Medication management at home: medication-related risk factors associated with poor health outcomes

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Abstract

Background: some patients may have medication-related risk factors only identified by home visits, but the extent to which those risk factors are associated with poor health outcomes remains unclear.
Objective: to determine the association between medication-related risk factors and poor patient health outcomes from observations in the patients' homes.
Design: cross-sectional study.
Setting: patients' homes.
Subjects: 204 general practice patients living in their own homes and at risk of medication-related poor health outcomes.
Methods: medications and medication-related risk factors were identified in the patients' homes by community pharmacists and general practitioners (GPs). The medication-related risk factors were examined as determinants of patients' self-reported health related quality of life (SF-36) and their medication use, as well as physicians' impression of patient adverse drug events and health status.
Results: key medication-related risk factors associated with poor health outcomes included: Lack of any medication administration routine, therapeutic duplication, hoarding, confusion between generic and trade names, multiple prescribers, discontinued medication repeats retained and multiple storage locations. Older age and female gender were associated with some poorer health outcomes. In addition, expired medication and poor adherence were also associated with poor health outcomes, however, not independently.
Conclusion: the findings support the theory that polypharmacy and medication-related risk factors as a result of polypharmacy are correlated to poor health outcomes.

Keywords: *medication, risk factors, in-home, elderly*

Introduction

A number of studies have investigated medications and medication-related risk factors in patients' homes [1–6]; however, the medication-related problems found in those studies were not linked to patients' health outcomes.

Other studies have sought to investigate the relationships between a limited number of medication-related risk factors that might be identified by a home visit and adverse health outcomes. Hospital admission secondary to adverse drug reactions was found to be related to the use of two or more pharmacies, while drug side effects were reported as the reason for non-adherence in 35% of patients whose admission was related to non-adherence [7]. Non-adherence also precipitated about 5% of hospital readmissions in geriatric patients previously discharged on three or more drugs prescribed for chronic conditions [8]. Similarly, poor adherence was associated with increased risk of adverse drug events (ADEs) in the elderly [4], and hospital admission due to drug-related problems can result in patient morbidity, mortality and increased health costs [9]. It is possible that other medication-related risk factors identified at home visits could be associated with poor health outcomes, but these medication-related risk factors have not, to date, been extensively studied.

In this study, we assess the relationship between medication-related risk factors and patient health outcomes. Establishing

such relationships might yield indicators for potential poor health outcomes, which, if they were screened for during home visits, could be addressed specifically.

Methods

Consenting patients were visited at home as part of the intervention in a randomised controlled trial of multidisciplinary domiciliary medication reviews [10]. Patients were recruited by General Practitioners (GPs), and GPs were recruited or identified by various sources including articles in GP targeted media, local pharmacists, local nurses and cold calling by project staff. Patients were included in the trial if they satisfied one or more of the following criteria: (i) on five or more regular medications; (ii) taking twelve or more doses of medication per day; (iii) three or more medical conditions; (iv) suspected by GP to be non-adherent with their medication regimen; (v) on medication(s) with a narrow therapeutic index or requiring therapeutic monitoring; (vi) had significant changes made to their medication regimen in the previous three months; (vii) had signs or symptoms suggestive of possible medication induced problems; (viii) had an inadequate response to medication treatment; (ix) admitted to hospital in preceding four weeks; (x) at risk in managing their own medications due to language difficulties, dexterity problems or impaired sight.

Patients were excluded if they were enrolled in other clinical trials of other treatment modalities. Participants were included from Queensland and Victoria, and selected areas in New South Wales and Western Australia. Of the intervention patients, 204 had home visit findings recorded and were used in the current analysis. Results from 61 intervention patients were not included in the current analysis: two died, three withdrew, and one was in hospital when the visit was due. Home visits were not conducted for two patients, while 25 home visit forms were not returned by the home visitor. A further 28 patients were lost to follow up.

Demographic factors were recorded on questionnaires by patients and their GPs during GP visits between 2 September 1999 and 5 February 2000. Home visits were conducted approximately 1–2 weeks after this initial data collection. Pharmacists conducted the home visits in 87.3% of the cases, and GPs in 12.7% of the cases.

The GP recorded impressions about the patient's health, including Duke's Severity of Illness Visual Analogue Scale (DUSOI-A) [11], and changes in the patient's health status and whether the patient had experienced adverse drug events in the preceding three months. The DUSOI-A (a point marked on a 100 mm line) was scored such that a high score indicated higher severity of illness. The patient questionnaire included the SF36 [12]. The mental component scores (MCS) and the physical component scores (PCS) of health-related quality of life were calculated using Australian norms. SF36 subscales and components were scored so that a higher score indicated better health [12].

During the home visit, potential medication-related risk factors such as poor adherence, expired medications, number of prescribers and dispensers for all medications found in the home, medication hoarding, multiple storage locations of medication, lack of a medication administration routine, presence of discontinued medication repeats, and the patient's understanding of generic versus trade names were identified. A proforma was used to guide the capture of observations and impressions and to capture data on all the patient's medications found in the home (patients indicated whether each medication was currently taken). A patient was coded as having therapeutic duplication if the medications found in the home included two or more items containing the same drug or drugs of the same therapeutic class. To define the type of medication duplicated and the risk of potential duplication, each duplicated item was coded as actual or possible. Actual duplication was coded when both medications were currently being taken. Possible duplication was coded when one or more of the medications were not currently being taken. Adherence was measured by using four questions previously constructed to identify poor adherence [11]. If one or more questions were answered positively, the patient was considered as having poor adherence. Hoarding was defined in cases where multiple medications were retained in the home, particularly when medications were no longer required or had expired.

Potential medication-related risk factors not found to be related to other medication-related risk factors, and therefore not included in the results section, were: marital status, inappropriate labelling, occupation, veteran or war widow status, whether or not English was spoken at home. 'Difficulty in getting prescriptions or medications' had a very low prevalence (3.4%) and was therefore excluded from analyses.

As this was an interstate, multidisciplinary study, ethics approval was sought from, and granted by, a range of ethic committees including two hospital, two university and two other research ethics committees.

The statistical methods used in this study were t-test and Pearson's correlation for normally distributed continuous variables; χ^2-test and Fisher's exact test for categorical variables; Spearman's rho and Mann–Whitney test for ordinal and non-normally distributed variables. All analyses were performed using SPSS for windows release 10. Given the interrelationship between variables, multivariate analyses were used to examine relative importance of medication-related risk factors in predicting health outcome. The independent effects on the outcome variables (multivariate analyses) are primarily considered in the current report although additional bivariate relationships are shown in the figures. Only medication-related risk factors where the P value from a bivariate relationship with other medication-related risk factors or health outcomes was less than 0.1 were considered for multivariate analyses. Multiple linear regression was used for continuous, normally distributed health outcome variables ('Number of medications in the home', 'Number of medications taken' and 'Severity of illness') and logistic regression was used for dichotomous health outcome variables ('Worsened health status' and 'Recently experienced ADEs'). A backwards elimination procedure was then used to remove from the model all variables for which the likelihood ratio statistic was not significant. This resulted in the most parsimonious model for each dependent variable. A

significance level of 0.05 was used, but results of statistical analyses approaching significance ($P<0.1$) were also included in the figures and tables. Negative findings were not included in the figures and tables. All the medication-related risk factors were considered *a priori* to potentially impact health outcomes. It was felt, therefore, to be unnecessary to carry out adjustment for multiple comparisons. DUSOI-A recorded by the GP and the patient-completed PCS were highly correlated as were the number of medications in the home and the number of medications taken. Consequently, PCS and DUSOI-A were not used together as independent variables in multivariate analyses nor were the number of medications in the home and the number of medications taken—the best predictor was used.

Results

The 204 patients from whom home visit data were available had an average age of 72.4 years (SD=10.3, range 37–99 years, median=74.0) with 60.8% being female. The patients for whom home visit data were not available were significantly older (mean=76.1, $P=0.017$), but had a similar gender distribution (70.7% female, $P=0.181$) to those with available data. Those patients with available home visit data had, however, a significantly higher severity of illness as measured by DUSOI-A ($P=0.023$) than those without home visit data.

The average number of medications taken per person was 9.9 (SD=4.0, range 3–27). By comparison, an average of 14.7 medications (range 6–37) was found in the homes, although not all were currently taken.

Overall, recent worsening of health status was seen in 55 (27.0%) patients and 51 (25.0%) patients experienced an adverse drug event (ADE) over the preceding 3 months. The mean score for DUSOI-A was 63.6 (SD=20.9, $n=177$). Complete SF36 data were available for 53% of patients. Many patients had failed to fill in all the questions of the SF36, and scores were not calculated for those patients.

Of the medication-related risk factors examined, patients were most frequently confused by generic and trade names (114 (55.9%) patients) while poor adherence was reported by 107 (52.5%). No medication administration routine was found for 56 (27.5%), 43 (21.1%) hoarded medications, 43 (21.1%) retained discontinued medication repeats, 40 (19.6%) had expired medications, and 17 (8.3%) stored their medications in multiple locations. Some 68 (33%) patients risked therapeutic duplication (actual or possible) and some patients had more than one duplicated set of items. For 22 (11%) patients, there was actual doubling up of various brands or types of current medications. When the sets of duplicated items were considered (number of duplicated sets=82), 50.0% represented actual duplication. The most frequently duplicated items were cardiovascular medications although these were predominantly possible duplications in that the patient claimed not to be currently taking one or other of the drugs present in the home. Actual antidepressant duplications involved double dosing of selective serotonin reuptake inhibitors (SSRIs) or combined use of SSRIs and tricyclic antidepressants.

Medications in the home

In the multivariate analysis, patients who had greater numbers of medications in the home were more likely to have therapeutic duplication, hoarding, have greater severity of illness (DUSOI-A) and more likely to be female. Patient confusion between generic and trade names was also independently associated with more medications in the home, and lack of any medication administration routine approached significance (Figure 1).

In multivariate analysis of the number of medications taken, patients taking more medications had greater severity of illness ($P<0.001$) and tended to have multiple prescribers (see Supplementary data on the journal website www.ageing.oxfordjournals.org).

Health outcomes

In multivariate analyses, recent worsened health as reported by a GP had the strongest independent association with greater severity of illness as measured by DUSOI-A (Figure 2), followed by (in descending order of significance) greater number of medications found in the home, not being confused by generic and trade names, and male gender.

Logistic regression showed that patients storing their medication in multiple locations were 4.2 times more likely (95% CI 1.3–13.6) to have recently experienced worsening of their health (Figure 3). Patients who had recently experienced ADEs were 3.5 times more likely (95% CI 1.6–7.7) to have had a recent decline in health status, and for every 10 mm increase in DUSOI-A score (severity of illness), the risk of a recent worsening of health status increased by 30% (Supplementary data).

Discussion

The major findings of this study include the identification of considerable relationships between the medication-related risk factors and health outcomes (Figures 1–3), which supports the theory that polypharmacy and medication-related risk factors as a result of polypharmacy are correlated with poor health outcomes. Medication-related risk factors were also more often related to the number of medications found in the home compared with the number of medications taken according to the patient, suggesting that the former is a better indicator of medication-related risk factors and poorer outcomes.

Number of medications

The average number of current medications taken by the patients in the study was 9.9; whereas the average number of medications found in the home was 14.7. The higher number of drugs found compared with other studies [13] was not unexpected since one of the inclusion criteria was taking five or more regular medications. Medications in the home included vitamins, over-the-counter (OTC) medication, and herbal products taken regularly, plus medication taken 'as needed' (pro re nata) and medication not currently taken. Medications taken by other people living in the home were not included.

Number of medications taken and number of medications found in the home were positively correlated, but the two variables differed in their association with medication-
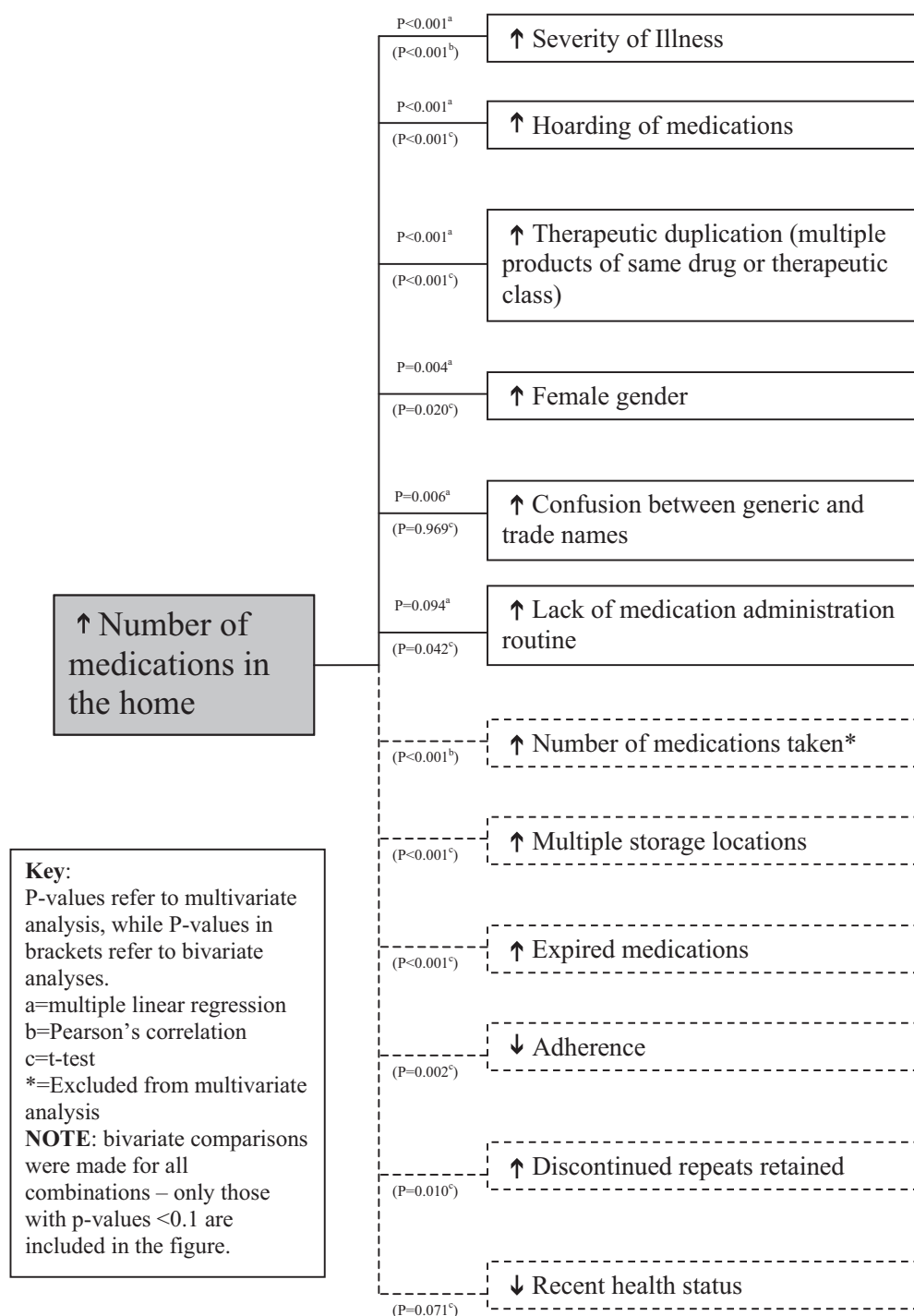
Figure 1. Bivariate and multivariate (general linear model) associations between medication-related risk factors and number of medications in the home. The solid lines indicate multivariate associations while the dotted lines indicate only bivariate associations.

related risk factors. The number of medications taken was bivariately only associated with multiple storage locations, while the number of medication in the home was associated with eight medication-related risk factors, including multiple storage locations. A home visit is therefore essential to identify whether there are medication-related risk factors present in patients' homes, since number of medications taken according to the patient is a poorer indicator of presence of medication-related risk factors. Further investigations are needed to determine the nature of medication-related risk factors associated with the number of medications a patient is taking according to pharmacy and doctor records.

Adverse drug events

In this study, ADEs were reported by GPs for 25% of patients although the actual rate may be higher. There is some
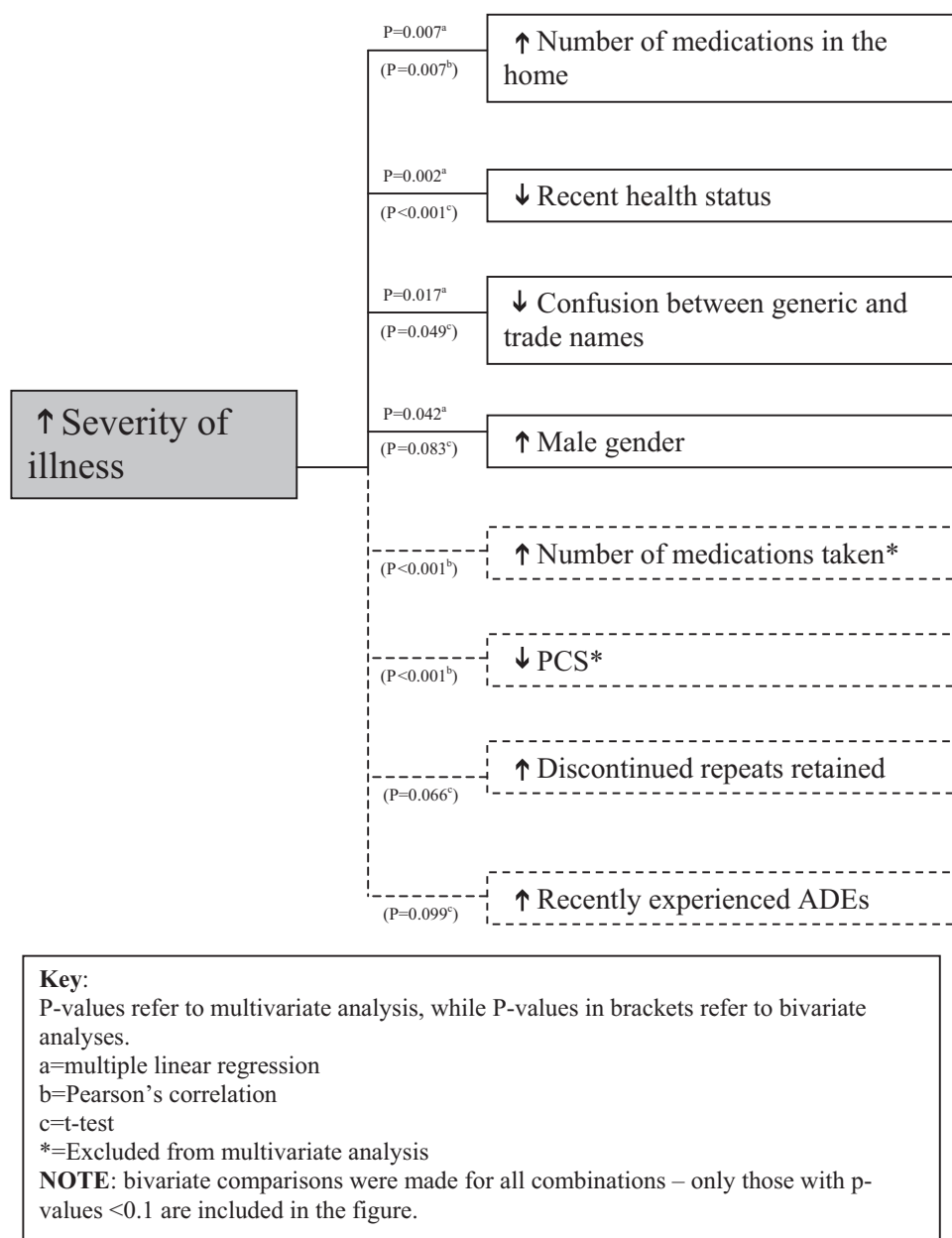
P=0.007[a]
(P=0.007[b])
↑ Number of medications in the home

P=0.002[a]
(P<0.001[c])
↓ Recent health status

P=0.017[a]
(P=0.049[c])
↓ Confusion between generic and trade names

↑ Severity of illness

P=0.042[a]
(P=0.083[c])
↑ Male gender

(P<0.001[b])
↑ Number of medications taken*

(P<0.001[b])
↓ PCS*

(P=0.066[c])
↑ Discontinued repeats retained

(P=0.099[c])
↑ Recently experienced ADEs

Key:
P-values refer to multivariate analysis, while P-values in brackets refer to bivariate analyses.
a=multiple linear regression
b=Pearson's correlation
c=t-test
*=Excluded from multivariate analysis
NOTE: bivariate comparisons were made for all combinations – only those with p-values <0.1 are included in the figure.

Figure 2. Bivariate and multivariate (general linear model) associations between medication-related risk factors and severity of illness. The solid lines indicate multivariate associations while the dotted lines indicate only bivariate associations.

evidence in the literature suggesting that not all ADEs are reported to GPs [14]. Risk of ADEs has been linked to past history of ADEs, multiple diseases [15], renal or hepatic dysfunction [16], increased severity of disease [17], age [15] and increased number of medicines [15]. In the current study, worsened health status was associated with ADEs, while age and polypharmacy were not. However, worsened health status could be associated with renal or hepatic impairment, possibly affecting medication elimination and increasing the risk of ADEs [16]. Alternatively, recent ADEs may have contributed to worsened health status. Previous studies have shown a relationship between increased numbers of drugs and ADEs [15]. The floor effect of the inclusion criteria, that patients were required to take five or more drugs concurrently on a daily basis, may account for the lack of a relationship between drug use and ADEs experienced in the current study. It is also possible that the timeframe for experiencing ADEs in this study was more strict (previous 3 months) than in previous studies.

Physical status

A British study [6] failed to link medication management related problems to age but we found increasing age was linked to expired medications and better adherence. While the average age of patients in the British cohort was not stated, more than half were aged between 75 and 84 years so it might have been more difficult to identify age-related effects due to age homogeneity compared with the current study. Consistent
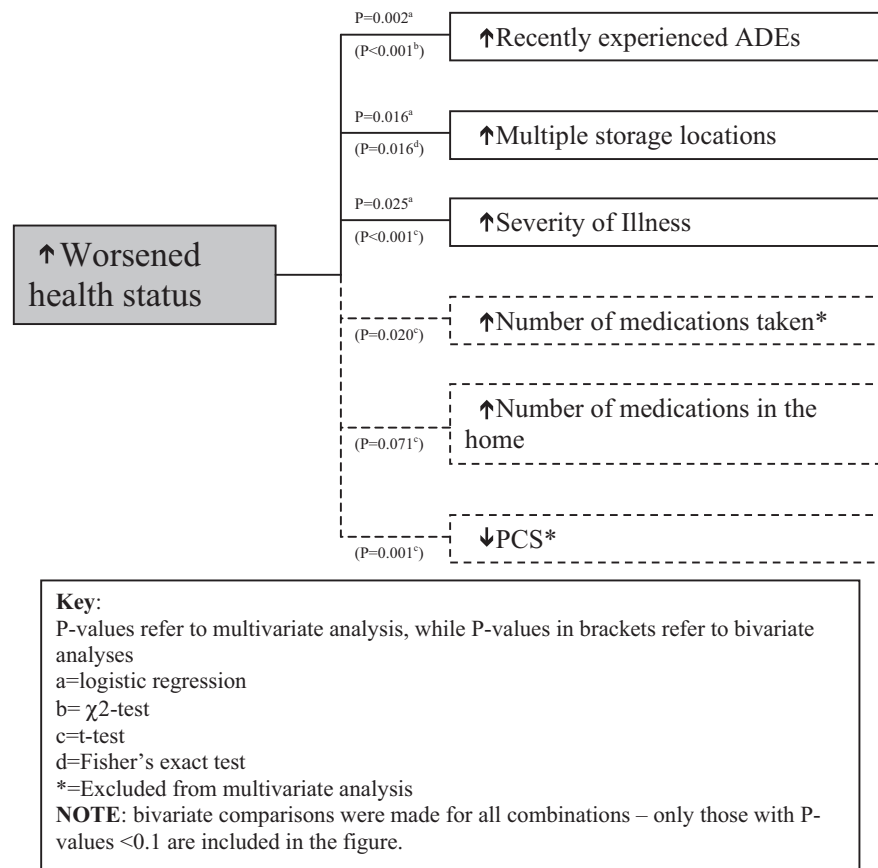
Figure 3. Bivariate and multivariate (logistic regression) associations between medication-related risk factors and recently worsened health status. The solid lines indicate multivariate associations while the dotted lines indicate only bivariate associations

with the British study, however, which found that some medication management related problems were related to physical disabilities independent of age, in our study we found that DUSOI-A was related to medication management problems but not influenced by age.

Limitations of the study

Since this was a cross-sectional study, and risk factors and health outcome data were collected simultaneously, it is difficult to determine whether the medication-related risk factors were affecting health outcomes or whether health outcomes were causing the medication-related risk factors and underlying associations.

The data in this study were collected voluntarily and the home visitors reported variation in ways of obtaining the data. Despite the intervention study continuing after the home visit, it was not possible to obtain home visit data records from all intervention patients. This was primarily due to non-completion of the study by GPs and/or their patients, but also because of health professionals failing to provide the data collection forms for evaluation. The trial participants were scattered throughout four Australian states, and the evaluators had to rely on participating health professionals to return collected data, which in some cases was an ineffective arrangement. Since the

patients for whom home visit data records were not available were older and had a lower severity of illness, it is possible that their enthusiasm for continuing in the trial was not as high.

It is possible that lack of statistical significance in some of the multivariate analyses may have been due to type II errors, i.e. a larger sample of patients might have confirmed some of the bivariate associations that were not significant in the multivariate analyses.

The calculation of the SF36 subscales requires that all questions in the questionnaire relating to the subscale are answered. When a respondent failed to answer as little as one relevant question, the subscale could not be calculated. A comparison of patients, for whom the subscales could be calculated with the rest of the cohort for all variables included in the overall analyses, showed that except for one factor, there were no significant differences between patients with completed SF36 subscales and those not completing all questions in the SF36. Of patients not completing the SF36, 42.3% had worsened health status, compared with 22.4% of those who did complete the SF36 ($P=0.005$).

In summary, medication-related risk factors that are related to poor health outcomes and therefore important to identify at home visits include lack of any medication administration routine, therapeutic duplication, hoarding,

confusion between generic and trade names and multiple storage locations, many of which can be addressed by further intervention or education. In addition, age and gender are also associated with health outcomes. It is important to conduct a home visit, because most of the risk factors cannot be detected by other methods, e.g. by 'brown bag' interviews, and home visits by accredited pharmacists are indeed now funded by the Australian government with the goal of reducing medication related problems [18].

Key points

- Medication-related risk factors identified in the home were associated with poor health outcomes.
- The number of medications found in the home is a better indicator of medication-related risk factors than the number of medications reported as being taken by the patients.

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