Statistical Package for the Social Sciences (SPSS), version 15.0 (SPSS Inc., Chicago). Categorical variables are presented as frequencies and proportions and continuous variables as means and standard deviation, or medians and range for skewed data. Data are reported with 95% confidence intervals (CI), where relevant.

Univariate analysis was performed to compare characteristics of the HMR vs non-HMR subjects. Student's *t*-test was used for normally distributed continuous variables, Mann–Whitney test for non-normally distributed continuous variables and Chi-square test for categorical variables; *P*-value < 0.05 was considered statistically significant. The

retirement village population in Victoria is estimated to be 25,000 [20]. A minimum of 268 responses was required for each item in the questionnaire to provide data with 90% confidence level and 5% margin of error.

Results

Responses were received from 2,140 residents; 15 questionnaires were returned to the researchers due to residents having moved or being deceased; 855 questionnaires were not returned at all. Twenty-four questionnaires were incom-

Table 1. Demographic and medication use features of respondents (n = 2,116)[a]

Study variable	Study sample n (%)[a]
Living alone	
Yes	1,007 (47.6)
No	1,088 (51.4)
Living arrangement	
Independent living/self-care unit	2,077 (98.2)
Assisted living/serviced unit	28 (1.3)
Location of residence	
Metropolitan	1,641 (77.6)
Regional/rural	434 (20.5)
Self-reported general health	
Excellent	115 (5.4)
Very good	656 (31.0)
Good	847 (40.0)
Fair	417 (19.7)
Poor	59 (2.8)
Number of prescribed medications taken on a regular basis	
0	104 (4.9)
1–2	485 (22.9)
3–4	601 (28.4)
5–6	449 (21.2)
7–8	197 (9.3)
9–10	98 (4.6)
>10	67 (3.2)
Number of prescribed medications taken as needed	
0	569 (26.9)
1–2	595 (28.1)
3–4	81 (3.8)
≥5	35 (1.7)
Adherence based on Morisky score[b]	
1	11 (0.5)
2	91 (4.3)
3	397 (18.8)
4	1,321 (62.4)
Number of medication-related risk factors[c]	
0	634 (30.0)
1	396 (18.7)
2	411 (19.4)
3	236 (11.2)
4	118 (5.6)
5	17 (0.8)
Receiving assistance with taking medications	
Yes	81 (3.8)
No	1,969 (93.1)

[a]Not all responses add up to 2,116 due to missing responses.
[b]Morisky score = 4 represented adherence; <4 represented nonadherence.
[c]Medication-related risk factors based on the five-item MRQ.

Table 2. Use of medications associated with increased risk of adverse events or drug-related hospitalisations in older people (n = 2,116)[a]

Types of medications	Study sample n (%)[a]
Antihypertensives	1,302 (61.5)
Antiplatelet agents	1,050 (49.6)
Non-steroidal anti-inflammatory drugs	440 (20.8)
Opioid analgesics	431 (20.4)
Hypnotics	399 (18.9)
Diuretics	338 (16.0)
Antidepressants	290 (13.7)
Warfarin	193 (9.1)
Oral corticosteroids	154 (7.3)
Oral hypoglycaemics	151 (7.1)
Anxiolytics	115 (5.4)
Digoxin	115 (5.4)
Insulin	44 (2.1)
Amiodarone	42 (2.0)
Antiparkinsonian agents	40 (1.9)
Methotrexate	36 (1.7)
Oxybutynin/propantheline	31 (1.5)
Carbamazepine	15 (0.7)
Nitrofurantoin	12 (0.6)
Antipsychotics	10 (0.5)
Phenytoin	11 (0.5)
Lithium	6 (0.3)

[a]Responses do not add up to 2,116 due to some respondents taking more than one of these medications.

plete and were excluded, leaving 2,116 (70.7%) questionnaires included in the analysis.

Demographic details and medication use features of the sample are shown in Table 1. The mean age of respondents was 78.6 (SD 6.7) years (range 54–100 years), and 1,253 (59.2%) were females. In the previous 3 months, 1,910 (90.3%; 95% CI 89.0–91.6%) respondents visited their GP and/or specialist at least once. The median number of GP and/or specialist visits was 2 (range 0–30). In the previous 12 months, 435 (20.6%; 95% CI 18.9–22.3%) respondents self-reported having one or more unplanned hospitalisations. Sixty-eight (3.2%; 95% CI 2.5–4.0%) respondents scored 5 or more on the Charlson co-morbidity index (median score 1, range 0–8) and hence had a high risk of mortality. Two hundred and seven (9.8%; 95% CI 8.5–11.1%) respondents scored 7 or more on the Townsend disability scale, indicating appreciable to very severe disability (median score 1, range 0–18).

The use of prescribed medication(s) was reported by 2,006 (94.8%; 95% CI 93.9–95.8%) respondents. The median number of prescribed medications taken on a regular basis was 4 (range 0–20); and on an 'as-needed' basis was 1 (range 0–13). The use of non-prescribed medication(s) was reported by 1,203 (56.9%; 95% CI 54.8–59.0%) respondents. There were 199 (9.4%; 95% CI 8.2–10.6%) respondents who reported experiencing an adverse drug reaction (ADR) from their medication(s) at the time of the study. Moreover, 1,884 (89.0%; 95% CI 87.7–90.3%) respondents reported taking at least one medication known

to be associated with an increased risk of adverse events or drug-related hospitalisations in the elderly (Table 2). Nonadherence to medications was seen in 499 (23.6%; 95% CI 21.8–25.4%) respondents. The median score on the Morisky scale was 4 (range 1–4).

According to the five-item MRQ, 993 (46.9%; 95% CI 44.8–49.0%) respondents reported taking medications regularly for three or more health conditions; 988 (46.7%; 95% CI 44.6–48.8%) reported taking five or more regular medications; 229 (10.8%; 95% CI 9.5–12.1%) reported taking 12 or more tablets or capsules a day; 264 (12.5%; 95% CI 11.1–13.9%) reported taking at least one narrow therapeutic index medication, such as warfarin, digoxin, lithium, phenytoin or carbamazepine; and 356 (16.8%; 95% CI 15.2–18.4%) reported having had changes to their medication regimen in the previous 3 months. One or more of these risk factors for medication-related problems were seen in 1,374 (64.9%; 95% CI 62.9–66.9%) respondents.

Of the 1,374 at-risk respondents, 313 (22.8%; 95% CI 21.05–24.6%) knew about the HMR service. Although 1,291 (94.0%; 95% CI 93.0–95.0%) of these at-risk respondents reported having regular visits to doctors or specialists in the previous 3 months, only 76 (5.5%; 95% CI 4.5–6.5%) reported receiving an HMR in the previous 12 months. Only 12 (6.0%; 95% CI 5.0–7.0%) of the 199 respondents who reported experiencing an ADR at the time of the study reported receiving an HMR.

In univariate analysis, the characteristics of at-risk residents who had received HMRs ($n = 76$) were compared with those of their counterparts ($n = 1,288$) (Table 3). There were significant differences in the following factors between the HMR vs non-HMR subjects: age ($P < 0.001$), number of prescribed medications taken on a regular basis ($P < 0.001$), self-collecting medications from the pharmacy ($P < 0.001$), disability scores ($P = 0.002$), use of one or more strategies to help remember taking medications ($P = 0.003$), seeing one or more doctors/specialists to obtain prescriptions ($P = 0.005$), use of non-solid and oral dose forms ($P = 0.006$), times seen by doctor/specialist in the previous 3 months ($P = 0.008$), have had a pharmacist speak with them about current medications ($P = 0.012$) and number of medication-related risk factors ($P = 0.035$). Multivariate analysis was not possible due to the small number of subjects in the HMR group.

Discussion

This is the first large scale study on medication use, medication risk and the uptake of medication review services among Australian retirement village residents. A high prevalence of medication-related risk factors, but a very low uptake of medication review services was identified in this group. Nearly two-thirds of respondents reported one or more risk factors for adverse medication events, and one in ten reported that they were experiencing an ADR at the time of the survey; however, about one in twenty of these at-risk residents had received a pharmacist-conducted HMR in the previous 12 months. At-risk residents who had a pharmacist-conducted HMR were older, frailer and sicker than their counterparts with medication-related risk factors.

There is evidence that the use of five or more medications (polypharmacy), 12 or more medication doses per day, medications with narrow therapeutic index, medication regimen changes, presence of three or more concurrent disease states (multiple co-morbidities) and having scores of five or greater on the Charlson co-morbidity index are associated with an increased risk of adverse medication outcomes and hospital admissions among older adults [3, 5, 15, 19]. The extent of self-reported ADRs in this study is consistent with that reported in the literature [21]. The use of cardiovascular medications, antiplatelet agents, non-steroidal anti-inflammatory drugs, opioid analgesics, hypnotics, antidepressants, anticoagulants, corticosteroids, oral hypoglycaemics, psychotropic agents, antiparkinsonian agents and anticonvulsants is associated with an increased risk of ADRs resulting in hospitalisations among older adults [5, 13, 22]. ADRs have been reported to cause 10 to 20% of unplanned hospital admissions in the elderly [5]. Nonadherence has been identified as a common cause of therapeutic failure leading to hospitalisations [23]. The association between disability and unplanned hospitalisation is also well established [3]. The majority of respondents in this study had one or more of these risk factors for adverse outcomes.

A multidisciplinary service model involving GPs and pharmacists delivering medication reviews to patients at risk of medication misadventure in the Australian community has been shown to have positive trends in clinical outcomes and costs [24]. A recent study demonstrated that HMRs resulted in a 45% reduction in the rate of hospitalisation for heart failure among the veterans who had received an HMR [25]. Pharmacist-conducted home-based medication reviews in older adults in the United Kingdom have been shown to result in improved patient knowledge and medication adherence [26]. Medication reviews performed by pharmacists for at-risk older adults in the United Kingdom and Australian primary care settings have resulted in identification and resolution of a significant number of medication-related problems [27, 28]. Such a collaborative medication review service model may have substantial effects on medication misadventure risk reduction and patient care [24, 25, 27, 29].

The UK National Prescribing Centre and National Service Framework for Older People recommend targeting older people or those who are at risk of adverse medication outcomes for MUR and require an annual review in those over 75 years [8, 30]. Similarly, the Australian Pharmaceutical Advisory Council recommends targeting those who are at risk of adverse medication outcomes for HMR [7]. The National Prescribing Service recommends an annual medication review as part of the annual health assessment for older people [29].

The five-item MRQ used to assess medication risk in our study closely resembles the UK MUR criteria [8], and the HMR eligibility criteria that are used by Australian GPs to

Table 3. Univariate comparison between HMR vs non-HMR subjects among the at-risk group of residents ($n = 1,374$)[a]

Study variable	Received HMR sample ($n=76$)	No HMR sample ($n = 1,288$)	P-value
Age Mean (SD) years	81.24 (5.18)	78.75 (6.53)	0.000
Male n (%)	30 (39.5)	521 (40.5)	0.940
Living alone n (%)	42 (55.3)	621 (48.2)	0.271
Living in independent living units n (%)	74 (97.4)	1250 (97.0)	0.373
Location — metropolitan n (%)	61 (80.3)	992 (77.0)	0.256
Receiving government pensions n (%)	63 (82.9)	1021 (79.3)	0.237
Self-reported general health based on scale[b] Median (IQR)[c]	3 (2–4)	3 (3–4)	0.104
Times seen by doctor in last 3 months Median (IQR)[c]	3 (2–6)	3 (2–4)	0.008
Number of unplanned hospitalisations in last 12 months Median (IQR)[c]	0 (0–1)	0 (0–1)	0.093
Co-morbidity score based on Charlson index[d] Median (IQR)[c]	2 (1–3)	2 (1–3)	0.129
Disability score based on Townsend scale[e] Median (IQR)[c]	3 (1–6)	2 (0–4)	0.002
Number of prescribed medications taken on a regular basis Median (IQR)[c]	6 (5–8)	5 (4–7)	0.000
Number of prescribed medications taken as needed Median (IQR)[c]	1 (0–2)	1 (0–2)	0.776
Taking non-prescribed medications n (%)	45 (59.2)	735 (57.1)	0.699
Taking non-solid and oral dose forms n (%)	55 (72.4)	728 (56.5)	0.006
Experiencing adverse drug reaction(s) n (%)	10 (13.2)	161 (12.5)	0.914
Taking ≥1 medications associated with increased risk of adverse events/drug-related hospitalisations in elderly n (%)	76 (100.0)	1254 (97.4)	0.395
Adherence score based on Morisky scale[f] Median (IQR)[c]	4 (3–4)	4 (3–4)	0.264
Number of risk factors for five-item MRQ[g] Median (IQR)[c]	2 (1–3)	2 (1–3)	0.035
Receiving assistance with taking medications n (%)	4 (5.3)	72 (5.6)	1.000
Using ≥1 strategy to remember to take medications[h] n (%)	54 (71.1)	681 (52.9)	0.003
Having ≥1 difficulties with using medications[i] n (%)	36 (47.4)	468 (36.3)	0.070
Seeing >1 doctor to obtain prescriptions n (%)	38 (50.0)	456 (35.4)	0.005
Using >1 pharmacy to get prescriptions n (%)	5 (6.6)	158 (12.3)	0.193
Pharmacist has spoken to patient about their current medications n (%)	55 (72.4)	769 (59.7)	0.012
Collecting own medications from pharmacy n (%)	46 (60.5)	1031 (80.0)	0.000
Experiencing difficulties taking medications as instructed by doctor n (%)	3 (3.9)	44 (3.4)	0.740
Not knowing the reason taking medication(s) n (%)	3 (3.9)	34 (2.6)	0.499

[a]Not all responses add up to 1,374 due to missing responses.
[b]Self-reported health rating scale: 1=Excellent; 2=Very good; 3=Good; 4=Fair; 5=Poor.
[c]IQR represents interquartile range.
[d]Charlson co-morbidity score — higher score represents greater risk of mortality.
[e]Townsend disability score — higher score represents greater physical disability.
[f]Adherence score — higher score represents greater adherence.
[g]Medication-related risk factors based on the five-item MRQ.
[h]Things help to remember taking medications — Webster/blister pack or dosette/pill box, medication list/reminder chart, alarm/beeper and calendar/diary.
[i]Difficulties with using medications — opening containers, using puffers or patches, getting to doctor/pharmacy when medicines run out, understanding different brands of medicines, reading and understanding labels, remembering doses and swallowing medicines.

identify people at risk of medication-related problems in order to make an HMR referral [7]; therefore, the majority of respondents in our study would qualify for an HMR. However, the uptake of HMRs was low despite the majority of respondents having regular visits to their doctors. Reasons for underutilisation of HMR services could include GP's lack of belief in the benefits of pharmacist-conducted HMRs, especially when evidence for the benefits of pharmacist medication review is inconclusive [11]. Workforce and/

or workload issues for GPs and poor awareness among the general public about the HMR service might also have contributed to the low uptake [11].

Our study has some strengths and limitations. The high response rate and large sample size suggest that our findings could be generalised to all retirement village residents and people living in similar settings; however, only RRVV members were included in the study, because RRVV was the only organisation that had a database of retirement village resi-

dents at the time of study. It may be that RRVV members are likely to represent a highly motivated group of retirement village residents. In addition, the fact that very few residents from assisted living units responded makes the results less relevant to people in assisted living units; however, residents in assisted living units tend to be older, have poorer health and take more medications [6, 31]. Hence, the extent of medication risk observed is likely to be an underestimation. The demographic characteristics of our study participants were similar to those of retirement village residents in general [6, 31], but it is possible that RRVV members had different socioeconomic features, such as education and income compared to their non-member counterparts, but those measures were not included in our questionnaire. Lastly, we relied on resident self-report and we cannot confirm its accuracy.

Our findings suggest that the screening of medication-related risk factors in retirement village residents requires improvement. Interventions for increasing the uptake of medication review services in retirement villages should also be explored. A simpler and more efficient screening/referral process for HMR using the expertise of trained non-medical professionals or pharmacist-initiated medication reviews (similar to the process that currently exists in Australian nursing homes) are possible solutions. Future studies should develop and test such screening programmes and interventions.

Conclusions

The majority of residents in retirement villages were potentially at risk of medication misadventure. Despite the high prevalence of medication-related risk factors, relatively few residents had received a government-subsidised HMR in the previous 12 months. The reasons for the current poor uptake of HMRs in this group, and strategies for increasing uptake, require further investigation.

Key points

- Older people are at increased risk of adverse medication outcomes.
- Data on medication use and risk factors among older people residing in retirement villages and their uptake of medication reviews are scant.
- In this study, two-thirds of retirement village residents had at least one risk factor for adverse medication events, but less than 10% had received a medication review service.
- The poor uptake of medication reviews in older people requires further investigation.

Acknowledgements

We thank RRVV officers for their assistance with the survey, the Council on the Ageing Victoria for their advice and support in endorsing the survey, Prof. Colin Chapman for advice on the survey methodology, RRVV members who participated in the survey and the National Health and Medical Research Council for the scholarship support.

Conflicts of interest

None declared.

Funding

References

1. Towart L. Retirement villages: a sunset industry in a sunrise situation. Australian Property Journal 2005; 38: 350–61.
2. Dischler JE, Plein JB, Plein EM. Pharmacists' consultations sought by residents of a retirement community. J Am Pharm Assoc 2001; 41: 709–17.
3. George J, Munro K, McCaig D, Stewart D. Risk factors for medication misadventure among residents in sheltered housing complexes. Br J Clin Pharmacol 2007; 63: 171–6.
4. Raehl CL, Bond CA, Woods T, Patry RA, Sleeper RB. Individualized drug use assessment in the elderly. Pharmacotherapy 2002; 22: 1239–48.
5. Atkin PA, Veitch PC, Veitch EM, Ogle SJ. The epidemiology of serious adverse drug reactions among the elderly. Drugs Aging 1999; 14: 141–52.
6. Mant A, Kehoe L, Eyland A *et al.* Use of medications by the elderly. Aust Fam Physician 1990; 19: 1405–11.
7. Australian Pharmaceutical Advisory Council. Guiding Principles for Medication Management in the Community. Canberra, ACT: Australian Government Department of Health and Ageing. http://www.health.gov.au/internet/main/publishing.nsf/Content/nmp-guide-medmgt-jul06-contents~nmp-guide-medmgt-jul06-guidepr6 (14 May 2009, date last accessed).
8. A Guide to Medication Review 2008. UK: National Prescribing Center (NPC) and Medicines Partnership Programme, Department of Health. 2009. http://www.npci.org.uk/medicines_management/review/medireview/resources/agtmr_web1.pdf (14 May 2009, date last accessed).
9. Medicare Australia. Home Medicines Review (HMR). ACT: Commonwealth of Australia. http://www.medicareaustralia.gov.au/provider/pbs/fourth-agreement/hmr.jsp#N10035 (14 May 2009, date last accessed).
10. Australian Association of Consultant Pharmacy. Medication Review: Home Medicines Review (HMR) and Residential Medication Management Reviews (RMMRs). Canberra, ACT: AACP. http://www.aacp.com.au/cgi-bin/WebObjects/FourpointAACPPortal.woa/1/wa/page?pid=8&wosid=oClhcoSqakMxB8tvfGJizw (20 August 2008, date last accessed).
11. Department of Health and Ageing. Home Medicines Review Program Qualitative Research Project Final Report. Canberra, ACT: Commonwealth of Australia. http://www.health.gov.

au/internet/main/publishing.nsf/Content/hmr-qualitative-re-search-final-report (17 June 2009, date last accessed).

12. Roughead EE. Managing adverse drug reactions: time to get serious. Med J Aust 2005; 182: 264–5.

13. Budnitz DS, Shehab N, Kegler SR, Richards CL. Medication use leading to emergency department visits for adverse drug events in older adults. Ann Intern Med 2007; 147: 755–65.

14. Roughead EE, Gilbert AL, Woodward MC. Medication use by Australian war veterans in residential aged care facilities. Journal of Pharmacy Practice and Research 2008; 38: 14–8.

15. Zhang M, Holman CD, Price SD, Sanfilippo FM, Preen DB, Bulsara MK. Comorbidity and repeat admission to hospital for adverse drug reactions in older adults: retrospective cohort study. BMJ 2009; 338: a2752.

16. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chron Dis 1987; 40: 373–83.

17. McGee MA, Johnson AL, Kay DW. The description of activities of daily living in five centres in England and Wales. Medical Research Council Cognitive Function and Ageing Study. Age Ageing 1998; 27: 605–13.

18. Morisky DE, Green LW, Levine DM. Concurrent and predictive validity of a self-reported measure of medication adherence. Med Care 1986; 24: 67–74.

19. Barenholtz Levy H. Self-administered medication-risk questionnaire in an elderly population. Ann Pharmacother 2003; 37: 982–7.

20. Consumer Affairs Victoria (CAV). CAV Annual Report 2007. Melbourne: CAV. 2007. http://www.consumer.vic.gov.au/ CA256902000FE154/Lookup/CAV_Publications_Annual_ Report_2007/$file/cav_annualreport_2007_chp3.pdf (28 January 2009, date last accessed).

21. Chrischilles EA, Segar ET, Wallace RB. Self-reported adverse drug reactions and related resource use. A study of community-dwelling persons 65 years of age and older. Ann Intern Med 1992; 117: 634–40.

22. Burgess CL, Holman CD, Satti AG. Adverse drug reactions in older Australians, 1981-2002. Med J Aust 2005; 182: 267–70.

23. Kaiser RM, Schmader KE, Pieper CF, Lindblad CI, Ruby CM, Hanlon JT. Therapeutic failure-related hospitalisations in the frail elderly. Drugs Aging 2006; 23: 579–86.

24. Sorensen L, Stokes JA, Purdie DM, Woodward M, Elliott R, Roberts MS. Medication reviews in the community: results of a randomized, controlled effectiveness trial. Br J Clin Pharmacol 2004; 58: 648–64.

25. Roughead EE, Barratt JD, Ramsay E et al. The effectiveness of collaborative medicine reviews in delaying time to next hospitalization for patients with heart failure in the practice setting: results of a cohort study. Circ Heart Fail 2009; 2: 424–8.

26. Lowe CJ, Raynor DK, Purvis J, Farrin A, Hudson J. Effects of a medicine review and education programme for older people in general practice. Br J Clin Pharmacol 2000; 50: 172–5.

27. Gilbert AL, Roughead EE, Beilby J, Mott K, Barratt JD. Collaborative medication management services: improving patient care. Med J Aust 2002; 177: 189–92.

28. Denneboom W, Dautzenberg MG, Grol R, De Smet PA. Treatment reviews of older people on polypharmacy in primary care: cluster controlled trial comparing two approaches. Br J Gen Pract 2007; 57: 723–31.

29. National Prescribing Service. NPS Prescribing Practice Review 7: What is a Medication Review? Australia: NPS Limited, Australian Government Department of Health and Ageing. http://www.nps.org.au/health_professionals/publications/ prescribing_practice_review/editions/archive/Prescribing_ Practice_Review_7 (20 March 2009, date last accessed).

30. Department of Health. Medicines and Older People Implementing Medicines-Related Aspects of the NSF for Older People. London: Department of Health. http://www.dh.gov. uk/en/Publicationsandstatistics/Publications/Publications PolicyAndGuidance/DH_4008020 (18 May 2009, date last accessed).

31. St George RJ, Delbaere K, Williams P, Lord SR. Sleep quality and falls in older people living in self- and assisted-care villages. Gerontology 2009; 55: 162–8.