

Interventions that can Reduce Inappropriate Prescribing in the Elderly

A Systematic Review

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Abstract

Inappropriate prescribing of medicines may lead to a significant risk of an adverse drug-related event. In particular, prescribing may be regarded as inappropriate when alternative therapy that is either more effective or associated with a lower risk exists to treat the same condition. This review aims to identify interventions and strategies that can significantly reduce inappropriate prescribing in the elderly. The review is based on a search of electronic databases using synonyms of keywords such as ‘elderly’, ‘interventions’, ‘optimized prescribing’ and ‘inappropriate prescribing’ to identify reported interventions intended to improve inappropriate prescribing in the elderly. A total of 711 articles published in English were retrieved and considered. Of these, 24 original studies, involving 56 to 124 802 participants, met the inclusion

criteria and were included in the systematic review. In 16 studies, the statistical power used to assess the impact of the intervention was >90% at a significance level of $\alpha=0.05$.

Various interventions were included in this study, such as educational interventions, medication reviews, geriatricians' services, multidisciplinary teams, computerized support systems, regulatory policies and multi-faceted approaches. Because of variability in assessment methodologies, mixed responses were found for education interventions aimed at improving inappropriate prescribing. For example, some studies did not assess what data were required to define whether a given level of intervention would be adequate, and others did not consider how many participants would be needed to demonstrate that a significant difference existed.

Each of the three computerized support system interventions reported produced a significant enhancement in both prescribing and dispensing practices. Pharmacist interventions in community and hospital settings were evaluated in seven studies. However, variable criteria were used, with two studies using the Medication Appropriateness Index, another two studies using self-designed criteria for inappropriate prescribing, and the remaining three studies using Beers' criteria. A difficulty in assessing studies involving nursing home residents is that both consultant pharmacists and onsite pharmacist services may be involved, and, in one of the studies, only the role of the consultant pharmacist was considered. One of the most effective interventions appeared to be multidisciplinary case conferences involving a geriatrician, which resulted in a number of examples of reduced inappropriate prescribing in both community and hospital settings. As the effect of regulatory policies as an intervention is dependent on the target population involved, the effectiveness of this type of intervention was variable.

Different strategies may be useful in reducing inappropriate prescribing in the elderly. It is not clear whether combined strategies undertaken simultaneously have a synergistic effect.

Inappropriate prescribing encompasses the use of medicines that introduce a significant risk of an adverse drug-related event. In particular, there may be equally effective or more effective therapies that incur a lower risk for treating the same condition.^[1] In addition to inappropriate prescribing, suboptimal use of medications, such as prescribing iron supplements to older anaemic patients, may also lead to a worsening of patient outcomes that can be rectified by appropriate education, review and alterations in medicine use behaviour.^[2,3] People aged >65 years are more vulnerable to medical misadventures, as they have a higher prevalence of chronic illness, disability and dependency than younger people. Older individuals are also more likely to be taking several medicines at once (polypharmacy) to treat

concomitant disease processes and therefore may have an increased risk of adverse drug reactions, drug-drug interactions and drug-disease interactions.^[1] Hence, whilst 12.6% of the US population are aged ≥ 65 years, they account for 33.6% of reported serious adverse events.^[4] Inappropriate medication is therefore one of the main causes of adverse drug reactions in elderly patients.^[5,6]

Improving prescribing quality for older people means reducing irrational and inappropriate prescribing, thereby resulting in better health outcomes. Accordingly, appropriate assessment tools are key elements in defining whether an effective change in prescribing has occurred. Desirably, such tools should also be inexpensive, user-friendly and aimed at assisting clinical judgement in medication selection for the elderly and reducing

inappropriate prescribing. At present there are only two well described assessment tools for inappropriate prescribing in elderly people in the scientific literature that are aimed at regular clinical use, i.e. Beers' criteria^[7] and the improved Inappropriate Prescribing in the Elderly Tool (IPET).^[8] Another prescribing quality assessment tool, the Medication Appropriateness Index (MAI),^[9] which measures overall prescribing quality in ten separate but interrelated domains, does not give precise guidance in relation to specific medicines and therefore has limited application for objectively defining inappropriate prescribing. Beers' criteria, published in 1991, is the most widely used instrument, with IPET used to a lesser extent.^[10]

Three versions of Beers' criteria have appeared to date. The original version was published in 1991 and was developed to identify rates of inappropriate prescribing of certain medications in elderly nursing home populations.^[7] It involved an explicit list of 26 drugs that was agreed to by a consensus panel. A subsequent review of Beers' criteria resulted in the publication of revised Beers' criteria in 1997 for inappropriate medications that included drug-drug interactions and drug-disease interactions.^[11] The list of medications was amended to include more than 50 drugs. The list was subsequently revised again on the basis of the findings of a national consensus panel and reported in 2003.^[12] IPET, sometimes referred to as the 'Canadian Criteria', consists of a list of the 14 most prevalent prescription errors identified from an extensive list of inappropriate prescription instances drawn up by an expert Canadian Consensus Panel.^[13]

Various studies have used either adapted or modified criteria according to their research requirements. For instance, in the US, Beers' criteria^[14] have been used to define inappropriate drugs for the elderly regardless of their place of residence (community or nursing homes). Recently, Beers' criteria have been used in several pharmaco-epidemiological studies conducted in Europe; however, many of the drugs to be avoided on that list are not regularly used in Scandinavia. This is why, for example, the Swedish National Board of Health and Welfare has published a corresponding list tailored to its setting.^[15]

The problem of inappropriate prescribing of medications to older people is widely acknowledged. A recent cross-sectional survey of nursing home records in Australia using Beers' criteria demonstrated that 18.5% of residents were prescribed one or more inappropriate medications and 1.5% of residents were prescribed two or more.^[16] Another study determined that 21.3% of community-dwelling elderly patients in the US received at least one of 33 potentially inappropriate medications.^[17] Data from Canada suggest that 40% of residents in aged care facilities are taking at least one inappropriate drug, with 10% receiving two or more inappropriate medication orders concurrently.^[18] A retrospective cross-sectional study of 2907 elderly patients from eight European countries that analysed use of at least one potentially inappropriate medication according to Beers' and McLeod's^[8] criteria separately and combined documented prevalence rates ranging from 41.1% in the Czech Republic to 5.8% in Denmark.^[19]

In Australia, there are a number of indicators of inappropriate drug use. These include the large quantities of unused medicines collected in the 'Return of Unwanted Medicines' campaign^[20] and studies showing that between 5.7% and 16.6% of all hospital admissions are drug-related events.^[21,22] Further, the South Australian Community Pharmacy Model Practices Project, which aimed to identify and solve medication-related problems and to provide follow-up services to manage medications, showed that, at entry to the project, 90% of patients at high risk of medication misadventure (usually those taking more than four medications) had unresolved health or medication problems, two-thirds of which were medication related.^[23]

Various methods/interventions to decrease inappropriate prescribing have been proposed. A systematic review by Garcia specified five ways to reduce inappropriate prescribing in the elderly: (i) obtain pharmacist recommendations; (ii) use computerized alerts; (iii) review patient medications; (iv) consider using Beers' criteria; and (v) educate patients to improve compliance.^[24] Patient education to improve medication compliance reduces polypharmacy and, therefore, leads to reductions in inappropriate prescribing and adverse events. Furthermore, it has been

suggested that greater involvement of pharmacists in patient management lessens hazards and reduces costs. The second community pharmacy agreement in Australia initially funded residential medication management reviews for all permanent residents of accredited aged care facilities. Subsequently, the third community pharmacy agreement in 2000 provided remuneration for pharmacists to conduct medication management reviews in a community setting and to provide consumer medicine information.^[25]

The most important criteria for judging the appropriateness of prescriptions are: (i) the patient's expectation; (ii) scientific and technical rationalism (including the clinical pharmacology of the medicine); and (iii) the general good. The term 'appropriateness' in this review takes into consideration only the scientific and technical rationalism of prescription.^[26] The authors believe this review will increase awareness of, and insight into, the importance of preventing inappropriate prescribing in the elderly. The aim of the review is to identify interventions and strategies that can significantly reduce inappropriate prescribing in the elderly.

1. Literature Search Methodology and Article Selection

The following electronic databases were searched: PubMed (1966 to September 2008), Cochrane databases (1996 to September 2008), International Pharmaceutical Abstracts (1970 to September 2008), EMBASE (1966 to September 2008) and CINAHL (1982 to September 2008). These databases were searched using synonyms of keywords such as 'elderly', 'interventions', 'optimizing prescribing' and 'inappropriate prescribing'. Reference lists of retrieved articles were checked for additional studies not identified in the original database searches.

1.1 Inclusion Criteria

Studies published in English that reported interventions intended to improve inappropriate prescribing in the elderly were considered. Patients aged ≥ 65 years were considered as elderly and all

studies with an average patient age ≥ 65 years were included in the review. Various interventions such as educational intervention, medication reviews, geriatricians' services, multidisciplinary teams, computerized support systems and regulatory policies were included. The following study designs were also included: randomized controlled trials, prospective studies, cohort studies, surveys, and retrospective and prospective case series.

1.2 Exclusion Criterion

If the abstract clearly indicated that the study did not relate to an intervention intended to improve inappropriate prescribing, the study was excluded at that point.

1.3 Assessment of Study Quality

All studies were classified according to type of intervention used to reduce inappropriate prescribing. The studies were evaluated on the basis of study design, sample size, intervention type, outcome measures, and significant outcomes.

2. Findings

2.1 Population Demographics in Retrieved Articles

A total of 711 articles were retrieved, of which 24 met the inclusion criteria and avoided the exclusion criterion and were therefore included in the review (figure 1). The number of participants in these studies ranged from 56 to 124 802, and 18 studies had a statistical power $>90\%$ with a significance level of $\alpha=0.05$ to show the impact of the intervention used.

This review includes elderly populations from different healthcare settings. Ten studies were conducted in outpatient settings,^[27-36] eight were from nursing homes, hospitals and residential aged care facilities,^[16,37-43] and three compared inappropriate drug prescribing on admission to hospital, at discharge and at follow-up of patients after discharge.^[44-46] One study compared patients in the community versus those in nursing homes,^[47] and another included patients transferring from hospital to a long-term care facility.^[48] An additional study included both inpatients

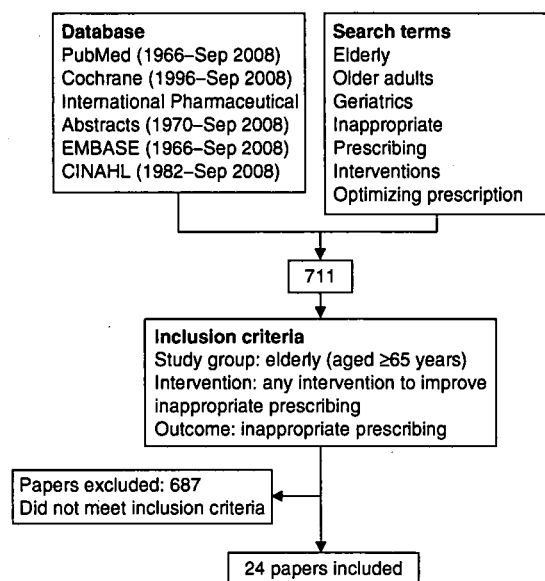


Fig. 1. Schematic diagram of the literature search.

and outpatients from the geriatric unit of a US Veterans Affairs hospital.^[49] The mean age of all patients ranged from 69 to 85 years. However, five studies did not mention an average age of patients, although all of these studies provided an age range: two studies^[36,46] mentioned that patients aged ≥ 65 years were included, two studies^[28,34] mentioned elderly patients were included and one study^[41] referred to patients aged ≥ 75 years.

2.2 Criteria for Inappropriate Prescribing

Various process measures were used to identify inappropriate prescribing. Eleven of the 24 studies used self-developed or adapted criteria to identify inappropriate medications;^[27,28,30,31,33–35,37,43,45,46] all other studies appeared to use robust and validated criteria. These included Beers' criteria (seven studies),^[16,36,39–41,44,47] the MAI (four studies),^[29,38,48,49] and a combination of Beers', MAI, Assessing Care of Vulnerable Elders (ACOVE) and the Zhan and Kaiser criteria (two studies).^[32,42]

2.3 Interventions Used

The 24 studies that met the criteria for inclusion in the review contained seven different categories of intervention (figure 2). An educational inter-

vention was used in four studies,^[28,31,33,36] three used a computerized support system,^[30,32,35] seven were based on pharmacist intervention^[29,39,40,44–46,48] and a geriatric medicine service approach was undertaken in a further three investigations.^[38,41,49] A multidisciplinary team approach, which consisted of a geriatrician or physician and other healthcare providers with specialized geriatrics training (e.g. nurse, pharmacist and psychiatrists), was used in three included studies.^[27,42,43] While a further three studies evaluated the effects of various regulatory policies developed to decrease inappropriate interventions in the elderly,^[16,37,47] only one investigation that used a multi-faceted approach (i.e. a combination of various types of interventions) was available for inclusion in the review.^[34]

2.4 Educational Interventions

Continuing medical education was the most common educational intervention and utilized various techniques, including interactive teaching complemented by a decision algorithm, mailed educational material combined with individualized feedback, and face-to-face visits to physicians. Educational interventions had mixed impacts on inappropriate prescribing (table I). The study by Rahme et al.^[33] showed that interactive workshops had more impact on prescribing of NSAIDs to elderly patients than presenting a physician with a decision algorithm. Presenting general practitioners (GPs) with both the decision algorithm and interactive workshops increased the odds ratio (OR) of impacting on prescribing NSAIDs to elderly patients to 1.5 (95% CI 0.9, 2.3). However, Batuwitige et al.^[28] showed that discussing the results of an audit of prescription of proton pump inhibitors with GPs had no impact on the rates of prescribing proton pump inhibitors.

The best means of promoting adherence to expected recommendations has yet to be determined. Passive dissemination of guidelines to physicians (i.e. circulation of letters discussing the results of an audit) was not effective. Pimlott et al.^[31] provided physicians with feedback on audit data plus evidence-based education sheets

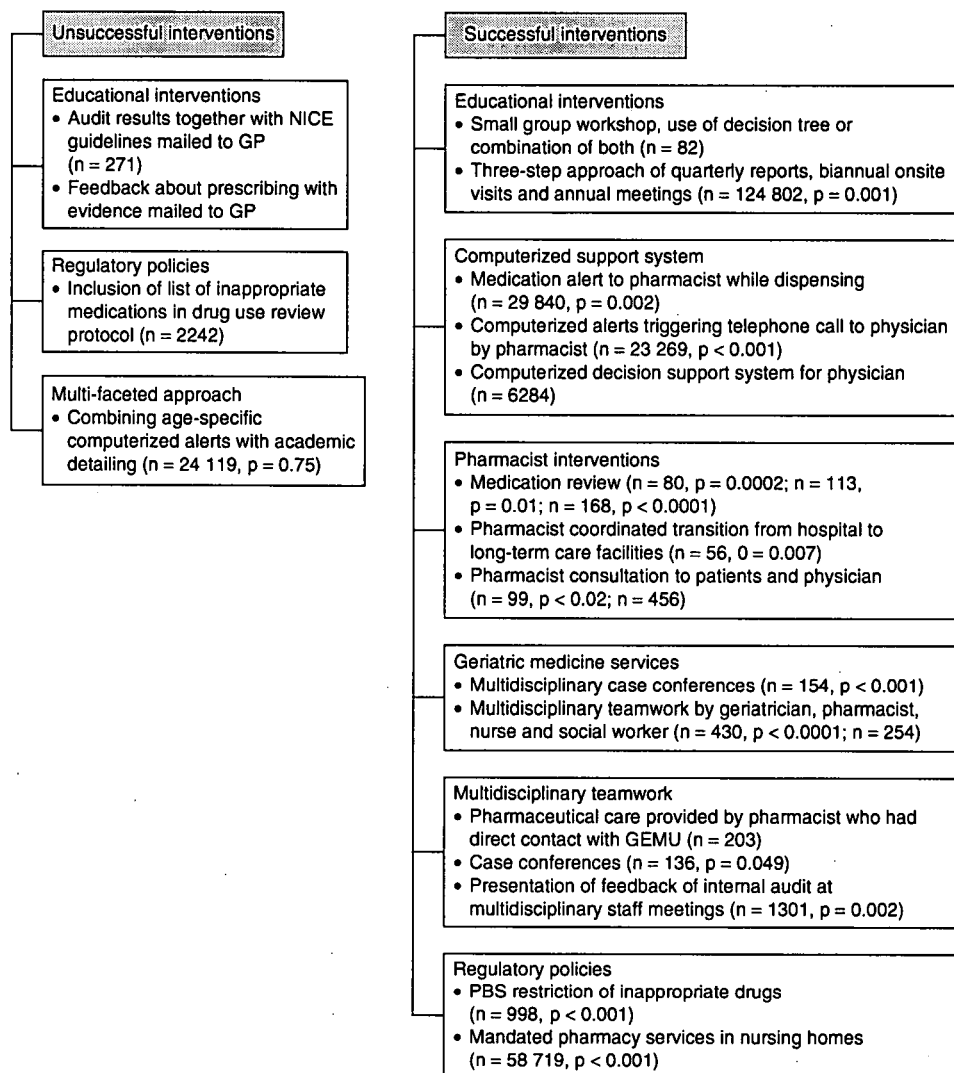


Fig. 2. Types of interventions used to reduce inappropriate prescribing. **GEMU**=geriatric evaluation and management unit; **GP**=general practitioner; **NICE**=National Institute for Health and Clinical Excellence; **PBS**=Pharmaceutical Benefits Scheme.

in an attempt to reduce benzodiazepine use in the elderly but found that this had no clinically significant impact on benzodiazepine prescribing. Wessell et al.^[36] used a three-step approach involving quarterly reports, biannual onsite visits and annual network meetings, and showed that always inappropriate and rarely appropriate¹

medication use decreased over time in this practice-based network study.

2.5 Computerized Support Systems

Three studies evaluated use of a computerized support system to reduce inappropriate

¹ In 1996, the US Medical Expenditure Panel survey divided 33 medications from Beers' criteria into 'always inappropriate', 'rarely appropriate' and 'appropriate for some indications'.

prescribing (table II). Computerized support was used at two different levels: at the prescribing level (computerized decision-making support) and at the pharmacy level (medication alerts/warnings when patients have newly prescribed inappropriate medications). A randomized, controlled trial conducted by Raebel et al.^[32] demonstrated the effectiveness of a computerized pharmacy alert system plus collaboration between health-care professionals for decreasing potentially inappropriate medication dispensing in elderly patients. Another study^[35] showed that computer-based access to complete drug profiles and alerts about potential prescribing problems reduced the occurrence of potentially inappropriate prescriptions. However, there was a more selective effect on the discontinuation of such prescriptions. Further, one study^[30] identified potentially inappropriate drug use in the elderly through a computerized online drug utilization review. A computer alert prompted pharmacists to call the physician to discuss a potential problem and

any therapeutic substitution options. This study demonstrated that this type of intervention can improve suboptimal medication use in the elderly.

2.6 Pharmacist-Based Interventions

Interventions by a pharmacist to influence the prescribing habits of physicians have taken several forms (table III). Active campaigns by pharmacists have sought to alter prescribing in specific areas, and pharmacists have also contributed to establishing drug information services and evidence that doctors find useful. Furthermore, prescription monitoring by pharmacists has led to the amendment of prescriptions that are unclear, erroneous, inadequate or inappropriate.^[50] A study by Hanlon et al.^[29] demonstrated that a clinical pharmacist providing pharmaceutical care for the elderly with polypharmacy in a primary care setting can reduce inappropriate prescribing and possibly avoid adverse drug effects without adversely affecting health-related

Table 1. Effects of continuing medical education on inappropriate prescribing in the elderly

Study (year)	Study design	Number of physicians	Intervention type	Outcome measures	Significant outcomes
Pimlott et al. ^[31] (2003)	Randomized controlled design	Intervention 168, control 206	Mailed packages of feedback about participants' prescribing together with evidence-based education material	Prescriptions of long-acting BZD	Long-acting BZD prescriptions decreased by 0.7% in intervention group and increased by 1.1% in control group ($p=0.036$), which was clinically insignificant
Rahme et al. ^[33] (2005)	Retrospective assessment of prescriptions	Intervention 167, control 82	Three interventions: small group workshop; decision tree reflecting current evidence based guidelines; small group plus decision tree	Score of 0 or 1 was given to prescriptions according to decision tree	The probability of an improvement in workshop and decision group over control was 94% [OR 1.5 (95% CI 0.9, 2.3)], compared with 74% [OR 1.3 (95% CI 0.6, 2.4)] in the workshop group and 55% [OR 1.1 (95% CI 0.6, 1.6)] in the decision tree group
Batuwitage et al. ^[28] (2007)	Prospective study	Intervention 271, control 66	Results of pre-intervention audits were discussed and findings together with NICE guidelines sent to all GPs	Number of patients receiving inappropriate prescription for proton pump inhibitors	No effect on proportion of patients taking proton pump inhibitors at the time of hospital admission or on the appropriateness of prescribing in the community
Wessell et al. ^[36] (2008)	Prospective study	Patients 124 802	Three-step intervention: quarterly practice performance reports then biannual onsite visits and finally annual meetings	Proportion of elderly prescribed with 'always inappropriate' and 'rarely inappropriate' medications	The adjusted absolute annual decline for the comprehensive categories of 'always inappropriate' medications was 0.018% ($p=0.03$) and for 'rarely appropriate' medications was 0.113% ($p=0.001$)

BZD = benzodiazepine; **GPs** = general practitioners; **NICE** = National Institute of Health and Clinical Excellence; **OR** = odds ratio.

Table II. Effects of computerized support systems on reducing inappropriate prescribing in the elderly

Study (year)	Study design	Sample size	Intervention type	Outcome measures	Significant outcomes
Raebel et al. ^[32] (2007)	Randomized controlled trial	Intervention 29 840, usual care 29 840	Medication alert to pharmacist regarding inappropriate prescription	Number of inappropriate medications dispensed to elderly during intervention period of 1 year	Newly dispensed prescriptions for inappropriate medications were 1.8% for intervention group and 2.2% in usual care group ($p=0.002$)
Monane et al. ^[30] (1998)	Cohort design	Patients 23 269	Computerized alerts triggered telephone call to physician by pharmacist	Contact rate with physician and change rate to suggested drug regimen over 1-year period	Contact rate for reaching the physician was 56% and rate of change to a more appropriate therapeutic agent was 24% ($p<0.001$, except for β -adrenoceptor antagonist)
Tamblyn et al. ^[35] (2003)	Cluster-randomized control design	Intervention 6284, control 6276	Physician provided with computerized decision support system	Initiation and discontinuation rates of inappropriate prescriptions	Number of new inappropriate prescriptions was significantly lower compared with control group [RR=0.82 (95% CI 0.69, 0.98)]

RR=relative risk.

quality of life. Lipton et al.^[46] showed similar results when a pharmacist consulted with patients and their physician at discharge from hospital and at periodic intervals post-discharge in an outpatient setting.

In a prospective case series^[40] of 456 residents of assisted living facilities, consultant pharmacists studied the prevalence of potentially inappropriate medications based on Beers' criteria and faxed recommendation letters to physicians for consideration. This intervention led to significant decreases in inappropriate prescribing. Moreover, the intervention presented an opportunity for pharmacists to educate physicians on the risks of using medications that may be potentially inappropriate for geriatric patients. Krska et al.^[45] showed that pharmacist-led medication reviews have the capacity to identify and resolve pharmaceutical care issues, with a consequent reduction in appropriate prescriptions.

Brown and Earnhart^[44] compared the prevalence of inappropriately prescribed medications using Beers' criteria in elderly patients upon admission and at discharge from a teaching hospital. Their work showed that medication review by the pharmacist in an acute care team for the elderly reduced the number of patients being prescribed inappropriate medications upon discharge compared with admission medication regimens.

Elderly patients transferring from hospital to a long-term care facility are vulnerable to frag-

mentation of care and adverse events. In one study, use of a pharmacist transition coordinator was shown to improve aspects of inappropriate use of medicines across health sectors.^[48]

A survey of a nationally representative sample of nursing homes and residents in Baltimore, MD, USA, studied the prevalence of inappropriate medication prescribing and found that the presence of a consultant pharmacist had no effect on potentially inappropriate prescriptions.^[39] However, the extent of the onsite pharmacists' role was not specified in this study and it is therefore uncertain whether this finding adequately reflects the effectiveness of a consultant pharmacist on the quality of prescribing in nursing homes.

2.7 Geriatric Medicine Services

Studies that utilize specialist geriatric medicine services designed to meet the special needs of elderly people and improve the appropriate prescribing in the elderly are outlined in table IV. Schmader et al.^[49] showed that, compared with usual care, outpatient geriatric evaluation and management reduces serious adverse drug reactions, and inpatient and outpatient geriatric evaluation and management reduces suboptimal prescribing, in frail elderly patients. Similarly, multidisciplinary case conferences involving GPs, geriatricians, pharmacists and residential care staff reduce the use of inappropriate medications in residential care.^[38]

Another study showed that patients treated in a geriatrics evaluation and management unit (GEMU) had a statistically insignificant differ-

ence in appropriateness of drug profiles compared with patients in general wards, in terms of prescription of fewer drugs with anticholinergic

Table III. Effects of interventions by pharmacists on reducing inappropriate prescribing in the elderly

Study (year)	Study design	Sample size	Intervention type	Outcome measures	Significant outcomes
Hanlon et al. ^[29] (1996)	Randomized controlled trial	Intervention 88, control 80	Medication review and written recommendations to physician	Prescribing appropriateness (MAI)	MAI declined significantly in interventions vs control group at 3 months (24% vs 6%; $p=0.0006$) and 12 months (28% vs 5%; $p=0.0002$)
Crotty et al. ^[48] (2004)	Randomized controlled trial	Intervention 56, control 54	Medication management transfer summary and medication review by community pharmacist followed by case conference	MAI	At 8-week follow-up, the mean MAI was significantly lower in the intervention group than in the control group (2.5 [95% CI 1.4, 3.7] vs 6.5 [95% CI 3.9, 9.1]; $p=0.007$)
Lipton et al. ^[46] (1992)	Randomized controlled trial	Experimental 123, control 113	Medication review at hospital discharge and at periodic intervals for 3 months post discharge	Major prescribing problems: scheduling, appropriateness, dosage and omitted but necessary therapy	Overall appropriateness of prescribing score differed significantly between experimental (mean \pm SE 0.59 \pm 0.05) and control (0.76 \pm 0.05) group ($p=0.01$)
Kraska et al. ^[45] (2001)	Randomized controlled trial	Intervention 168, control 164	Medication review	Resolution of pharmaceutical care issues and health-related quality of life	Inappropriate dosage regimen was found in 5.7% of intervention group and was resolved in 78.3% cases, whereas, in the control group, inappropriate dosage regimen was found in 6.5% and was resolved in only 17.9% cases ($p<0.0001$)
Lau et al. ^[39] (2004)	Survey	Intervention 1588, control 1814	Weekly onsite availability of consultant pharmacist	Relationship between resident and facility characteristics and potentially inappropriate medication	No significant relationship between potentially inappropriate medication and weekly onsite availability of consultant pharmacist. For intervention group, OR 0.96 (95% CI 0.81, 1.14) and for control group, OR 1.00 (95% CI 1.00, 1.00)
Brown and Earnhart ^[44] (2004)	Retrospective case series	99	ACE team pharmacist consulted all patients	Prevalence of inappropriately prescribed medications according to Beers' criteria	Upon admission, 10.1% were prescribed inappropriate medicines compared with 2.02% on discharge ($p<0.02$)
Rhoads and Thai ^[40] (2003)	Prospective case series	456	Consultant pharmacist identified potentially inappropriate medications and faxed recommendation letters to physician	Prevalence of inappropriate medications based on Beers' criteria and physician acceptance and return rate of recommendations	31.6% prescribed one or more routine or as-required medications considered potentially inappropriate. Of these, 16.7% were discontinued after pharmacist recommendations. The overall return rate of all faxed recommendations was 88.7%

ACE = Acute Care for Elders; MAI = Medication Appropriateness Index; OR = odds ratio; SE = standard error.

Table IV. Effects of geriatric medicine services on reducing inappropriate prescribing in the elderly

Study (year)	Study design	Sample size	Intervention type	Outcome measures	Significant outcomes
Schmader et al. ^[49] (2004)	Randomized controlled trial	Intervention 430, control 404	Multidisciplinary geriatric team care including a geriatrician, social worker and nurse for inpatients and outpatients	Adverse drug reactions and inappropriate drug use (MAI and Beers' criteria)	GEMU was associated with significant reductions ($p < 0.05$) in the number of unnecessary drugs, MAI score and number of inappropriate drugs
Crotty et al. ^[38] (2004)	Randomized controlled trial	Residents 154	Two multidisciplinary case conferences (including a geriatrician, GP, pharmacist and residential care staff)	MAI	Medication appropriateness improved in the intervention group (MAI mean change 4.1 [95% CI 2.1, 6.1]) compared with control group (MAI mean change 0.4 [95% CI -0.4, 1.2]; $p < 0.001$)
Saltvedt et al. ^[41] (2005)	Randomized trial	Patients 254	Multidisciplinary geriatric team care including a geriatrician	Inappropriate drug prescribing according to Beers' criteria	13 (10%) GEMU patients and 12 (9%) medical ward patients prescribed inappropriate medications at inclusion compared with (4%) GEMU patients and 7 (6%) medical ward patients at discharge (statistically insignificant differences)

GEMU = geriatric evaluation and management unit; **GP** = general practitioner; **MAI** = Medication Appropriateness Index.

effects, psychotropic drugs and cardiovascular drugs.^[41]

2.8 Multidisciplinary Team Reviews

Three studies evaluated the effect of multidisciplinary teamwork in improving inappropriate medication prescribing in the elderly (table V). Allard et al.^[27] tested the effectiveness of a team comprising pharmacist/physician pairs and a nurse, and found no effect on the prescribing of potentially inappropriate prescriptions. In another study, pharmaceutical care by a pharmacist who had direct contacts with the GEMU team and patients improved the appropriate use of medicines during the hospital stay and after discharge.^[42] A multidisciplinary intervention^[43] based on audit and feedback at multidisciplinary meetings also improved prescribing; the impact was evident 6 months after the intervention ceased.

2.9 Regulatory Policies

Various regulatory policies have been developed to improve inappropriate prescribing in the elderly (table VI). Provision of pharmacy services is mandated in nursing homes in Canada, where a retrospective cohort study^[47] showed that poten-

tially inappropriate drug therapy in the 'always avoid' and 'rarely indicated' categories was dispensed less frequently to nursing home residents than to older community-dwelling adults. In the US, the Centers for Medicare and Medicaid Services have expanded the drug use review protocol of nursing homes to include a list of inappropriate medications. When data were collected from 3 years of the Medicare Current Beneficiary Survey,^[37] multivariate analysis detected no post-policy differences in inappropriate medications between long-term care facilities with mandatory drug use reviews and those without such reviews. However, another study^[16] conducted by the current authors' group that examined the impact of Australia's national scheme of subsidizing medicines on inappropriate prescribing found that the level of Pharmaceutical Benefits Scheme (PBS) restriction and the percentage of residents prescribed medication were highly correlated. Increases in the level of PBS restriction were associated with a decrease in the prevalence of inappropriate prescribing.

2.10 Multi-Faceted Interventions

The multi-faceted approach combines a number of techniques within a single intervention.

It has been observed that providing the prescriber with a real-time computerized drug alert concerning potentially inappropriate medicines in the elderly results in a decrease in inappropriate prescribing.^[51] Simon et al.^[34] analysed the effect of age-specific computerized alerts alone and in combination with intensive education outreach or academic detailing (table VII). Age-specific alerts resulted in a continuation of the effects of drug-specific alerts without measurable additional effect, but use of age-specific alerts also resulted in fewer false positive alerts for clinicians. Group academic detailing did not enhance the effect of the alerts.

3. Discussion

The optimization of therapy for an individual patient is not a straightforward process, and depends on patient needs and co-morbidities. A major difficulty in optimizing drug therapy for patients is that most data have been derived from randomized controlled studies involving a single drug, and such trials do not always take into account the confounding effects of various co-morbidities and patient preferences. Accordingly, approaches for optimizing prescribing in younger patients might not be applicable to frail elderly patients. Elderly patients usually have several co-

morbidities such as hypertension, myocardial infarction, depression, diabetes mellitus and osteoporosis, which leads to polypharmacy. The objectives of treatment in elderly patients differ from those in younger adults,^[52] which means implementation of guidelines for specific chronic disorders is also not always suited to this population. The randomized controlled trials on which the recommendations and guidelines are based provide evidence of modest reductions in the relative risk of the disease-specific outcomes that are associated with individual medications, and sometimes with combinations of medications. Older patients and those with multiple health conditions have been excluded from many evidence-generating randomized controlled trials, which means the generalizability of the results of these trials to the types of patients who have been excluded from them remains unknown for many medications.^[53]

The studies involving educational interventions showed mixed effects on inappropriate prescribing in the elderly. All four studies used different types of educational interventions and different drug categories, which impacts on the likely effectiveness of these interventions. For instance, Pimlott et al.^[31] studied chronic benzodiazepine prescribing, but we know that physician preferences are easier to change for one-time-only

Table V. Effects of multidisciplinary teamwork on reducing inappropriate prescribing in the elderly

Study	Study design	Sample size	Intervention type	Outcome measures	Significant outcomes
Allard et al. ^[27] (2001)	Randomized controlled trial	Experimental 136, control 130	Team of 2 physicians, pharmacist and a nurse reviewed drug regimen in case conference	Number of PIPs	In intent-to-treat analysis, the OR of the experimental group not having a PIP after intervention was 1.83 (95% CI 0.94, 3.57)
Spinewine et al. ^[42] (2007)	Randomized controlled trial	Patients 203	Pharmaceutical care provided by clinical pharmacist who had direct contacts with GEMU team and patients	Appropriateness of prescribing at admission, discharge and 3 months after discharge using MAI, Beers' criteria and ACOVE	Intervention patients significantly more likely than control patients to have improvements in MAI (OR 9.1 [95% CI 4.2, 21.6]), Beers' criteria (OR 0.6 [95% CI 0.3, 1.1]) and ACOVE underuse criteria (OR 6.1 [95% CI 2.2, 17.0])
Elliott et al. ^[43] (2001)	Quasi-experimental study	Patients 1301	Multidisciplinary feedback on quality of BZD use	Prevalence and appropriateness of BZD prescriptions	6 months after feedback, appropriateness of prescribing improved compared with baseline (50%; $p=0.002$)

ACOVE=Assessing Care of Vulnerable Elders; **BZD**=benzodiazepine; **GEMU**=geriatric evaluation and management unit; **MAI**=Medication Appropriateness Index; **OR**=odds ratio; **PIP**=potentially inappropriate prescription.

Table VI. Effect of regulatory policies on reducing inappropriate prescribing in the elderly

Study (year)	Study design	Sample size	Intervention type	Outcome measures	Significant outcomes
Lane et al. ^[47] (2004)	Retrospective cohort study	Community dwelling 1216 990, nursing homes 58 719	Provision of pharmacy services is mandated in nursing homes of Canada. No comparable programme exists for older adults in community settings	Receipt of at least one potentially inappropriate drug therapy in 'always avoid' or 'rarely appropriate' category	Potentially inappropriate drug therapy less often dispensed to nursing home patients than to older community-dwelling patients (2.3% vs 3.3%; $p < 0.001$)
Briesacher et al. ^[37] (2005)	Quasi-experimental longitudinal study	Nursing homes 2242, assisted living facility 664	CMS in US expanded drug use review protocol to include a list of inappropriate medications (review usually conducted by the consultant pharmacist)	Prevalence and incidence of use of inappropriate medications	Some post-policy declines in nursing home use of potentially inappropriate medications noted but decrease was uneven and could not be attributed to drug use reviews
King and Roberts ^[16] (2007)	Cross-sectional survey in Australia	Nursing homes 998		Prevalence of inappropriate prescribing defined by Beers' criteria and influence of PBS	Correlation between levels of PBS restriction and percentage of residents prescribed inappropriate medications ($\rho = -0.87$; $p < 0.001$)

CMS = Centers for Medicare and Medicaid Services; PBS = Pharmaceutical Benefits Scheme.

drugs such as antibacterials^[54] rather than for long-term drugs such as benzodiazepines. Furthermore, Batuwitage et al.^[28] attempted to influence prescribing of proton pump inhibitors. These are usually perceived as a harmless and relatively inexpensive remedy for a chronic problem, so it is difficult to change physician perceptions about prescribing these drugs. The other two studies^[33,36] showed that educational intervention led to improvements in appropriate prescribing. Both studies evaluated comprehensive educational packages, which included workshops, onsite visits and meetings, whereas the studies by Pimlott et al.^[31] and Batuwitage et al.^[28] used only mailed educational packages. In order to achieve changes in prescribing behaviour, features such as local participation in guideline development, clearly defined behavioural goals, and multi-faceted programmes that enable and reinforce appropriate prescribing and personal contact with the prescriber should be included.

All the studies that used a computerized support intervention showed a positive result, suggesting that these types of interventions can reduce inappropriate prescribing. Tamblyn et al.^[35] illustrated that, even with the magnitude of the challenge of coordinating healthcare for elderly

patients, improvements were achieved by a computerized support intervention. In this study, primary care physicians provided only half of all medical services to their elderly patients, who, on average, also received prescriptions from at least three other physicians and filled those prescriptions at several pharmacies. Raebel et al.^[32] conducted the first randomized study testing an intervention to decrease potentially inappropriate medication prescribing in the elderly in which the intervention occurred at the point of medication dispensing. The resource requirements for merging computer online databases, pharmacist intervention and physician involvement continue to be major constraints.

There were various studies in which pharmacists conducted medication reviews and provided suggestions to physicians to improve appropriate prescribing in the elderly. These results could not be combined because the inclusion criteria differed. For instance, Hanlon et al.^[29] included elderly patients with polypharmacy, which could affect this study's generalizability because as the number of medications increases, the prevalence of inappropriate medications also increases.^[55] The study by Brown and Earnhart^[44] did not include a control group, so its results could not be

combined with those of other studies. In the study by Lau et al.,^[39] it is uncertain whether measuring the relationship between potentially inappropriate prescriptions and the onsite availability of a pharmacist adequately reflected the effectiveness of a consultant pharmacist on the quality of prescribing in nursing homes. Most of the studies included routine medications only, but Rhoads and Thai^[40] included both as-required and routine medications. The results from all except one study^[39] demonstrated that intervention by a pharmacist can lead to improvement in inappropriate prescribing. The extensive clinical training of pharmacists has been underutilized, and clinical pharmacists can enhance the appropriateness of physician's prescribing practices for geriatric patients.

All of the geriatric medicine service interventions led to improvements in appropriate prescribing; however, again, all the studies used different approaches. Schmader et al.^[49] used a multidisciplinary team in which the research assistants created a study chart and then interviewed the patients by phone. Patients who were identified as having drug-related problems were followed up by either a nurse or a pharmacist. Crotty et al.^[38] used multidisciplinary case conferences to reduce inappropriate medications in residential care. Saltvedt et al.^[41] used an interdisciplinary approach in which the comprehensive geriatric assessment and treatment of all relevant illnesses, with a focus on nutritional status and drug elimination, was essential. However, this study did not show statistically significant reductions in inappropriate prescribing. The major limitation is that it was started only 6 months after the GEMU was established, with only one specialist in geriatric medicine employed.

The results of multidisciplinary approaches were mixed. The study by Allard et al.^[27] did not find a significant effect, which is possibly attributable to the fact that it involved a single intervention over a 1-year period. During this period, many events could have occurred over which the investigators had no control but which may have had an impact on the drug profile. In addition, there may have been a lack of consensus between team members on some questions related to drug use.

Simon et al.^[34] hypothesized that addressing barriers to adherence to prescribing alerts through educational intervention would lead to a greater reduction in the use of inappropriate medications. However, the academic detailing was not focused on the prescribing behaviour but rather aimed at enhancing clinicians' acceptance of the prescribing alerts system. This approach appeared not sufficiently potent to further enhance the effect of the computerized alerts, and this multi-faceted approach therefore did not show any improvement in inappropriate prescribing.

There are some potential limitations of this review. Some studies (usually with negative findings) may not have been published, and their data could not be included. A quantitative synthesis (i.e. meta-analysis) could not be conducted because the interventions were significantly heterogeneous with respect to their settings and outcome measures.

In addition, this review focused on inappropriate prescribing. The actual misuse of medicines by patients is likely to be an even more important determinant of drug misadventure. Sorensen et al.,^[3] in a randomized, controlled trial of home medicine reviews by pharmacists, reported that adverse drug reactions (16.9%),

Table VII. Effects of a multi-faceted approach on reducing inappropriate prescribing in the elderly

Study (year)	Study design	Sample size	Intervention type	Outcome measures	Significant outcomes
Simon et al. ^[34] (2006)	Randomized controlled trial	Intervention 24 119, control 26 805	Age-specific alerts raised at time of prescribing inappropriate medication with alternative medication suggested. Academic detailing to clinicians at seven selected sites	Number of times target inappropriate medications dispensed per 10 000 patients per quarter	No apparent effect of group academic detailing intervention and age-specific alerts compared with drug-specific alerts on reducing rates of use of target medication (p=0.52 and p=0.75, respectively)

suboptimal monitoring (16.3%) and drugs not taken as indicated or recommended (12.8%) were more frequent than inappropriate prescribing, whereby a disorder is treated with an incorrect (or suboptimal) drug (9.3%), or an overdosage or sub-therapeutic dosage of the correct drug (9.3%).^[3] Other issues also exist, such as patients sharing medicines with their spouse, neighbours and even their pets,^[56] lack of any medication administration routine, therapeutic duplication, hoarding, confusion between generic and trade names, multiple prescribers, discontinued medication repeats retained, multiple storage locations,^[57,58] use of complementary medicines,^[59] and inadequate communication between the specialist, prescriber and pharmacist.^[23] An old strategy was for the prescriber to include on a prescription the purpose for which the medicine was prescribed to enable more informed feedback to the prescriber from the pharmacist.^[23] In addition, there are issues in continuity of care, whereby prescribing may be undertaken by specialists and, in some places and for limited medications, nurse practitioners and pharmacists. Concordance between what the prescriber may think a patient may be taking and what the patient is actually taking has often been found wanting.^[24] Perhaps the time has come to revisit the proposed strategy of including the purpose for prescribing the medicine on the prescription so that the pharmacist can provide more informed feedback to the prescriber.

4. Conclusions

Prescribing should not be considered as a solitary activity undertaken by a physician in isolation. Communication between specialists, other prescribers and pharmacists with the responsible prescriber is essential for the most rational prescribing of medicines. Also of fundamental importance is communication with the patient, because if the patient is taking medicines that are different from those that were initially intended on prescribing, the potential for adverse consequences escalates. Various interventions that have positively affected prescribing include educational interventions, computerized support systems, medication

reviews by pharmacists, geriatric medicine service approaches, involvement of multidisciplinary teams, and regulatory policies. Combined efforts are necessary to improve the care of patients with complex drug regimens, multiple co-morbidities, and other risk factors for drug-related morbidities. The process of planning to reduce inappropriate prescribing should involve all the stakeholders of the healthcare system, e.g. regulatory policy makers, physicians, pharmacists and other members of the geriatric management team. A comprehensive approach including more than one method to improve inappropriate prescribing in the elderly should be developed.

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