Homecare safety and medication management with older adults: a scoping review of the quantitative and qualitative evidence

Christina M Godfrey RN PhD¹
Margaret B Harrison RN PhD²
Ariella Lang RN PhD³,
Marilyn Macdonald RN PhD⁴
Tina Leung RN⁵
Michelle Swab MA MLIS⁶

1. Deputy Director/Methodologist, The Queen's Joanna Briggs Collaboration for Patient Safety: a collaborating centre of the Joanna Briggs Institute, Queen's University, Kingston, Ontario, Canada (QJBC)
2 Director, The Queen's Joanna Briggs Collaboration for Patient Safety: a collaborating centre of the Joanna Briggs Institute, Queen's University, Kingston, Ontario, Canada (QJBC)
3 VON Canada, 635 Powell Avenue, Town of Mount Royal, Quebec Canada H3R 1L7
4 School of Nursing, Dalhousie University, 5689 University Avenue, Halifax, Nova Scotia, Canada B3H 3J5
5 School of Nursing, Queen's University, Kingston, Ontario, Canada, K7L 3N6
6 Bracken Health Sciences Library, Queen’s University, Kingston, Ontario, Canada, K7L 3N6

Corresponding Author:
Christina M Godfrey
godfreyc@queensu.ca

Executive summary

Background
Healthcare safety is a current national and international priority, and within healthcare safety, one of the most prevalent, high-risk issues is medication safety. While medication safety in general demands consideration, there is a critical gap in our understanding of medication safety in the homecare sector. Understanding what factors contribute to, and/or reduce the risk of adverse drug
events in the home setting will enable the identification and promotion of safer medication administration practices.

**Objectives**

In this review we focused on the pertinent issues specifically related to medication management for individuals living at home and receiving homecare services.

**Inclusion criteria**

**Types of participants**

We considered studies that included older individuals, mean age 65 years or older, who were receiving homecare services.

**Types of intervention(s)/phenomena of interest**

We considered studies that focused on individuals living at home and receiving homecare services and evaluated the process of medication management involving either providers (licensed and unlicensed) or caregivers (family/friends paid or unpaid).

**Types of studies**

We included all quantitative and qualitative research designs.

**Types of outcomes**

The purpose of this review was to map existing literature on this topic and to identify what outcomes were being measured by the current research. Research to date has identified outcomes such as: death, re-hospitalization, emergency room use and adverse drug reactions; adherence; deterioration in primary condition; and experience of medication management (individual report and/or provider/caregiver report).

**Search strategy**

A three-step search strategy was utilized in this review. An initial limited search of MEDLINE and CINAHL was undertaken followed by an analysis of the text words contained in the title and abstract, and of the index terms used to describe the article. A second search using all identified keywords and index terms was then undertaken across all included databases. Thirdly, the reference list of all identified reports and articles were searched for additional studies. Studies published in English and French were considered for inclusion in this review. No date limitation was imposed.

**Methodological quality**

This review is a scoping review to provide a broader picture of the existing literature on this topic. Hence, assessment of methodological quality was not performed to exclude studies based on quality scores.
Data collection

Data was extracted using an expanded extraction tool from the Joanna Briggs Institute Meta-Analysis of Statistics Assessment and Review Instrument (JBI-MAStARI).

Data synthesis

The findings are presented in narrative form including tables and figures to aid in data presentation where appropriate.

Results

Thirty-six studies published in English were included in this review. No French studies were located. Research designs of the included studies are heavily weighted in descriptive designs (n=28), one randomized controlled trial, three controlled before and after designs, three pre-post designs and one qualitative design. There was a single mixed methods study combining results from a pre-post (not controlled) investigation and qualitative focus groups. There was a single qualitative study using interpretive qualitative methods.

Following the three research questions proposed for this review, three main categories were analyzed: issues (including contributing factors and risk factors) (n=21 studies), documented adverse events or errors that occur in the homecare environment (n=13 studies), and strategies or interventions to prevent the occurrence of errors in the homecare environment (n=11 studies).

Conclusions

In this scoping review, we sought to gather information to shed light on the current evidence related to medication management in the homecare setting. This is an area of emerging evidence on both the issue and risks in this context, as well interventions to ameliorate the problems. There was a common theme that did emerge across the study designs with respect to polypharmacy, which is recognized as a significant issue and predictor of medication errors, and/or potential inappropriate medication use. Benefits were reported by two experimental studies with the inclusion of a pharmacist to assess medications: improvements in medication use and increased coordination of information between healthcare providers and individuals. Further evidence describing and substantiating the issues and problems specific to home care and medication management is needed to develop and test appropriate interventions in this setting.

Keyword

medication management; medication mismanagement; medication errors; inappropriate medication; adverse events; homecare (home care); homecare safety
Introduction

Background

Healthcare safety is a current national and international priority, and within healthcare safety, one of the most prevalent, high-risk issues is medication safety. Links in the chain of events necessary for medication safety include assessment, prescription, dispensing and monitoring of medications. A weakness in any one of these essential links or a tenuous connection between links may result in an adverse event and harm to the individual. While medication safety across the healthcare sector in general demands consideration, there is a critical gap in our understanding of medication safety in the homecare setting. Understanding what factors contribute to, and/or reduce the risk of adverse drug events in the home setting will enable the identification and promotion of safer medication administration practices.

Medication safety issues are often compounded for older adults. Management of multiple chronic illnesses as well as multiple care needs increase the complexity of the medication regimens common in the older population. In Canada’s seniors, the total annual cost of preventable drug-related morbidity (PDRM) was estimated to be $11 billion in 2000. In addition, a study by MacKinnon observed that up to one in 11 seniors experienced a PDRM within a two-year period. Many of these lapses in medication safety occur in individuals’ homes. Because of the myriad of issues faced by older homecare recipients, this review focused on medication safety issues for older adults who receive homecare services, their caregivers/families, and providers.

Key definitions

Homecare research and literature is rife with inconsistent terminology related to roles and services. Discussion of medication safety in homecare necessitates clarification of terms. For the purposes of this study, terms have been operationalized as follows:

Caregivers

The term ‘caregivers’ refers to family members or friends in a paid or unpaid role who are responsible for, or charged with, caring for the individual. Family members or friends are identified by the individual as being related through blood, legal or emotional ties, and who may or may not reside in the same home as the individual.

Homecare services personnel

Homecare services encompass the provision of care by a licensed or unlicensed healthcare provider (referred to as a ‘provider’ in this review) who is contracted with a homecare agency. This includes any paid caregiver (regulated or unregulated), with or without training, including personal support workers, home support workers, healthcare aides and lay healthcare workers.

Homecare services

Homecare services include services to address the treatment of any health condition delivered in the client’s/patient’s home, but must specifically address medication management.
Home-dwelling

Home-dwelling includes people living at home, with friends or family, in retirement homes, senior’s apartments, residential centers or communal residences. Different countries use different terms to describe various communal or residential dwellings but for the purpose of this review the focus was on individuals who are receiving homecare as a specific service. Thus, residences providing scheduled healthcare delivery as part of their existing services were excluded from the review.

Adverse/harmful events

Adverse events have been referred to by multiple terms in the literature. For the purpose of this review we have elected to use the definition by Masotti et al., in 2007 (“Events or occurrences, which become apparent during the delivery of home care services and which have a negative or potentially negative impact on: patient care, patient outcomes, family or support care, and resource utilization”.7,p.63)

Implications of medication mismanagement

When medications are not managed safely, the associated costs for individuals, their caregivers/families, providers and the healthcare system can be severe.4,5,8-12 For example, Canadian studies indicate that as many as one in five hospitalized Canadians suffer adverse events following their discharge from hospital to home, and two thirds of those events are related to compromised medication safety.13-15 Furthermore, individuals themselves have identified problematic outcomes related to insufficient medication safety processes. The Commonwealth Survey (2002), a study surveying 3849 people across Australia (AUS), Canada, New Zealand (NZ), the United Kingdom (UK) and United States of America (USA) stated that 10 to 12% of individuals in each of the countries surveyed (CAN 11%, AUS 11%, NZ 13%, UK 10%, and USA 12%) reported they had received an incorrect medication at least once.16

Complexity of care in the home

Provision of healthcare in the home is inherently complex. As care for individuals discharged from hospitals becomes increasingly complex, the demands on the knowledge, ability, energy and finances of those who care for them also increase. The decreasing length of hospital stay, and the increasing availability of mobile health care technology including peritoneal and hemodialysis, long term intravenous catheters and oxygen/inhalation therapy, have made homecare a more viable option than previously.17 In addition, the physical home environment, which is not typically designed for providing health care, is also influenced by family relationships as well as the cognitive and physical abilities of both individuals and caregivers in terms of care provision.

During hospital stays, care provided is predominantly the responsibility of regulated professional workers who work in shifts; in private homes, however, unregulated providers, family, and caregivers deliver much of the care throughout the day and night.18 Family and caregivers are frequently elderly, and they often grapple with health challenges of their own in addition to lack of sleep as they provide round-the-clock care
often with little assistance or relief. Family and caregivers often agree to care for individuals at home out of love and/or a sense of responsibility, but are unaware of the extent of the commitment involved and the drastic impact it can have on their own lives and health. Thus, the safety of the individual, and that of the caregiver/family and provider are inextricably linked. Safety of medication management in homecare cannot be addressed without including caregivers, family members and providers in the equation.

Medication safety in homecare

Current medication safety research focuses predominantly on healthcare institutions and regulated providers. Assessment of medication-related problems in the home setting, however, demands consideration of issues that are often irrelevant or not encountered in hospital settings. Examples of these are economic issues, such as whether the individual can afford to fill his or her prescriptions; access issues, such as whether the individual has the physical capacity to get to a pharmacy; and social issues, such as living with an overwhelmed caregiver who has his or her own health concerns.

Additionally, there is a great deal of variation in the abilities of caregivers, many of whom are lay people with no formal healthcare training. There is little in the way of education or preparation for these caregivers, who manage an array of medications in potentially ill-equipped home settings, commonly while under the influence of stress and fatigue. Though providers can help to alleviate risks through assessment and collaborative discussions with individuals and caregivers, the nature of the home setting requires individuals and caregivers to make frequent autonomous decisions about medication use with minimal professional supervision, and deficient or absent home and community supports. In addition, the home setting presents unique difficulties in documentation and communication related to medications. Research shows points of transfer across sectors already hold increased challenges in these essential functions. One acknowledged danger to individuals receiving homecare is attributable to insufficient communication for medication reconciliation, defined as the "systematic and comprehensive review of all the medications a patient is taking to ensure that medications being added, changed or discontinued are carefully assessed and documented". As the potential for receiving inappropriate medication increases, so too does the potential for harmful incidents ("an incident which results in harm to a patient").

Home healthcare: a change in paradigm

Despite an ever-increasing demand for homecare services, homecare is often under-funded within healthcare systems dominated by the provision of care in the acute care or hospital setting. Healthcare strategies for the elderly, including seniors with chronic conditions and those that need end-of-life care, require a greater emphasis. The current disease-oriented perspective emphasizing diagnosis and treatment of individual condition/disease specific focus needs to expand to a longer term perspective with an emphasis on functional capacity, health maintenance, and prevention of further deterioration. Furthermore, health promotion for the individual and caregivers/families as well as comfort and supportive care are important considerations. As recently proposed by the Canadian Institutes for Health Research
(CIHR), “decision-makers need information and implementation strategies on how to shift from a world of acute care solutions for chronic care needs to a world of chronic care solutions for chronic care needs”.

Such a shift in perspective calls for a new set of competencies (such as education and skills), and alternative approaches (including behavioral strategies) to care for these individuals and caregivers/families receiving care in the home. Specific to the implications for safety with medication management in homecare, key areas that need to be addressed include: i) service provision for vulnerable individuals (i.e., elderly, chronically and/or terminally ill), ii) ethical considerations for the myriad of daily decisions in homecare, and iii) the critical role of individuals, caregivers and family members as integral members of the health care delivery team.

This review explores existing knowledge related to medication management from a safety perspective for older adults receiving homecare. To illuminate gaps in current knowledge, identify priority research areas, and potentially advance safety in the home, the intent in this review was to scope the literature and examine existing research related to the issues and challenges faced by this population and strategies used to mitigate or ameliorate safety risks. To this end we undertook a mixed method (quantitative and qualitative) scoping review on this topic. It was anticipated that the scoping review would provide an indication of areas to explore further and at greater depth in subsequent systematic reviews.

An initial search of the Joanna Briggs Institute Library and the Cochrane Library, Medline and CINAHL was conducted and one scoping review was located related to this topic. In 2010, Masotti and colleagues conducted a scoping review of all types of adverse events in the homecare setting that integrated the evidence from 168 articles. In this review, adverse drug events and line-related adverse events were the most frequently reported and had the highest proportion of events. Furthermore, reported medication error rates (not always resulting in adverse events) were wide ranging, from 19-77%. The most frequently reported individual-level characteristic “associated with cause or increased risk of an adverse event in the homecare setting was increased age and co-morbidities”. When addressing adverse events in the homecare setting, the following interventions emerged as successful or potentially effective: “(i) improving staff knowledge and training; (ii) increased individual monitoring and reporting by providers; (iii) use of computerized screening to identify potential adverse drug events; (iv) implementing required standardized reporting; (v) improved collaboration/communication between local providers (acute care, primary care and homecare); (vi) using an appropriate interdisciplinary team mix; (vii) focus on both individual (includes home and caregivers) and provider level characteristics; and (viii) targeting identified adverse events for further comprehensive investigation into individual-level and provider-level”. In their general review of homecare safety, Masotti and colleagues’ review highlights the importance of drug-related events especially with older adults. Thus to build on this we undertook a more directed review specifically on medication management with seniors receiving care in their homes.
Objectives

In this review we focused on the pertinent issues specifically related to medication management for individuals living at home and receiving homecare services and were guided by the following research questions:

1. What are the issues encountered by individuals, families, caregivers and healthcare providers related to the medication management of individuals living in the community and receiving homecare services?

2. What are the documented errors or adverse events that occur in this population that relate to the management of their medications?

3. What strategies have been implemented and evaluated in the home setting that address the issues related to medication management encountered by this population?

Inclusion criteria

Types of participants

In this review we considered studies that included older individuals, mean age 65 years or older, who were receiving homecare services. We focused on older adults because older adults have been associated with an increased cause or increased risk of an adverse event related to medication management in the homecare setting.29

Studies that focused on providers (licensed or unlicensed) and caregivers (family/friends [paid or unpaid]) who were involved in the medication management process were also included.

Specifically we considered studies that investigated the experience of individuals, mean age 65 years or older, who were receiving homecare services that specifically included medication management. The experience of providers (licensed or unlicensed) and caregivers (family/friends, paid or unpaid) who were involved in the medication management process were included.

The following topics and settings were not included in this review:

1. Individuals performing self-care at home but not receiving homecare services.
2. Hospital-at-Home, acute care services.
3. Assisted living facilities, long term care, nursing homes.
4. Palliative care.
5. Acute exacerbation of chronic illness.
6. Home services for situations not considered ‘a health condition’, eg midwives for home births, respite services, environmental services (maintenance) programs to prevent child abuse, and fire prevention.
7. Mental health services/psychiatric care provided at home (including medication management because this population brings to the table different issues around medication management than those found in the general older adult population).
Types of intervention(s)/phenomena of interest

In this review we considered studies that evaluated the process of medication management involving either providers (licensed and unlicensed) or caregivers (family/friends paid or unpaid).

Comparator

The comparators could be different interventions or strategies: a) within homecare; b) within or between homecare agency settings (across cities, states, provinces or countries); or c) between different caregivers such as providers (licensed and unlicensed) or caregivers (family/friends).

This review also considered studies that investigated either the experience of the individual receiving medication from providers/caregivers, or the experience of the providers/caregivers administering the medication.

Context

The context of this review was the provision of care in the individual’s home or residence.

Types of studies

In this review, we included all quantitative and qualitative research designs. Quantitative designs included, but were not limited to, experimental designs (randomized controlled trials, controlled clinical trials, controlled before and after trials, and time series studies) and observational designs (descriptive studies, cohort studies, cross sectional studies, case studies and case series studies). Qualitative designs included, but were not limited to, designs such as phenomenology, grounded theory, ethnography, action research and feminist research.

Types of outcomes

Our intention in this scoping review was to map the literature and represent the range of outcomes investigated on this topic. Outcomes measured in the general literature on adverse events within the homecare setting suggest the following items:

• Death, re-hospitalization, emergency room use, adverse drug events, potentially inappropriate medication rates
• Adherence and compliance rate
• Wellbeing (self-efficacy, self-reported wellbeing scale, quality of life scale, caregiver burden)
• Confidence to continue medication administration
• Deterioration in primary condition
• Experience of medication management
  • Individual report
  • Provider/caregiver report.
**Search strategy**

The search strategy was completed with the assistance and guidance from a library scientist (MS) with experience in search methodologies for the Joanna Briggs Institute systematic review processes (Appendix I). As this is a scoping review and the intent is to map out the existing research on this topic, the search strategy was designed to find published research studies.

A three-step search strategy was utilized in this review. An initial limited search of MEDLINE and CINAHL was undertaken followed by an analysis of the text words contained in the title and abstract, and of the index terms used to describe the article. A second search using all identified keywords and index terms was then undertaken across all included databases. Thirdly, the reference list of all identified reports and articles were searched for additional studies. Studies published in English and French were considered for inclusion in this review. Studies published in other languages would be tallied (but not translated) to provide an indication of the range of international literature available on this topic. No date limitation was imposed upon the search strategies.

The databases searched using both OVID and EBSCO platforms, and included:

- MEDLINE, CINAHL, PsycINFO, EMBASE, AMED, HEALTHSTAR

Initial keywords used included, but were not limited to:

- medication management, medication mismanagement, medication errors, inappropriate medication, adverse events, homecare (home care), homecare safety, elderly, frail elderly, senior, aged

**Method of the review**

This review is a scoping review\(^{30}\) to provide a broader picture of the existing literature on this topic. Hence assessment of methodological quality was not performed to include/exclude studies based on quality scores.

**Data collection**

Quantitative data were extracted from papers included in the review using the standardized data extraction tool from the Joanna Briggs Institute Meta-Analysis of Statistics Assessment and Review Instrument (JBI-MAStARI) (Appendix II). The data extracted included specific details about the interventions, populations, study methods and outcomes of significance to the review question and specific objectives.

Qualitative data were extracted from papers included in the review using the standardized data extraction tool from the Joanna Briggs Institute Qualitative Assessment and Review Instrument (JBI-QARI) (Appendix III). The data extracted included specific details about the interventions, populations, study methods and outcomes of significance to the review question and specific objectives.

Healthcare safety data in the home environment poses several challenges to the synthesis of the available evidence. The conceptualization of community-based homecare varies between countries as does the
notion of ‘provider’ (formal, professional, lay, family). Each retrieved study required very close scrutiny to identify and sort out nuances in nomenclature and terminology used. To avoid misinterpretation of concepts as much as possible in this regard, several members of the review team were involved and when there was difficulty or disagreement; a meeting was held with a third party to come to consensus.

Data synthesis

The synthesis of the review findings was guided by a safety/medications management conceptual framework (Appendix IV). The findings of this review are presented in narrative form including tables and figures to aid in data presentation where appropriate.

Results

Description of studies

Number of studies found and retrieved

<table>
<thead>
<tr>
<th>Number of studies found</th>
<th>Number selected for retrieval</th>
</tr>
</thead>
<tbody>
<tr>
<td>3190</td>
<td>156</td>
</tr>
</tbody>
</table>

Please note: The target population in this review (older adults receiving homecare services) are referred to by many different terms in the literature. For the purpose of consistency, they are referred to throughout this review as ‘individuals’.

Results

The search strategy located a total of 3190 citations. After the removal of 921 duplicates and 2113 irrelevant citations, full text of 156 papers were retrieved and read to determine relevance to our inclusion criteria. A further 29 papers were added through hand searching. From this total set of 185, a further 149 were discarded as not meeting the inclusion criteria. The final set of included studies in this review is 36 studies (Appendix V). No French studies were located. Four other-language studies were identified and tallied (Japanese [2], German [1], and Swedish [1]).

Included studies were published over a 31-year period between the years of 1981 and 2012. Based on the country of the lead author, the majority of studies were conducted by authors residing in the United States (Table 1). The participants included in these studies ranged from individuals (age range 52-104 years) receiving homecare or community nursing (n=3,031,341), home care agencies (n=263), and providers (registered nurses, home carers, home care assistants, nurses aids, assistant nurses and home help) (n=5,682). Unfortunately, these various caring/helping roles are seldom defined in the literature. Stromme & Botten\(^\text{31}\) explain that ‘nursing assistants’ have one to two years of professional education and ‘home
help' usually have no professional training. Goldstein et al.\textsuperscript{32} report that ‘home help' and ‘home care aide' staff are collectively referred to as home carers, but these authors do not provide any further indication of their training or qualification.

The scope of the combined studies is categorized into the following levels: country level (n=3 studies), state/county/district/municipality (n=5 studies), organizational (n=3 studies), agencies (n=20 studies), individuals (n=4 studies), and healthcare professional (n=1 study). Organizations refer to larger institutions such as universities or a group model not-for-profit health maintenance organization. Agencies refer exclusively to home healthcare agencies.

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of studies</th>
<th>Year range</th>
<th>Range of sites included</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>24</td>
<td>1981-2012</td>
<td>2 studies: nationwide sample 1 study: 1 Southeastern state 1 study: 2 suburban areas 1 study: 1 organization 15 studies: 1-132 home healthcare agencies 3 studies: individuals receiving homecare services 1 study: providers</td>
</tr>
<tr>
<td>Norway</td>
<td>3</td>
<td>1993-2010</td>
<td>1 study: 1 organization 1 study: 7 urban districts 1 study: 10 homecare units</td>
</tr>
<tr>
<td>Sweden</td>
<td>3</td>
<td>2001-2011</td>
<td>1 study: 2 counties 1 study: 15 municipalities 1 study: 1 university</td>
</tr>
<tr>
<td>Australia</td>
<td>2</td>
<td>2004-2005</td>
<td>1 study: 6 metropolitan community health centers 1 study: 113 individuals receiving homecare services</td>
</tr>
<tr>
<td>UK</td>
<td>2</td>
<td>1993-2001</td>
<td>1 study: 1 homecare agency 1 study: 11 of social services area offices</td>
</tr>
<tr>
<td>Canada</td>
<td>1</td>
<td>2006</td>
<td>1 study: 1 home care agency</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>1</td>
<td>2005</td>
<td>8 countries across Europe: Netherlands, United Kingdom, Italy, Norway, Czech Republic, Iceland, Denmark, Finland</td>
</tr>
</tbody>
</table>

Research designs of the included studies are heavily weighted in descriptive designs (n=28) with only one randomized controlled trial (RCT) and three controlled before and after (CBA) designs. There was a single mixed methods study combining results from a pre-post (not controlled) investigation and qualitative focus.
groups. There was a single qualitative study using interpretive qualitative methods. Table 2 lists the full set of study designs.

<table>
<thead>
<tr>
<th>Table 2: Different types of study designs identified (n=36)</th>
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<tbody>
<tr>
<td>Number of studies</td>
</tr>
<tr>
<td>Randomized controlled trial (RCT)</td>
</tr>
<tr>
<td>Controlled before and after (CBA)</td>
</tr>
<tr>
<td>Pre-post (one mixed method)</td>
</tr>
<tr>
<td>Descriptive</td>
</tr>
<tr>
<td>Qualitative</td>
</tr>
</tbody>
</table>

Following the three objectives and research questions proposed for this review, the analysis is presented as: 1) issues (including contributing factors and risk factors) (n=21 studies), 2) documented errors and adverse events (n=13 studies), and 3) strategies or interventions to prevent medication mismanagement (n=11 studies). Studies that are in multiple categories are counted more than once for the specified category. (Characteristics of included studies – Appendix VI)

1. Range of issues encountered with medication management

Twenty-one studies investigated issues encountered by individuals related to medication management. Research designs in this set included: one CBA study\textsuperscript{33} and 20 descriptive designs.\textsuperscript{31,32,34-51} Total study populations in this set included 8552 individuals, 230 agencies and 5546 providers.

The most frequently reported issue related to medication management and consistently reported as a predictor of adverse events was polypharmacy, reported by eight studies.\textsuperscript{34,35,40,43,45,49-51} Four of these studies focused on potentially inappropriate medication use.\textsuperscript{34,35,49,50} Alkema et al.\textsuperscript{35} established that the number of prescribed medications was an independent predictor of any potential medication problem (OR 1.18; 95% CI 1.13 to 1.24; p<0.001) and Fialova et al.\textsuperscript{34} reported that the risk of potentially inappropriate medication use in elderly individuals in the homecare setting was increased with polypharmacy (≥ 4 medications) (RR, 1.91; 95% CI, 1.62-2.22). In a study that examined individuals with Diabetes Mellitus and individuals with hypertension, Feldman et al.\textsuperscript{51} reported the number of medications was significantly related to generating an automated drug alert (indicating potential drug interactions) for both these populations. Polypharmacy was also identified as a factor influencing the adherence of individuals to their medication regimes. Gray et al.\textsuperscript{43} examined under-adherence and using univariate analyses, and established that a higher total number of medications was significantly associated with under-adherence (p=0.019). In their multivariate model, under-adherence was also predicted by higher medication use (OR 1.16; 95% CI 1.03 to 1.31, for each 1-unit increase in number of medications). Johnson et al.\textsuperscript{45} identified several medication related risk factors that were associated with under-adherence: taking five or more regular medications per day (r = -0.49, p < 0.001); taking 12 or more doses per day (r = -0.65, p < 0.001);
having medications prescribed by more than one doctor ($r = -0.25$, $p < 0.05$); and having a high Medication Complexity Index ($r = -0.71$, $p < 0.001$).

One descriptive study examined the appropriateness of medication prescribing by retrospectively assessing pharmacists’ decisions using a Medication Appropriateness Index (MAI) Score.$^{47}$ Pharmacists’ medication review recommendations were categorized and the degree of recommendation acceptance obtained. The total number of medications for the entire cohort ($n=79$) decreased from 1069 at the initial review to 974 at the final review, representing an approximately 9% decrease ($P<0.001$). By the end of the study, 121 medications had been discontinued through provider acceptance of pharmacist recommendations. This study also concluded that pharmacists’ recommendations significantly improved the appropriateness of medication use among veterans receiving home healthcare.

Issues contributing to medication mismanagement that related specifically to the individuals receiving homecare were individual knowledge,$^{32,37,44}$ and poor cognition.$^{44}$ This is further supported by Gray and colleagues$^{40}$ study where it was found that the highest risk for adverse drug events were women with low cognitive functioning. Further to this, low cognitive functioning was identified as a predictor of under-adherence to medication therapies (OR 2.5; 95% CI 1.02 to 6.10).$^{43}$

Two studies noted provider knowledge or insufficient knowledge as being a potential risk factor for medication mismanagement, and was reported by Davis et al.$^{36}$ and Ashgar et al.$^{41}$ In the study by Odegard & Andersson$^{42}$ insufficient knowledge about reasons for hypoglycemic insulin reactions was significantly related to risky behaviours related to care of individuals with Diabetes Mellitus.

From the providers’ perspective, responsibility for medication management appears to have shifted from the physician to other members of the healthcare team. In the earliest study (1981 report), Davis et al.$^{36}$ reported both the participant nurses and agency supervisors described themselves as not overly concerned about medication management because the physician was seen as the person responsible for medication monitoring. Later studies describe the full involvement of nurses and other healthcare professionals such as pharmacists in the responsibility for medication management.$^{31,38}$ From the nurses’ perspective, it was reported that failure to receive drugs due to financial issues was the most serious problem encountered by individuals receiving homecare services.$^{38}$ Stromme & Botten$^{31}$ report that individuals’ failure to take medications as prescribed was a concern of nurses, nursing assistants and home help (most commonly reported as a problem by nursing assistants rather than nurses 80% vs 57%, $p<0.05$, or home help 80% vs 47%, $p<0.001$).

2. Documented errors or adverse events related to the management of medications

Thirteen studies documented the errors related to medication management that occur in this population of older adults receiving homecare services. Study designs in this set included 12 descriptive designs$^{31,34,35,40,43,44,52-57}$ and one qualitative study.$^{58}$ The total number of participants in this set of studies included 3,024,870 individuals, 33 agencies and 315 providers.
In the largest study, Madigan\textsuperscript{57} examined a national sample of 3,013,287 individuals receiving homecare services and reported that 13% of these individuals experienced an adverse event. Almost 3% (84,333 individuals) experienced a decline with oral medication management, representing 21.4% of total adverse events, and 0.1% (3,738 individuals) had emergent care for improper medication administration or side effects, representing 0.9% of total adverse events.

From a sample of 14,624 individuals receiving homecare services in Winnipeg, Manitoba, Canada, Johnson\textsuperscript{56} extracted a random subset of 400 medical records. Johnson established that medication-related events accounted for 23% of adverse events in this population of individuals receiving long-term homecare services. With a focus specifically on adherence, Gray et al.'s.\textsuperscript{43} study identified that 30.6% (n=45) participants were under-adherent with at least one medication and 18.4% (n=27) participants were over-adherent with at least one medication.

Seven studies examined potential medication errors including possible inappropriate medication (PIM) use reporting a range from 19% to 49% of individuals possibly compromised. From a study sample of 6718 individuals receiving homecare services in two of the largest urban home healthcare agencies in the United States, Meredith and colleagues\textsuperscript{52} established that 19% of their sample was taking nine or more medications. Possible medication errors were identified using two sets of consensus-based expert panels: i) The Home Health Criteria to identify patterns of medication use and signs and symptoms that indicate sufficient likelihood of a medication-related problem, and ii) The Beers criteria to identify medications that experts have deemed generally inappropriate for older individuals. A possible medication error was identified for 19% of individuals according to Home Health Criteria and 17% according to the Beers criteria and when both sets of criteria were considered, 30% of individuals had a possible medication error.\textsuperscript{52,p.719}

Fialova and colleagues\textsuperscript{34} examined the data from 2707 elderly individuals receiving homecare in the metropolitan areas of the Czech Republic, Denmark, Finland, Iceland, Italy, the Netherlands, Norway and the United Kingdom. Potentially inappropriate medication use was assessed using Beers criteria (1997 and 2003) and McLeod criteria (1997). Combining all three sets of criteria, 19.8% of individuals in the total sample used at least one inappropriate medication. Potentially inappropriate medication use was associated with the patient’s poor economic situation (adjusted relative risk [RR], 1.96; 95% CI, 1.58-2.36), polypharmacy (RR, 1.91; 95% CI, 1.62-2.22), anxiolytic drug use (RR, 1.82; 95% CI, 1.51-2.15), and depression (RR, 1.29; 95% CI, 1.06-1.55). Negatively associated factors were age 85 years and older (RR, 0.78; 95% CI, 0.65-0.92) and living alone (RR, 0.76; 95% CI, 0.64-0.89). The odds of potentially inappropriate medication use significantly increased with the number of associated factors ($P<.001$).\textsuperscript{34,p.304}

Three studies also used the Beers criteria to establish potential inappropriate medication use: Cannon et al.\textsuperscript{55,p.134} established a rate of 31% potential inappropriate medication use in 786 individuals receiving homecare services from one agency in the Texas. Johnson\textsuperscript{56} established that 23.9% of her sample of 400 individuals receiving homecare services in Winnipeg had taken potentially inappropriate medications. Using data from the 2007 National Home and Hospice Care Survey, Bao et al.\textsuperscript{49,p.304} reported that 38% (95% CI: 36–41) of the 3124 individuals receiving homecare services were taking at least one PIM. Polypharmacy was associated with an increased risk of PIM use. Taking eight to ten medications at a time

\textsuperscript{\textit{Godfrey et al. Homecare safety and medication management with older adults: a scoping review of the quantitative and qualitative evidence © the authors 2013  doi: 10.11124/jbisrir-2013-959 page 96}}
was associated with an OR of 2.23 (95% CI: 1.70–3.32) compared with seven or fewer medications; taking 15 or more medications was associated with an OR of 6.19 (95% CI: 4.67–8.20).

In their study on 615 individuals enrolled in a Medi-Cal waiver care management program, Alkema et al.\textsuperscript{35} used the Home Health Criteria and identified 49% of the sample had a potential medication problem with unnecessary therapeutic duplication being the most prevalent (24%). With a slightly different focus, Ibrahim et al.\textsuperscript{54,p.88} examined potential drug interactions in a sample of 139 individuals diagnosed with Diabetes Mellitus and receiving homecare services from one agency in one mid-Atlantic city. To assess drug-drug interactions, they used Micromedex\textsuperscript{®} formulary DRUG-REAX\textsuperscript{®} System and found that 38.8% of the individuals in the sample could potentially be subject to at least one severe drug-drug interaction. Nearly all of the individuals (92.8%) were at risk for moderate drug-drug interactions, and 70.5% could have mild drug-drug interactions.

Provider perspectives

Between 1990 and 1991, 71% of providers in the study by Stromme \& Botten\textsuperscript{31} stated that they often or sometimes discovered individuals who did not take their medications as prescribed. Nurses and nursing assistants reported discovery of individual medication errors with significantly greater frequency than did home help (91% vs 59%, p<0.01). The two most frequently reported types of errors were forgetting to take medications and taking too large a dose. In the study by Ellenbecker et al.\textsuperscript{44} nurses similarly reported individuals being at risk for medication errors and estimated that 78% of older homecare individuals were at risk. Actual observations did not support this estimate but rather indicated that 5% of individuals visited in the previous week were at risk. Supporting the provider concerns raised in these two studies, Absulem \& Hardin\textsuperscript{53} reported that medication errors were ranked as the number one healthcare error among their home health nurses.

In a qualitative study by Hamre et al.,\textsuperscript{58} interpretive qualitative methods were used to contextualize the drug-order and delivery process. Nurses were observed in two homecare zones, healthcare secretaries in one general practice (GP), and pharmacists in one pharmacy. The researchers examined the process from medication prescription (GP practice) through medication dispensing (pharmacist) to nurses administering the medications in the home. Findings revealed that having multiple ‘handlers’ increased the risk of errors. However, they found that healthcare providers had mechanisms to alert the next in line in the process of the need to take action. These functions were seen (by the researchers) as an attempt to counter the underlying systems’ failures as providers strive to reduce the errors in medication management. For example, in the general practice environment, being responsible for an individual's multi-dose order requires awareness of when changes to the order are needed, but there are no standard procedures for timely communication about changes. Health secretaries then often act as intermediaries to ensure timely flow of information. In the homecare environment, nurses spend a lot of time making sure they receive up-to-date information and compensating for missing drugs or lack of resources and experience. It was noted that the pharmacy environment often requires detective work with pharmacists reporting an inordinate amount of time matching medication orders, making sure that the dose, time and route are correct, watching for changes and drug interactions.
3. Strategies or interventions implemented or evaluated

In total, 11 studies focused on interventions to address medication management in this population of older adults receiving homecare services. In nine studies researchers implemented and evaluated interventions. Study designs in this set included one RCT, three CBA studies, and three pre-post designs. Four descriptive studies focused on interventions to assess their usefulness (rather than effect) provided new knowledge about medication management interventions in homecare (exploratory, correlational). Total study populations in this set included 1548 individuals, 230 agencies and 136 providers.

Experimental designs

Some evidence is emerging related to intervention effectiveness. One RCT and three CBA studies (11% of total studies) were located. In two of these studies the intervention involved a medication review by a pharmacist. In both studies the pharmacist was tasked to identify drug-related problems and improve medication use. In the study by Welch et al., the pharmacist also ensured the individual was appropriately integrated into clinical programs and/or other chronic care programs. Both studies reported favourable results. In the study by Meredith et al., (n=259, intervention n=130, control n=129) there was an improvement in medication use for 50% of individuals in the intervention group compared to 38% of individuals in the control group. Intervention effect was the greatest for individuals with a baseline therapeutic duplication and 71% of intervention individuals had at least one duplicative drug stopped by follow-up, compared with 24% of control group individuals, an attributable improvement of 47 individuals per 100 (95% CI = 20–74, P = .003). The primary outcome in Welch et al.'s study was all-cause mortality in the 180 days after individuals received the Medication Therapy Management intervention. Individuals who received this intervention were less likely to die compared with individuals who opted out (adjusted OR [AOR] 0.5, 95% CI 0.3 to 0.9) but were more likely to have had a hospitalization (AOR 1.4; 95% CI 1.1 to 2.0) and an increase in medication costs (AOR 1.4; 95% CI 1.1 to 1.9) during follow up. Both sets of authors concluded positively about their interventions, quoting improvements in medication use and increased coordination of information between healthcare providers and individuals.

The study by Wekre et al. (n=59) examined the implementation of a multi-dose drug dispensing (MDD) system and examined the association of changes in the number of discrepancies in the medication record at the general practitioners (GPs) and the community homecare services. The number of discrepancies was reduced from 203 to 133 (p<0.001), and the total risk score decreased from 308 to 181 (p<0.001) after the implementation of MDD. The most frequent type of discrepancy both before and after implementation of MDD was that a prescription in the homecare services record was missing in the GP's record. There was also a significant reduction in the number of high-risk medication records during the implementation of MDD (p< 0.02). The authors conclude that it is likely that the positive effect was caused by the change in routines and enhanced focus on the medication process.

Pesznecker et al. (n=48) examined medication management within the context of the individual’s adherence/compliance to their medication regime with a structured measurement of the level of individual adherence/compliance. The researchers implemented the Comprehensive Medication Assessment...
Interview Guide (CMAIG) to evaluate whether nurses who used this guide performed significantly more nursing activities than nurses who used a standard assessment guide or no nursing assessment guide to establish medication adherence/compliance. The CMAIG contained a list of intervention activities to assess nurses’ focus on both the details of medication management clinically as well other important aspects such as financial management and use of multiple pharmacies. It was anticipated that nurses using the CMAIG would use a wider range of nursing interventions than the other two groups of nurses not following the comprehensive guide (group 2 - standard medication assessment guide, group 3 – control). However, the only statistically significantly difference was for the activity “teaching about special instructions”. Authors concluded that although the CMAIG was comprehensive, the nurses using the CMAIG were not provided with training on assessment using the instrument, or instruction on additional interviewing skills to address the depth and range of issues requiring exploration, and hence were not able to use the guide to its fullest potential.

Quasi-experimental designs

Three studies where a pre-post design was used investigated a) collaboration with consultant pharmacists to assess medication issues, b) nurse-led intervention involving assessment using Personal Digital Assistants (PDAs), and c) nurse-led intervention to educate individuals, consult pharmacists or refer to GPs when problems were identified (Table 3). The study by Johansson et al.\textsuperscript{64} employed mixed methods and used focus groups and content analysis to identify nurses’ responses to the use of the PDAs in the home healthcare environment.
Table 3: Range of interventions and findings from pre-post design studies (n=3)

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkema et al. 2009</td>
<td>26% of individuals (n=162) had a confirmed medication problem. 37% of individuals had 2 or more confirmed medication problems. Change rates for each medication problem ranged from 46% to 68%. Pharmacists communicated with physicians, care managers and individuals/caregivers at varying levels. In 22 cases where all three parties were contacted, change rate was 73%.</td>
</tr>
<tr>
<td>Johansson et al. 2010</td>
<td>Using PDAs, majority of nurses found it easier to obtain a profile of individuals' medication, information about drug interactions, therapeutic duplications and warnings about unsuitable drugs than without the use of a PDA. Nurses reported positive and negative responses regarding usefulness of the device.</td>
</tr>
</tbody>
</table>
| Griffiths et al. 2004                                                         | • Significantly less participants required education about their medications at follow-up ($X^2 = 4.85$, $P < 0.05$). Participants were able to correctly name more of their medications ($t(1,23) = -2.34$, $P < 0.05$) and correctly identify the scheduling of their medications ($t(1,23) = -2.20$, $P < 0.05$).  
• However, the identification of the function of medications remained a difficult area for participants with no significant difference being found ($t(1,23) = -0.94$, $P > 0.05$).  
• Little change in adherence. There was little reported non-adherence and, therefore, little area for improvement. |

Descriptive studies on interventions and strategies

Four studies focused on interventions to assess their usefulness (rather than effect) Gusdal et al. conducted an exploratory study in which nurses were given a Safe Medication Assessment (SMA) tool to assess their individual medication management practices. The SMA had the capability to identify factors highly related to unsafe medication management among their elderly individuals. In 64% of assessments nurses using the SMA obtained new information about their individuals regarding the individual’s capacity to manage his medications. In 23% of these cases, nurses were able to intervene and provide further assistance, education or consultation with other providers.

Shearer surveyed the directors or managers of 132 Medicare certified agencies and identified four evidence-based practices that were significantly associated with above average oral medication outcome rates ($R^2=0.2186$, $F=6.71$, $p<0.0001$):
• Use of reminder strategies (cuing strategies such as alarm clock use, the location of the medications, and written notes on doors)
• Use of phone follow-up intervention by agency staff
• Repetition of individual medication education at future home care visits
• Use of medication simplification strategies for individuals taking multiple medications.

Davis et al.\textsuperscript{36} interviewed homecare agency supervisors to examine possible medication monitoring interventions that might be implemented in homecare agencies. Estimated ratings by agency supervisors of ‘moderate to very effective’ for the following interventions were: education programs aimed at clients themselves 78%; pharmacist involvement 75%; education for supervisors 71%; education for staff members 68%; education for doctors 50%; programs to increase volunteer activity 26%; and lobbying efforts to change Medicare/Medicaid regulations 7%.

In an experientially-based approach Patsdaughter & Pesznecker\textsuperscript{66} asked their sample of nurses (n = 48) to describe their current assessment and intervention activities related to facilitating appropriate medication self-administration by elderly clients in the home. Each nurse reflected on the care they provided for one individual. The categorization of nurses’ responses was based on the Comprehensive Medication Assessment Interview Guide (CMAIG), an instrument designed to guide nurses’ assessment in the homecare environment and included a focus on both the details of medication management as well as on the bigger picture such as financial management and use of multiple pharmacies. The findings revealed that nursing interventions primarily concentrated within the realm of education with little time given to other intervention strategies. Sixty-five percent of nurses reported teaching individuals or families about potential side effects, adverse reactions and reportable signs and symptoms related to prescribed medications. Seventy-one percent of nurses reported teaching about purpose of prescribed medications. No nurses reported communicating with insurance companies/financial agents, or coordinating/consolidating multiple pharmacies.

**Discussion**

In this review 36 studies were included that investigated or described the issue of medication management in the population of elderly individuals receiving homecare services. This is an emerging area of evidence in terms of observational studies documenting the occurrence of medication issues and interventional studies testing solutions. The majority of included studies were quantitative descriptive/exploratory studies, (78%) with four experimental and three quasi-experimental studies identified on topic. Despite this heavier presence of descriptive designs medication management in the homecare setting has recently increased as a focus of research.

The analysis of the evidence followed the review questions and described the issues related to medication management in the home for individuals receiving homecare services, the documented adverse events and errors, and the interventions and strategies used to prevent medication mismanagement in this
setting. There was a common theme that emerged across the study designs within the category of issues, with respect to polypharmacy. Polypharmacy is recognized as a significant issue and predictor of medication errors, and/or potential inappropriate medication use.

With regard to the range of interventions, the inclusion of a pharmacist to assess medications was reported by two experimental studies and one descriptive study that concluded positively about their interventions/observations, quoting improvements in medication use and increased coordination of information between healthcare providers and individuals. Other intervention strategies included the use of structured assessment instruments such as the Comprehensive Medication Assessment Interview Guide (CMAIG), and the Safe Medication Assessment (SMA) tool, both of which provided positive results in assisting providers with the task and reducing errors related to medication management. Studies changed the dosing strategy by implementing multi-dosing dispensing with good effect, or augmented nursing care strategies to focus more comprehensively on medication education and medication management strategies, that increased knowledge of medication schedules.

The lack of rigorous research to consistently identify the issues related to medication management in the homecare setting unfortunately reduces the ability to develop appropriate interventions. Hence more consistent and replicable studies are required to enrich the knowledge base in this area and provide direction for intervention research. Generally, medication management intervention strategies lack consistency and the range of outcomes measured by these studies varies widely. Fialova et al. verified this problem in a multi-country study that found that no standards were in place to clarify inappropriate medication use, and a variety of methods was used to measure adverse outcomes.

Several of the outcomes garnered from the research on general adverse events in the homecare setting and listed as potential outcomes for this review were not reported in our included studies. Notably, outcomes such as sense of wellbeing, confidence to continue medication administration and the experience of medication mismanagement from the perspective of the individual were lacking. Unfortunately, there is also paucity of research into the perspective of caregivers of individuals receiving homecare services. The full set of outcomes that were reported by the studies included in this review are presented in Appendix VII and visually represented in Figure 1.

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Limitations of the review

This is a mapping/scoping review to present the current range of evidence specific to the safety issue of medication management, for older adults receiving care in the home. It should not be generalized beyond that nor conclusions drawn other than about the ‘state of knowledge’. The aim was to identify the range of
evidence and where there was a body of evidence that would lead to more focused critical reviews eg interventional studies on effectiveness.

Besides the range of nomenclature and terminology used in this research, another issue is that there is little replication of existing studies and no consensus about which outcomes nor how those outcomes should be measured to establish a consistent base of knowledge in this area. The scale of adverse events/harmful incidents is tracked by provider reports of estimates or perceptions on how many individuals in their care endured medication mismanagement issues as well as actual measures of documented medication error occurrences. Given this, it was not possible to synthesize rates and report potentially reliable estimates of the problems. Finally we were only able to work with research reported in English and French and excluded four foreign language studies that may have met our inclusion criteria and influenced the conclusions.

Conclusion

In this scoping review, we sought to gather information to shed light on the current evidence related to medication management in the homecare setting. This is an area of emerging evidence on both the issue and risks in this context, as well as interventions to ameliorate the problems. Medication management is a pressing area of concern in the homecare environment yet improved understanding of the issues in this context is necessary. Although some issues are generic to the hospital and home environment eg lack of adherence to medication regimens, there would be different reasons for lack of adherence within the homecare setting that would require different strategies to both measure and intervene. Studies focused on the experience with medication management in the home from the individual/family perspective seem paramount as we could only identify one qualitative study and one mixed-method study with self-reporting. This is particularly important to understand as polypharmacy is raised as a key concern in numerous studies in our scoping review and previously by Masotti and colleagues.29

From an intervention perspective, the studies we located point to several worthwhile and successful strategies that would benefit from repeated and more rigorous research to validate these findings. Results from this review raise questions for further work: what interventions have been used in aged care or long term care settings that might be transferable? What is the feasibility of interventions used in other settings in the home environment? Context and individual/family resources and capability are critical. Well-organized and timed assessment is imperative to enhance continuity of care and to establish the most efficient and effective inter-professional dynamic for the provision of care.

Implications for practice

Several studies in this review addressed issues related to knowledge or lack of knowledge about medication management contributing to errors for both providers and individuals receiving homecare services. Strategies to increase nurses’ assessment of the issues related to medication mismanagement

were successful and point to areas where improvements can be made in practice to address this issue. Overarching system issues beyond the nursing clinical management such as lack of finances and poor communication between providers and between providers and individuals/families are important to address. Tools that emerge from this literature as potentially useful are the SMA tool\textsuperscript{65,p.354} which the nurses found to be to be “satisfactory regarding its level of simplicity, relevance, completeness, intelligibility, and time for implementation” and the CMAIG (Patsdaughter & Pesznecker\textsuperscript{66}).

Implications for research

As a first issue, concept clarification is necessary in order for studies to be compared and synthesized. At the very least, good practice would include explicit definitions for key constructs (eg family carers, caregivers, what is included as “homecare”) by study authors.

To advance safety in the home with medication management, rigorous and replicable studies are needed to first document incidence, prevalence and risk of medication issues. Many studies examined potentially inappropriate medication use, which although it is important to know, does not provide a clear indication of the extent of the problem being faced with regard to safety in the homecare environment. Related to this, studies that document the individual/family experience to improve understanding of both the issues and how people deal with them (or not) are needed in order to develop relevant and practical interventions to meet their needs. Intervention research may need to be developed from a foundational assessment then structured to the particular home environment and individual/family abilities rather than across-the-board intervention approach. In addition to the individual/family perspective, the provider perspective is also key and there is foundational research uncovered in this review related to that perspective.\textsuperscript{31,44,53}

Finally, an important area not covered in this review is self-management and self-care with medications in home-dwelling older adults who are not receiving homecare services. We found 111 articles that might provide some understanding of the challenges in medication management in the home; synthesis of this research would be an important undertaking. It will be important to compare these two groups (people receiving services versus those who are not) and to include both the individual and family caregiver perspective.

Conflicts of interest

Nne to declare.

Acknowledgements

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\textsuperscript{Godfrey et al. Homecare safety and medication management with older adults: a scoping review of the quantitative and qualitative evidence © the authors 2013 doi: 10.11124/jbisrir-2013-959 page 105}
References


(25) Accreditation Canada, the Canadian Institute for Health Information, the Canadian Institute for Patient Safety, the Institute for Safe Medication Practices Canada. Medication Reconciliation in Canada: Raising The Bar - Progress to date and the course ahead. Ottawa Ontario: Accreditation Canada; 2012.


(56) Johnson KG. Adverse events among Winnipeg Home Care clients. Healthc Q 20069 Spec No:127-134.


Appendix I: Search strategy (MEDLINE database)
1. Aged/
2. "Aged, 80 and over"/
3. Frail Elderly/
4. (older adj adult$).mp.
5. senior$.mp.
6. Homebound Persons/
7. exp Medicare/
8. Chronic Disease/
9. Comorbidity/
10. Caregivers/
11. caregiver$.ab,ti.
12. carer$.ab,ti.
13. Nurses/
14. exp Allied Health Personnel/
15. or/1-14
16. Medication Therapy Management/
17. medication administration.ab,ti.
18. medication manag$.ab,ti.
19. medication mismanag$.ab,ti.
20. medication misadventure$.ab,ti.
21. Medication Errors/
22. medication err$.ab,ti.
23. drug err$.ab,ti.
24. Drug Toxicity/
25. adverse drug event$.ab,ti.
26. medication safe$.ab,ti.
27. Medication Adherence/
28. medication adherence.ab,ti.
29. medication compliance.ab,ti.
30. Self Administration/
31. Self Medication/
32. Prescription Drugs/
33. Nonprescription Drugs/
34. Drug Monitoring/
35. Drug Prescriptions/
36. Capsules/ad, ae [Administration & Dosage, Adverse Effects]
37. exp Tablets/ad, ae [Administration & Dosage, Adverse Effects]
38. exp Pharmaceutical Preparations/ad [Administration & Dosage]
39. Drug Administration Schedule/
40. Drug Monitoring/
41. Pharmaceutical Services/
42. Polypharmacy/
43. pharmacotherapy.ab,ti.
44. exp Drug Therapy/
45. Drug Utilization/
46. "Drug Utilization Review"/
47. Medication Systems/
48. Drug Information Services/
49. or/16-48
50. Home Care Services/
51. Home Care Agencies/
52. Home Health Aides/
53. Home Nursing/
54. Homemaker Services/
55. community health services/
56. community health nursing/
57. community pharmacy services/
58. Accidents, Home/
59. Community Networks/
60. Community Mental Health Services/
61. Residence Characteristics/
62. Housing/
63. Housing for the Elderly/
64. Independent Living/
65. Community Medicine/
66. House Calls/
67. Community Health Workers/
68. Community Health Centers/
69. Community Psychiatry/
70. community dwell$.ab,ti.
71. living in the community.ab,ti.
72. home dwell$.ab,ti.
73. living at home.ab,ti.
74. home base$.ab,ti.
75. care at home.ab,ti.
76. or/50-75
77. 15 and 49 and 76
Appendix II: Data extraction instruments

MAStARI data extraction instrument

<table>
<thead>
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<th>JBI Data Extraction Form for Experimental / Observational Studies</th>
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<tr>
<td>Reviewer __________________________ Date ____________________</td>
</tr>
<tr>
<td>Author ___________________________ Year ______________________</td>
</tr>
<tr>
<td>Journal __________________________ Record Number ______________</td>
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</tbody>
</table>

**Study Method**

- RCT □
- Quasi-RCT □
- Longitudinal □
- Retrospective □
- Observational □
- Other □

**Participants**

**Setting**

**Population**

**Sample size**

- Group A __________  Group B __________

**Interventions**

- Intervention A

- Intervention B

**Authors Conclusions:**

**Reviewers Conclusions:**
### Study results

#### Dichotomous data

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#### Continuous data

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Appendix III: Data extraction instruments

QARI data extraction instrument

JBI QARI Data Extraction Form for Interpretive & Critical Research

Reviewer: ___________________________ Date: ___________________________

Author: ___________________________ Year: ___________________________

Journal: ___________________________ Record Number: ___________________________

Study Description

Methodology

Method

Phenomena of interest

Setting

Geographical

Cultural

Participants

Data analysis

Authors Conclusions

Comments

Complete: Yes [ ] No [ ]
<table>
<thead>
<tr>
<th>Findings</th>
<th>Illustration from Publication (page number)</th>
<th>Evidence</th>
<th>Unequivocal</th>
<th>Credible</th>
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Extraction of findings complete    Yes ☐    No ☐
Appendix IV: Conceptual framework

Homecare safety and medication management with older adults [n=36 studies]

- n=11 Strategies/interventions
- Issues n=21
- Errors/adverse events n=13
Appendix V: Search decision tree

- Cinahl 958
- Medline 799
- Psychinfo 244
- AMED 27
- Embase 519
- Healthstar 643

Total combined 3190

Removed - duplicates: 921

Final combined total 2269

Discarded - off topic: 2113

Full article read to determine match with inclusion criteria 156

Hand searching: 29

Discarded – Not meeting inclusion criteria: 149

Final total 36
### Appendix VI: Characteristics of included studies

<table>
<thead>
<tr>
<th></th>
<th>Author/year</th>
<th>Country of lead author</th>
<th>Length of time</th>
<th>Range of sample size</th>
<th>Scope</th>
<th>Design</th>
<th>Purpose</th>
<th>Issue/intervention/adverse event/error</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bao et al.(^{37}) 2012</td>
<td>USA</td>
<td>Did not specify</td>
<td>3124 home health individuals</td>
<td>Ind.</td>
<td>Descriptive Secondary analysis; Cross-sectional</td>
<td>To estimate the prevalence of potentially inappropriate medications (PIMs) among current elderly home health individuals in the US.</td>
<td>Issue: PIM.</td>
</tr>
<tr>
<td>2</td>
<td>Absulem &amp; Hardin(^{33}) 2011</td>
<td>USA</td>
<td>Did not specify</td>
<td>33 agencies</td>
<td>State</td>
<td>Descriptive Cross-sectional study</td>
<td>To assess how home health nurses and agencies perceive and deal with healthcare errors in their practice settings. Specific aims were to 1) explore home health nurses’ response to questions about patient safety, 2) examine what home health nurses perceive as types of care errors in home health, 3) examine how home health agencies deal with care errors.</td>
<td>Adverse event/errors-Provider Perspective-Healthcare errors</td>
</tr>
<tr>
<td>3</td>
<td>Dierich et al.(^{36}) 2011</td>
<td>USA</td>
<td>Prior to 2004 to Dec. 2006</td>
<td>911 individuals</td>
<td>Ind.</td>
<td>Descriptive Secondary analysis</td>
<td>To describe the older adult population admitted from the hospital to home care and examine their medication regimens in terms of polypharmacy, PIM use, and medication regimen complexity.</td>
<td>Issue: polypharmacy, PIMs; medication regimen complexity.</td>
</tr>
<tr>
<td>4</td>
<td>Gusdal et al.(^{35}) 2011</td>
<td>Sweden</td>
<td>3-6 month period</td>
<td>25 district nurses (DNs), 160 individuals from primary health care centres</td>
<td>2 Swedish counties</td>
<td>Descriptive</td>
<td>To explore the capability of the Safe Medication Assessment (SMA) tool in identifying factors highly related to unsafe medication management among elderly individuals and to investigate the DNs opinions of the SMA’s usefulness as a tool in their daily primary healthcare practice.</td>
<td>Intervention: provider perspective-SMA.</td>
</tr>
<tr>
<td>5</td>
<td>Hamre et al.(^{38}) 2010</td>
<td>Norway</td>
<td>2 periods of 3</td>
<td>Did not specify</td>
<td>Organization</td>
<td>Descriptive Qualitative</td>
<td>Contextualize the collaborating actions in the</td>
<td>Adverse event/errors: drug order and delivery process.</td>
</tr>
<tr>
<td>Author/year</td>
<td>Country of lead author</td>
<td>Length of time</td>
<td>Range of sample size</td>
<td>Scope</td>
<td>Design</td>
<td>Purpose</td>
<td>Issue/intervention/ adverse event/error</td>
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<tr>
<td>6 Johansson et al. 64 2010</td>
<td>Sweden</td>
<td>5 weeks</td>
<td>15 nurses from University of Kalmar</td>
<td>Agency</td>
<td>Descriptive Mixed methods: Before and after (no control), and qualitative</td>
<td>To evaluate nurses’ experiences of using a MDSS (medical decision support system) in a PDA with a barcode reader, in order to obtain profiles of the individuals’ medication, regarding drug-drug interactions, therapeutic duplications, and warnings for drugs unsuitable for elderly in home care.</td>
<td>Intervention: provider Perspective-PDA).</td>
<td></td>
</tr>
<tr>
<td>7 Wekre et al. 33 2010</td>
<td>Norway</td>
<td>May 2006-January 2008</td>
<td>59 individuals in 10 home care units</td>
<td>Agency</td>
<td>Descriptive CBA-Controlled before and after</td>
<td>To investigate whether implementation of multidose drug dispensing (MDD) for elderly outpatients is associated with a change in number of discrepancies in the medication record at the general practitioners (GPs) and at the community home-care services.</td>
<td>Intervention: MDD; Issue: discrepancies in the medication record at the GPs and at the community home-care services.</td>
<td></td>
</tr>
<tr>
<td>8 Alkema et al. 65 2009</td>
<td>USA</td>
<td>June 2004 to January 2006</td>
<td>162 community dwelling elders</td>
<td>Ind.</td>
<td>Descriptive Pre-test – post-test design</td>
<td>To evaluate the impact of an evidence-based medication management intervention to reduce four targeted medication problems among older adults at risk for placement in a nursing facility.</td>
<td>Intervention-collaboration with care managers, consultant pharmacists confirmed medication problems, developed individualized treatment plans, recommended changes.</td>
<td></td>
</tr>
<tr>
<td>9 Shearer 48 2009</td>
<td>USA</td>
<td>Early 2007</td>
<td>132 RNs from 6 home health agencies</td>
<td>Agency</td>
<td>Descriptive</td>
<td>To report findings from a study aimed at describing nurses’ current assessment and intervention activities related to facilitating appropriate medication self-administration by elderly clients in the home.</td>
<td>Strategies: nursing interventions.</td>
<td></td>
</tr>
<tr>
<td>10 Welch et al. 61 2009</td>
<td>USA</td>
<td>Opted in during year of</td>
<td>459 individuals</td>
<td>Organization</td>
<td>Descriptive CBA-Non-randomized</td>
<td>To assess the impact of a Medication Therapy Management (MTM) program</td>
<td>Intervention: medication Therapy management; Issue: DRPs.</td>
<td></td>
</tr>
<tr>
<td>Author/year</td>
<td>Country of lead author</td>
<td>Length of time</td>
<td>Range of sample size</td>
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<td>Purpose</td>
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<tr>
<td>11 Alkema et al.2007</td>
<td>USA</td>
<td>June 2004 to January 2006</td>
<td>615 elders</td>
<td>Ind.</td>
<td>Descriptive Cross-sectional survey</td>
<td>To assess the prevalence of potential medication problems for older adults enrolled in a Medicaid waiver service using tested Home Health Criteria that combine medication use and clinical risk factors for screening drug regimens.</td>
<td>Adverse event/errors-potential medication problems.</td>
<td></td>
</tr>
<tr>
<td>12 Davis et al.2007</td>
<td>USA</td>
<td>March 2002 to January 2004; med. reviews occurred at ~9 weeks intervals</td>
<td>79 individuals</td>
<td>Ind.</td>
<td>Descriptive Retrospective analysis</td>
<td>To examine medication appropriateness using the Medication Appropriateness Index (MAI) and the degree of recommendation acceptance associated with clinical pharmacist medication reviews for veterans enrolled in the Home-Based Primary Care (HBPC) program.</td>
<td>Issue: MAI.</td>
<td></td>
</tr>
<tr>
<td>13 Madigan2007</td>
<td>USA</td>
<td>Calendar year 2003</td>
<td>3,013,287 individuals</td>
<td>National</td>
<td>Descriptive Secondary analysis</td>
<td>To describe the CMS adverse events among the population of individuals receiving Medicare and Medicaid home healthcare in 2003, and to compare the demographic, social and clinical characteristics between those individuals who had adverse events and those that did not.</td>
<td>Adverse event/errors – frequency of adverse events for those individuals receiving home care.</td>
<td></td>
</tr>
<tr>
<td>14 Cannon et al.2006</td>
<td>USA</td>
<td>Unknown</td>
<td>786 individuals</td>
<td>Ind.</td>
<td>Descriptive - Retrospective data analysis</td>
<td>To review medication use in elderly individuals receiving home health care to identify the prevalence of potentially inappropriate medication (PIM) use, dangerous drug interactions (DDI), and other patterns of medication use</td>
<td>Adverse event/errors: PIM use was identified using the Beers criteria. (DDI were identified using the Multidisciplinary Medication Management (M3) Project criteria.</td>
<td></td>
</tr>
<tr>
<td>15 Feldman et al.2006</td>
<td>USA</td>
<td>Data from OASIS for individuals</td>
<td>150 individuals with Agency</td>
<td>Descriptive Secondary analysis</td>
<td>Study aimed to assess the potential for computerized drug utilization review (DUR)</td>
<td>Issue: The study addressed 4 questions: a) What individuals characteristics are associated</td>
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<tr>
<td>Author/year</td>
<td>Country of lead author</td>
<td>Length of time</td>
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<tr>
<td>Godfrey et al.</td>
<td>Canada</td>
<td>Feb-Mar 2004</td>
<td>215 charts</td>
<td>Discharge d in 2002</td>
<td>Hypertension (HTN) 150 individuals with Diabetes Mellitus (DM)</td>
<td>In the home healthcare setting. DUR programs typically send an alert warning of potential drug interactions. The study focused on individuals with HTN and DM and high use of 3 medication classes (hypoglycemic, diuretics and anticoagulants) most often associated with adverse events.</td>
<td>With a drug alert? b) What types of alerts are generated? c) How do nurses respond to alerts? d) What are the implications for individuals?</td>
<td></td>
</tr>
<tr>
<td>Johnson et al.</td>
<td>USA</td>
<td>4 weeks</td>
<td>12 individuals 6 nurses</td>
<td>Agency</td>
<td>Descriptive, retrospective record review</td>
<td>Measure incidence, type, severity, cause preventability &amp; amelioration of adverse events (AEs) among Winnipeg HC individuals.</td>
<td>Adverse event/errors: incidence of AEs, type, severity, cause, preventability &amp; amelioration.</td>
<td></td>
</tr>
<tr>
<td>Owens et al.</td>
<td>USA</td>
<td>March 1, 1998 – Sept. 30, 1999</td>
<td>139 individuals</td>
<td>Agency</td>
<td>Descriptive</td>
<td>To examine drug regimens of diabetic individuals. Receiving home healthcare services to measure the prevalence of polypharmacy &amp; to assess likelihood of drug-drug interactions</td>
<td>Adverse event/errors: Drug-drug interactions.</td>
<td></td>
</tr>
<tr>
<td>Ibrahim et al.</td>
<td>USA</td>
<td>July to October 2001</td>
<td>N=111 individuals</td>
<td>Agency</td>
<td>Descriptive, correlational design</td>
<td>Develop &amp; test a set of criteria to identify elders who are at no or high risk of an untoward medication event.</td>
<td>Issue: medication knowledge, regime, management abilities &amp; adherence.</td>
<td></td>
</tr>
<tr>
<td>Ellenbecker et al.</td>
<td>USA</td>
<td>Unknown</td>
<td>101 nurses</td>
<td>States</td>
<td>Descriptive-Mixed methods (survey and qualitative analysis of</td>
<td>To explore and describe the current state of medication management of individuals receiving services from certified home health care</td>
<td>Adverse event/errors: the amount and type of medication errors observed by home health care nurses. Issues: factors associated with</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Author/year</th>
<th>Country of lead author</th>
<th>Length of time</th>
<th>Range of sample size</th>
<th>Scope</th>
<th>Design</th>
<th>Purpose</th>
<th>Issue/intervention/adverse event/error</th>
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</thead>
<tbody>
<tr>
<td>22 Griffiths et al., 2004</td>
<td>Australia</td>
<td>4 weeks</td>
<td>24 clients receiving community nursing care</td>
<td>Individual</td>
<td>Descriptive</td>
<td>Pre-post design</td>
<td>To explore the effectiveness of community nurses (CNs) in improving knowledge and medication self-management in a group of older people receiving community nursing care.</td>
</tr>
<tr>
<td>23 Meredith et al., 2002</td>
<td>USA</td>
<td>October 1996 - September 1998; individuals follow-up 6-12 wks</td>
<td>259 individuals</td>
<td>Agency</td>
<td>RCT</td>
<td>To develop &amp; test a program for improving med. use designed specifically for use in health care.</td>
<td>Intervention: structured templates provided by study used to develop plan presented to individuals' physician (by nurse or, for complicated individuals, by pharmacist), asked for instructions re changes in treatment &amp; individuals' follow-up. Nurse assisted individuals with medication changes &amp; monitored their effect. When necessary, consultation available from coordinating center clinical pharmacologist. Clinical pharmacists provided specially developed educational materials for nurses that explained background of each problem &amp; suggested ways to resolve it.</td>
</tr>
<tr>
<td>24 Ashgar et al., 2001</td>
<td>UK</td>
<td>June 1999</td>
<td>293 home care assistants</td>
<td>Organization</td>
<td>Descriptive</td>
<td>1) How medicines were handled by home care staff in a residential setting. 2) The</td>
<td>Issue: provider perspective.</td>
</tr>
<tr>
<td>Author/year</td>
<td>Country of lead author</td>
<td>Length of time</td>
<td>Range of sample size</td>
<td>Scope</td>
<td>Design</td>
<td>Purpose</td>
<td>Issue/intervention/ adverse event/error</td>
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<tr>
<td>Gray et al. 2001</td>
<td>USA</td>
<td>April 1994-May 1996; 2 week follow-up period</td>
<td>147 individuals</td>
<td>Agency</td>
<td>Descriptive prospective cohort study</td>
<td>To assess prevalence and risk factors for medication under- and over-adherence in a two-week period following hospital discharge in adults &gt;65 years</td>
<td>Adverse event/errors: profile-risk factors and prevalence.</td>
</tr>
<tr>
<td>Meredith et al. 2001</td>
<td>USA</td>
<td>October 1996 – Sept. 1998</td>
<td>6,718 individuals</td>
<td>Agency</td>
<td>Descriptive Cross sectional survey</td>
<td>To determine the frequency of possible medication errors in a population of older home healthcare individuals according to expert panel objective criteria.</td>
<td>Adverse event/ errors: frequency of medication errors.</td>
</tr>
<tr>
<td>Gray et al. 1999</td>
<td>USA</td>
<td>April 1994 - May 1996</td>
<td>256 individuals</td>
<td>Agency</td>
<td>Descriptive-Pro spective cohort</td>
<td>Describe incidence, types, &amp; healthcare consequences of adverse drug events (ADE) &amp; identify risk factors for ADE occurrence in mo. following hospital discharge in elderly individuals receiving home health services.</td>
<td>Adverse event/errors: self-reported ADEs (possible, probable or definite).</td>
</tr>
<tr>
<td>Poirier &amp; Barbeau 1999</td>
<td>USA</td>
<td>July-August</td>
<td>141 individuals from 2 community health centers</td>
<td>Agency</td>
<td>Descriptive</td>
<td>Examines the medications stored in homes of elderly to determine the nature and extent of medications kept, and to provide information on the storage a disposal of medications by community-living elderly.</td>
<td>Issues: medication inventory.</td>
</tr>
<tr>
<td>Goldstein et al. 1993</td>
<td>UK</td>
<td>In 1991</td>
<td>1992 homecarers</td>
<td>Homecarers</td>
<td>Descriptive</td>
<td>To measure the demand on the home carers for assistance with medication, and respondent were asked to</td>
<td>Issue: provider perspective.</td>
</tr>
<tr>
<td>Author/year</td>
<td>Country of lead author</td>
<td>Length of time</td>
<td>Range of sample size</td>
<td>Scope</td>
<td>Design</td>
<td>Purpose</td>
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<tr>
<td>31 Stromme &amp; Botten[31] 1993</td>
<td>Norway</td>
<td>1990-1991</td>
<td>Registered nurses 23/73, nursing assistants 49/93 and home helps 142/369 Total=214</td>
<td>Districts</td>
<td>Descriptive</td>
<td>To study the potential of home care providers for playing a role in the medication of elderly. To reveal the most important drug-related problems as perceived by providers of home care, &amp; their experiences of medication errors &amp; adverse reactions in old people.</td>
<td>Adverse event/errors: providers’ perception of the most important drug-related problem experienced by their elderly clients.</td>
</tr>
<tr>
<td>32 Wolfgang et al.[32] 1993</td>
<td>USA</td>
<td>Unknown</td>
<td>40 nurses</td>
<td>Nurses</td>
<td>Descriptive</td>
<td>To determine a) rural home healthcare nurses’ perceptions of the severity of drug-related problems among their individuals, b) the perceived use of various types of drug related information to those nurses, and c) the nurses’ current use of, and satisfaction with, selected sources of drug-related information.</td>
<td>Issues: issues related to individuals medication management and issues related information resources for nurses.</td>
</tr>
<tr>
<td>33 Esposito[33] 1992</td>
<td>USA</td>
<td>April 1992</td>
<td>30 home care individuals</td>
<td>Ind.</td>
<td>Descriptive</td>
<td>Exploratory study in a rural area to determine the extent of elderly clients’ knowledge of their medications. Two populations compared – elders in senior citizen housing &amp; home care individuals. It was hypothesized that elders in senior housing would have more knowledge and make fewer errors than home care individuals, who are believed to be more ill.</td>
<td>Issue: knowledge of medications.</td>
</tr>
<tr>
<td>34 Pesznecker et al.[34] 1990</td>
<td>USA</td>
<td>One point in time</td>
<td>48 nurses</td>
<td>Agency</td>
<td>CBA: Before-after quasi</td>
<td>a) Describe the nursing activities of a sample of home care nurses related to</td>
<td>Intervention: assessment of medication adherence/compliance using CMAG.</td>
</tr>
<tr>
<td>Author/year</td>
<td>Country of lead author</td>
<td>Length of time</td>
<td>Range of sample size</td>
<td>Scope</td>
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<td>Purpose</td>
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<td>Experimental design with 2 intervention groups and 1 control group</td>
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<td>medication assessment and intervention. b) To test whether nurses who use the Comprehensive Medication Assessment Interview Guide (CMAG) performed significantly more nursing activities than nurses who used a standard assessment guide or no nursing assessment guide. c) To determine if significant differences occurred in categories of nursing activities reported by nurses who used the CMAG as contrasted to nurses who used a standard assessment guide or no assessment guide.</td>
<td></td>
</tr>
<tr>
<td>36 Davis et al., 1981</td>
<td>USA</td>
<td>Unknown</td>
<td>Study 1: n=98 agencies Study 2: n=30 agencies</td>
<td>Agency</td>
<td>Descriptive telephone interviews using semi-structured questionnaire</td>
<td>Study 1) To determine the medication monitoring practices of home care staff Study 2) To examine possible medication monitoring interventions that might be implemented in home care agencies.</td>
<td>Issue: study 1) medication monitoring practices Intervention; study 2) feasibility of proposed strategies to reduce medication errors.</td>
</tr>
</tbody>
</table>
### Appendix VII: Outcome measures

#### Table 4: Outcomes measured by study

<table>
<thead>
<tr>
<th>Author/Year</th>
<th>Outcomes measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Bao et al. 2012</td>
<td>Prevalence and classification of Potentially Inappropriate Medication (PIM) use. Association between PIM use and individual and home health agency characteristics</td>
</tr>
<tr>
<td>2. Absulem &amp; Hardin 2011</td>
<td>Homecare providers’ perception of healthcare errors with respect to: • Type of error and severity • Circumstances and causes of errors • Consequence of errors • How homecare agency deals with errors</td>
</tr>
<tr>
<td>3. Dierich et al. 2011</td>
<td>Polypharmacy PIM Medication regimen complexity Comorbidity Readmission to hospital</td>
</tr>
<tr>
<td>4. Gusdal et al. 2011</td>
<td>Ability of the Safe Medication Assessment (SMA) tool to identify factors related to unsafe medication management. Nurses’ opinions of the SMA’s usefulness as a tool in their daily primary healthcare practice</td>
</tr>
<tr>
<td>5. Hamre et al. 2010</td>
<td>Drug order process Drug delivery process Drug administration process</td>
</tr>
<tr>
<td>6. Johansson et al. 2010</td>
<td>Use of medical decision support system on a Personal Digital Assistant (PDA) to assess individuals’ medication: • Drug–drug interactions • Therapeutic duplications • Warnings for drugs unsuitable for elderly in home care</td>
</tr>
<tr>
<td>7. Wekre et al. 2010</td>
<td>Discrepancies between the individuals’ medication records at the General Practitioner (GP) and at the homecare services, and the number of drugs in the GPs’ medication records. The potential harm resulting from these discrepancies</td>
</tr>
<tr>
<td>8. Alkema et al. 2009</td>
<td>Change in medication at three months follow-up based on • Unnecessary duplication of meds • Use of psychotropic medications with concurrent falls or confusion • Cardiovascular medications • Use of non-steroidal anti-inflammatory drugs (NSAIDS) with risk of peptic ulcer</td>
</tr>
<tr>
<td>Author/year</td>
<td>Outcomes measured</td>
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</tbody>
</table>
| Shearer et al. 48 2009 | Agency characteristics with respect to the improvement of the management of oral medications:  
- Quality of improvement activities  
- Evidence-based practices implemented |
| Welch et al. 61 2009 | Mortality  
Healthcare utilization  
Prescription medication costs  
Drug-related problems |
| Alkema et al. 35 2007 | Prevalence and prediction of having one of four potential problems  
- Unnecessary duplication of meds  
- Use of psychotropic medications with concurrent falls or confusion  
- Cardiovascular medications  
- Use of NSAIDS with risk of peptic ulcer |
| Davis et al. 47 2007 | Medication appropriateness using Medication Appropriateness Index scale (MAI)  
Degree of recommendation acceptance associated with clinical pharmacist medication reviews |
| Madigan 37 2007 | The most frequent adverse events for individuals receiving homecare services |
| Cannon et al. 35 2006 | Potentially inappropriate medication use  
Dangerous drug interactions |
| Feldman et al. 41 2006 | Drug alerts for dangerous drug interactions ranked as severe of moderate  
Drug alerts for duplicative drugs  
Individual characteristics associated with drug alerts  
Type of alerts triggered  
Nurses’ response to alerts  
Implications for individuals |
| Johnson 56 2006 | Incidence, type, severity, cause, preventability and ameliorability of adverse events PIM |
| Owens 45 2006 | Medication adherence |
| Fialova et al. 34 2005 | Prevalence of potentially inappropriate medication use  
Individual-related characteristics independently associated with inappropriate medication use |
| Ibrahim et al. 34 2005 | Number of medications taken  
Drug-drug interactions  
Possible severe, moderate and mild drug-drug interactions |
| Johnson et al. 45 2005 | Individual medication knowledge  
Medication regime and management abilities |
### Author/year | Outcomes measured
--- | ---
|  | Number of medications per day  
  Number of doses administered per day  
  Number of prescriptions  
  Factors related to medication complexity index (complexity of medication regime)  
  Factors related to adherence |
21. Ellenbecker et al. **4** 2004 | The amount and type of medication errors observed by home healthcare nurses  
  The extent to which adverse reactions occur because of medication error  
  Factors associated with home medication error  
  Nurses’ experiences with and perceptions of medication management in the homecare population |
22. Griffiths et al. **2** 2004 | Individuals’ knowledge of and ability to cope with their medication regime  
  Community nurses’ medication review and interventions |
23. Meredith et al. **3** 2002 | Improved medication use based on the assessment of:  
  - Unnecessary duplication of meds  
  - Use of psychotropic medications with concurrent falls or confusion  
  - Cardiovascular medications  
  - Use of NSAIDS with risk of peptic ulcer |
24. Ashgar et al. **3** 2001 | Provider knowledge regarding safe and secure handling of medications |
25. Gray et al. **4** 2001 | Prevalence and risk factors for under and over adherence |
26. Meredith et al. **3** 2001 | Frequency of possible medication errors in the home |
27. Odegard & Andersson **6** 2001 | Provider knowledge |
28. Gray et al. **7** 1999 | In month following discharge from hospital to home:  
  - Incidence of adverse drug events  
  - Healthcare consequences of adverse drug events  
  - Risk factors for adverse drug events |
29. Poirier & Barbeau **5** 1999 | Medications stored within the home:  
  - Nature of the medications  
  - Extent of medications kept  
  - Storage and disposal of medications |
30. Goldstein et al. **3** 1993 | Demand on home carers for assistance with medication tasks |
31. Stromme & Botten **1** 1993 | Homecare providers’ perception of the most important drug-related problems |
32. Wolfgang et al. **8** 1993 | Nurses’ ranking of most serious drug-related problems  
  Nurses’ perceived sources of drug-related information  
  Nurses’ use of sources for drug information |
<table>
<thead>
<tr>
<th>Author/year</th>
<th>Outcomes measured</th>
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<tr>
<td>33. Esposito et al. 1992</td>
<td>Individuals’ knowledge of their medications</td>
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<tr>
<td>34. Pesznecker et al. 1990</td>
<td>Nurses’ medication-related assessments and interventions</td>
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<tr>
<td>35. Patsdaughter &amp; Pesznecker 1988</td>
<td>Nurses’ assessment and intervention activities to facilitate medication self-administration</td>
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<tr>
<td>36. Davis et al. 1981</td>
<td>Homecare staffs’ medication monitoring practices</td>
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<td>Possible medication monitoring interventions suggested by homecare agency supervisors</td>
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