Scandinavian Journal of Primary Health Care

ISSN: 0281-3432 (Print) 1502-7724 (Online) Journal homepage: http://www.tandfonline.com/loi/ipri20

Inappropriate prescribing for older people admitted to an intermediate-care nursing home unit and hospital wards

Marit Stordal Bakken, Anette Hylen Ranhoff, Anders Engeland & Sabine Ruths

To cite this article: Marit Stordal Bakken, Anette Hylen Ranhoff, Anders Engeland & Sabine Ruths (2012) Inappropriate prescribing for older people admitted to an intermediate-care nursing home unit and hospital wards, Scandinavian Journal of Primary Health Care, 30:3, 169-175, DOI: 10.3109/02813432.2012.704813

To link to this article: http://dx.doi.org/10.3109/02813432.2012.704813

Published online: 25 Jul 2012.

Scandinavian Journal of Primary Health Care, 2012; 30: 169–175

informa
healthcare

ORIGINAL ARTICLE

Inappropriate prescribing for older people admitted to an intermediate-care nursing home unit and hospital wards

MARIT STORDAL BAKKEN[1,2], ANETTE HYLEN RANHOFF[1,3], ANDERS ENGELAND[2,4] & SABINE RUTHS[2,5]

[1]*Kavli Research Centre for Ageing and Dementia, Haraldsplass Deaconess Hospital, Bergen, Norway,* [2]*Department of Public Health and Primary Health Care, University of Bergen, Norway,* [3]*Institute of Medicine, University of Bergen, Norway,* [4]*Department of Pharmacoepidemiology, Norwegian Institute of Public Health, Oslo, Norway, and* [5]*Research Unit for General Practice, Uni Health, Bergen, Norway*

Abstract

Objective. To identify inappropriate prescribing among older patients on admission to and discharge from an intermediate-care nursing home unit and hospital wards, and to compare changes during stay within and between these groups. *Design.* Observational study. *Setting and subjects.* Altogether 400 community-dwelling people aged ≥ 70 years, on consecutive emergency admittance to hospital wards of internal medicine and orthopaedic surgery, were randomized to an intermediate-care nursing home unit or hospital wards; 290 (157 at the intermediate-care nursing home unit and 133 in hospital wards) were eligible for this sub-study. *Main outcome measures.* Prevalence on admission and discharge of potentially inappropriate medications (Norwegian general practice [NORGEP] criteria) and drug–drug interactions; changes during stay. *Results.* The mean (SD) age was 84.7 (6.2) years; 71% were women. From admission to discharge, the mean numbers of drugs prescribed per person increased from 6.0 (3.3) to 9.3 (3.8), $p < 0.01$. The prevalence of potentially inappropriate medications increased from 24% to 35%, $p < 0.01$; concomitant use of ≥ 3 psychotropic/opioid drugs and drug combinations including non-steroid anti-inflammatory drugs (NSAIDs) increased significantly. Serious drug–drug interactions were scarce both on admission and discharge (0.7%). *Conclusions.* Inappropriate prescribing was prevalent among older people acutely admitted to hospital, and the prevalence was not reduced during stay at an intermediate-care nursing home unit specially designed for these patients.

Key Words: *Acute illness, drug–drug interactions, elderly, general practice, hospital, intermediate care unit, NORGEP screening tool, Norway, potentially inappropriate medications*

Introduction

Community-dwelling older people are treated with on average 2.8 to 5.0 drugs [1,2]. Due to age-related changes and drug interactions, they are at increased risk of adverse drug events.

Inappropriate drug prescribing can be defined as medication for which the risks outweigh the benefits [3,4]. Based on the widely cited Beers' criteria for drugs to avoid for older people [5], the prevalence of potentially inappropriate medications (PIMs) ranged from 18% to 42% in the community [4]. However, almost half the drugs meeting Beers' criteria are unavailable outside the United States; consequently, other criteria have been established in European countries, such as the Norwegian general practice (NORGEP) [6] criteria.

Frail older people are at risk of acute health deterioration that may necessitate emergency hospital admission. Hospital departments are becoming increasingly specialized, while the length of stay is declining. Older people with complex health problems often need more comprehensive treatment and rehabilitation than hospital departments can provide. To close the gap between hospitals and primary health care, various types of intermediate-care units have been developed [7]. Studies suggest that these units may reduce readmissions to hospital and improve survival [7–9]. Treatment in an

Correspondence: Marit Stordal Bakken, MD, Kavli Research Centre for Ageing and Dementia, Haraldsplass Deaconess Hospital, Ulriksdal 8c, N-5009 Bergen, Norway. Tel: +47 55978500. E-mail: Marit.Bakken@isf.uib.no

(Received 16 June 2011; accepted 8 May 2012)

ISSN 0281-3432 print/ISSN 1502-7724 online
DOI: 10.3109/02813432.2012.704813

Older people are at increased risk of adverse drug events. Screening tools may identify potentially inappropriate medications. Treatment in intermediate care units may possibly provide an opportunity for reducing inappropriate prescribing.

- Inappropriate prescribing was prevalent among community-dwelling older people on emergency admittance to hospitals in Bergen, Norway.
- Concomitant use of ≥ 3 psychotropic/opioid drugs and drug combinations including non-steroid anti-inflammatory drugs (NSAIDs) increased significantly during stay.
- Serious drug–drug interactions were scarce on admission and discharge.

intermediate-care nursing home unit (INHU) is based on a multidisciplinary geriatric approach under the guidance of a specialist in geriatrics and may possibly provide better conditions than hospital wards (HWs) for improving the quality of drug prescribing.

On the instructions of the Municipality of Bergen, Norway, an open randomized study was conducted to evaluate a recently established INHU. Community-dwelling older people acutely admitted to hospital were randomly assigned to treatment in the INHU or in HWs. Retrospectively we designed the present study aiming to identify inappropriate prescribing on admission and discharge, and to compare changes during stay within and between the study groups.

Material and methods

Setting

Two hospitals provide emergency treatment in Bergen (about 250 000 inhabitants). The INHU provides health care to inhabitants aged ≥ 70 years after discharge from hospital departments of internal medicine or orthopaedic surgery. Patients are eligible for the INHU if transferrable within 72 hours after emergency admission and dischargeable from the INHU to their residence within three weeks. Patients who need surgery or intensive care, and those with delirium or severe dementia, are not eligible. The INHU provides a multidisciplinary geriatric approach, with physicians, nurses, and physiotherapists more available than in regular nursing home units. Essentially, treatment in the INHU is targeted at rehabilitation, nutrition, and medication review; however, the procedures are not standardized.

Study population

From August 2007 to June 2008, 400 patients were consecutively recruited on emergency hospital admission. Randomization was performed at each hospital; 200 patients were assigned to the INHU and 200 to HWs. In this substudy, 290 patients (157 in the INHU and 133 in HWs) were included. Patients were regarded as ineligible if not retrospectively identifiable in the hospital data systems (n = 10), medication lists were unavailable (n = 6), consent was withdrawn (n = 14), or due to practical and administrative errors early in the study period, such as patients not actually meeting the inclusion criteria or being randomized twice (n = 80).

Data collection

Charged by the Municipality of Bergen, a private research institute (Agenda Musemann) performed inclusion, randomization, and data collection. We obtained the following variables; patients' age and sex, setting (INHU or HW), length of stay, all medications used regularly and "as required" on admission and discharge. Medications were coded according to the Anatomical Therapeutic Chemical (ATC) classification system [10].

Inappropriate prescribing

As clinical information was not available, patients' medication lists were screened according to the explicit NORGEP criteria [6], comprising 21 single drugs and 15 drug combinations considered inappropriate for community-dwelling people aged ≥ 70 years, regardless of their clinical condition (Table I). Two NORGEP-listed drugs have been withdrawn from the Norwegian market, leaving 34 eligible criteria. Medication lists were screened for drug–drug interactions (DDIs) listed in a Norwegian interactive database (DRUID) [11]. DDIs were classified on a four-point severity scale: (A) of academic interest; (B) take precautions; (C) should be administration 2–3 hours apart; and (D) should not be combined [11].

Statistical analysis

A chi-squared test (categorical data) and Student's t-test (continuous data) were used to compare prevalence of drug use, PIMs, and DDIs on admission and discharge, within and between study groups. Logistic regression was performed to compare changes regarding drug use, PIMs, and DDIs from admission to discharge, between HW and INHUs (adjusted for patients' age, sex and drug use, PIMs, and DDIs on admission). We considered $p < 0.05$ to

Table I. Potentially inappropriate medications (PIMs) identified on admission to and discharge from intermediate care nursing home unit (INHU) and hospital ward (HW).

NORGEP criteria	INHU admission (n = 157) %	INHU discharge (n = 157) %	HW admission (n = 133) %	HW discharge (n = 133) %	All patients admission (n = 290) %	All patients discharge (n = 290) %
1. Amitriptyline	1.3	0.6	2.3	2.3	1.7	1.4
2. Doxepin	0.6	0.6	0	0	0.3	0.3
3. Clomipramine	0.6	0.6	0	0	0.3	0.3
4. Trimipramine	0	0	0	0	0	0
5. Chlorpromazine[1]	0	0	0	0	0	0
6. Chlorprothixene	0	0	0	0	0	0
7. Levomepromazine	0	0	0	0	0	0
8. Prochlorperazine	1.3	1.9	3.0	3.0	2.1	2.4
9. Diazepam	4.5	4.5	5.3	11.3	4.8	7.6
10. Nitrazepam	4.5	3.2	2.3	3.0	3.4	3.1
11. Flunitrazepam	0	0	0	0	0	0
12. Oxazepam 30 mg/24 h	1.9	5.7	0	0	1.0	3.1
13. Zopiclone 7.5 mg/24 h	0.6	0.6	0	0	0.3	0.3
14. Carisoprodol[1]	0	0	0	0	0	0
15. Dextropropoxyphene	2.5	2.5	0.8	0.8	1.7	1.7
16. Theophylline	0.6	0.6	1.5	1.5	1.0	1.0
17. Sotalol	0	0	0	0	0	0
18. Dexchlorfeniramine	0	0.6	0	0	0	0.3
19. Promethazine	0	0	0	0	0	0
20. Hydroxyzine	0.6	1.9	0	0	0.3	1.0
21. Alimemazine	0	0	0	1.5	0	0.7
22. Warfarin + NSAID	0.6	0.6	0	0	0.3	0.3
23. Warfarin + ofloxacin or ciprofloxacin	0	0	1.5	2.3	0.7	1.0
24. Warfarin + erythromycin or clarithromycin	0	0	0	0	0	0
25. Warfarin + SSRI	1.9	3.2	3.8	3.0	2.8	3.1
26. NSAID/coxib + ACE inhibitor/ARB	2.5	5.1	1.5	1.5	2.1	3.4
27. NSAID + diuretic	1.3	3.2	0	2.3	0.7	2.8
28. NSAID + glucocorticoid	0	1.3	0	1.5	0	1.4*
29. NSAID + SSRI	0	3.2	0	0.8	0	2.1**
30. Erythromycin or clarithromycin + statin	1.3	0	0	0	0.7	0
31. ACE inhibitor + potassium or potassium-sparing	1.3	1.3	3.8	5.3	2.4	3.1
32. Fluoxetine or fluvoxamine + TCA	0	0	0	0	0	0
33. Beta blocker + cardioselective calcium antagonist	0	0	0	0	0	0
34. Diltiazem + lovastatin or simvastatin	0.6	0.6	0	0	0.3	0.3
35. Erythromycin or clarithromycin + carbamazepine	0	0	0	0	0	0
36. Concomitant prescription of three or more drugs within the groups centrally acting analgesics, antipsychotic agents, antidepressants and/or benzodiazepines	4.5	14.0**	2.3	12.8**	3.4	13.4**
Any NORGEP criterion	25.5	33.1	22.6	36.8**	24.1	34.8**

Notes: NSAID = non-steroidal anti-inflammatory drug; SSRI = selective serotonin reuptake inhibitor; ACE angiotensin-converting enzyme; ARB = angiotensin-receptor blocker; TCA = tricyclic antidepressant. [1]Withdrawn from the Norwegian market. Chi-squared test with Yates' correction for changes from admission to discharge; Fisher if < 5 expected cases; $*p < 0.05$; $**p < 0.01$. Logistic regression was not conducted due to multiple empty cells, and very small numbers in most remaining cells.

be statistically significant. PASW version 17 software was used.

Results

The 290 study participants (71% women) had a mean (SD) age of 84.7 (6.2) years. Patients in the INHU and HWs did not differ significantly regarding age, sex, or drug use on admission. The mean length of stay was 21 days in the INHU, 10 days in the HW ($p < 0.01$).

Drug use

The mean (SD) number of drugs used increased from 6.0 (3.3) per patient on admission to 9.3 (3.8)

on discharge ($p < 0.01$); regular drugs increased from 5.6 (3.2) to 7.3 (3.3), and drugs used "as required" from 0.4 (0.8) to 2.0 (1.6), both $p < 0.01$. Increased drug use was mainly caused by more prescribing of antiemetics, laxatives, antibiotics, analgesics, anxiolytics, hypnotics/sedatives, and cough and cold medications, all $p < 0.01$ (Table II).

Compared with patients in HWs, INHU patients were less likely to use antithrombotic agents (odds ratio (OR) = 0.36, 95% confidence interval (CI) 0.16–0.78) and antibiotics (OR = 0.32, 95% CI 0.17–0.60) at discharge and more likely to use non-opioid analgesics (OR = 2.20, 95% CI 1.32–3.67) and cough and cold medications (OR = 2.24, 95% CI 1.09–4.61) (see Table I).

Potentially inappropriate medications

We identified 23 out of 34 NORGEP criteria in our study population (see Table I). The prevalence of using any PIM increased from 24% on admission (20% men, 26% women), to 35% on discharge ($p < 0.01$), due to more PIMs in HWs ($p = 0.02$) but not in the INHU ($p = 0.2$). Concomitant use of ≥ 3 psychotropic/opioid drugs was the criterion most frequently identified and increased from admission

Table II. Prevalence of drug use on admission and discharge, and changes in drug use during stay, within and between study groups.

ATC code	Drug group	All patients admission (n = 290) %	All patients discharge (n = 290[1]) %	HW discharge (n = 133) %	INHU discharge (n = 157) %	Comparison of the change in drug use from admission to discharge between HW and INHU[2]	
						Odds ratio	95% Confidence interval
A02	Drugs for acid-related disorders	20.3	24.5	26.3	22.9	0.80	0.32–2.17
A03	Drugs for functional gastrointestinal disorders	1.4	20.7**	21.8	19.7	0.85	0.47–1.53
A06	Laxatives	12.4	45.2**	41.4	48.4	1.57	0.94–2.62
A11	Vitamins	10.0	15.5*	15.0	15.9	1.70	0.61–4.64
A12	Minerals	20	27.9*	26.3	29.3	1.03	0.48–2.23
B01	Antithrombotic agents	59.0	64.5	72.2	58.0	0.36	0.16–0.78
B03	Anti-anaemic preparations	14.1	19.0	16.5	21.0	1.44	0.54–3.88
C01	Cardiac therapy	23.1	25.2	26.3	24.2	0.76	0.29–2.00
C03	Diuretics	39.7	42.1	45.9	3.8	0.76	0.26–2.18
C07	Beta-blocking agents	40.0	42.4	44.4	40.8	0.44	0.15–1.35
C08	Ca^{2+} channel blockers	16.9	18.6	21.8	15.9	4.16	0.91–19.02
C09	Agents acting on the renin-angiotensin system	38.6	36.6	36.8	36.3	1.12	0.48–2.59
C10	Lipid-modifying agents	27.6	29.0	27.1	30.6	0.89	0.12–6.51
H03	Thyroid therapy	15.5	25.9	12.0	17.8	–	
J01	Antibacterial agents for systemic use	10.0	21.4**	29.3	14.6	0.32	0.17–0.60
M01	Anti-inflammatory and anti-rheumatic products, including non-steroids	4.1	9.7**	6.8	12.1	0.67	0.28–1.61
M others	Musculoskeletal system; other drugs	13.4	15.9	18.0	14.0	1.35	0.32–5.69
N02A	Analgesics: opioids	15.9	49.0**	51.1	47.1	0.91	0.55–1.52
N02B	Analgesics: other analgesics and antipyretics	15.9	60.3**	51.9	67.5	2.20	1.32–3.67
N05A	Psycholeptics: antipsychotics	3.8	5.5	6.0	5.1	1.0	0.25–3.91
N05B	Psycholeptics; anxiolytics	11.0	19.0**	18.0	19.7	1.37	0.59–3.18
N05C	Psycholeptics: hypnotics and sedatives	23.8	49.0**	47.4	50.3	1.19	0.68–2.01
N06A	Psychoanaleptics: antidepressants	16.2	17.6	15.0	19.7	1.65	0.38–7.16
R03	Drugs for obstructive airway disease	14.8	19.3	16.5	21.7	1.32	0.48–3.60
R05	Cough and cold preparations	3.8	17.9**	13.5	21.7	2.24	1.09–4.61
S01	Ophthalmologicals	11.7	17.6*	18.0	17.2	2.59	0.89–7.50

Notes: INHU = intermediate nursing home unit; HW = hospital ward. [1]Test of overall change in proportion of drug use from admission to discharge (chi-squared test, Fisher if < 5 expected cases). [2]Logistic regression, adjusted for age, sex, and drugs used on admission (reference: INHU). *$p < 0.05$, **$p < 0.01$.

to discharge ($p < 0.01$), mainly due to enhanced use of anxiolytics and hypnotics/sedatives. The prevalence of inappropriate drug combinations increased for NSAIDs + steroids ($p \leq 0.05$) and NSAIDs + selective serotonin reuptake inhibitors (SSRIs) ($p \leq 0.01$). No significant reduction in any criterion could be identified. Patients in the INHU were less likely than HW patients to start treatment with diazepam (OR = 0.17, 95% CI 0.04–0.79, not shown in table).

Drug–drug interactions

Serious DDIs (class D) were scarce (0.7% on admission and discharge); clarithromycin + simvastatin (n = 1), warfarin + NSAIDs (n = 2), trimethoprim/sulphamethoxazole + methotrexate (n = 1). Less serious DDIs increased significantly (Table III), but there were no significant differences between study groups. Generally, being exposed to a certain DDI on admission was the strongest predictor of this DDI at discharge (not shown in table). Prevalence of DDIs did not differ significantly between genders.

Discussion

On admission, every fourth patient was exposed to inappropriate prescribing, and prevalence increased during the stay in both INHU and HWs.

Strengths and limitations

To our knowledge, this is the first study examining inappropriate prescribing in an INHU. NORGEP, tailored for community-dwelling older persons, and DRUID provide the advantage of being based on the national drug formulary. Although the design was appropriate to examine drug therapy changes during the stay in INHU and HWs, the main study was not designed for assessing difference in inappropriate prescribing between these units. We have included patients' complete medication lists. Prescribing of drugs used "as required" increased from 0.4 on admittance to 2.0 on discharge, indicating that most of these drugs were initiated for the treatment of actual symptoms; we have no reasons to believe that these drugs have not been used. The most important limitation was the lack of clinical information. Consequently, the reasons for drug therapy changes made could not be examined. Assessing drugs prescribed for specific diagnoses, or structured medication reviews [1,12,13], would have provided a more comprehensive picture, including overprescribing, underprescribing, and incorrect prescribing.

Drug utilization

Drug utilization studies among community-dwelling older people are scarce, and comparison is hampered by differences in study population, data source, and criteria for inappropriate prescribing; prevalence figures should therefore be interpreted with caution.

Our study population used on average 5.6 regular drugs versus 2.8 regular drugs used by the general community-dwelling population aged 70–74 years in the same county in Norway [14] and 5.0 drugs used by people on average aged 78 years on acute hospital admission in Ireland [1]. Increased drug use during the study period was mainly due to treatment of infections and pain that may have caused the actual hospital admissions. Earlier discharge from the HW may explain group differences on discharge regarding antibiotics and antithrombotic agents, while more use of non-opioid analgesics or cough and cold medications in the INHU may reflect more symptomatic treatment during longer stays.

Table III. Drug–drug interactions identified on admission to and discharge from intermediate-care nursing home unit (INHU) and hospital ward (HW).

Drug–drug interaction (DRUID) severity scale	HW admission (n = 133) %	HW discharge (n = 133) %	INHU admission (n = 157) %	INHU discharge (n = 157) %	All patients admission (n = 290) %	All patients discharge (n = 290) %
A	31.6	44.4*	24.8	39.5**	27.9	41.7**
B	39.8	54.1*	40.1	46.5	40.0	50.0*
C	8.3	12.8	6.4	11.5	7.2	12.1*
D	0	0	1.3	1.3	0.7	0.7
Any drug–drug interaction	54.9	67.7*	52.9	66.9**	53.8	67.7**

Notes: A = of academic interest; B = take precautions; C = should be administered 2–3 hours apart; D = should not be combined. Chi-squared test for changes from admission to discharge; Fisher if < 5 expected cases; *$p < 0.05$; **$p < 0.01$. Logistic regression did not reveal significant differences between study groups; results are not shown.

Inappropriate prescribing

Based on NORGEP we found a 24% point prevalence of PIMs on acute hospital admission versus a 35% one-year prevalence among the general Norwegian population 70 years and older in 2008 [15]. The prevalence of PIMs in our study was in accordance with comparable studies regarding long-acting benzodiazepines, multiple psychotropic drugs, anticholinergic drugs, and NSAIDs [2,14–21]. These PIMs are clinically significant due to the increased risk of adverse side effects; extensive use of psychotropic drugs leads to sedation, cognitive decline, delirium, and falls; use of NSAIDs by older people may induce renal failure, congestive heart failure, and gastrointestinal bleeding. The high overall DDI prevalence in this study supports previous studies on older inpatients [22,23]. The increase in DDIs during stay is explained by increased overall drug use [24]. However, one might question the clinical relevance, because serious DDIs were scarce in our as in other studies [24–26].

In Norway, GPs have an overall responsibility for coordinating drug therapy for the patients on their list. However, older people with complex health problems are commonly exposed to prescribing from several doctors, e.g. out-of-hours services and specialists; this represents challenges to ensure overall prescribing quality. About 20% of hospital admissions of older patients are caused by drug-related problems, most of which are considered preventable [27]. An ongoing Norwegian patient safety campaign recommends that structured medication reviews based on patients' individual clinical characteristics and feasible tools [12] should be conducted when the patients' clinical situation is altered, and when the patients are transmitted between different health care levels [28]. Questions might be raised as to whether these requirements can be met during short hospital stays; however, appropriate drug therapy changes for the acute conditions, and withdrawal of obviously dangerous medications, should always be conducted. A randomized controlled trial revealed more appropriate drug treatment in a geriatric evaluation and management unit than in general medical wards [29]. Consequently, one might expect that a specially designed INHU for older people with complex health problems could reduce inappropriate prescribing. We can only speculate why this was not the case in this study; possibly INHU physicians were reluctant to interfere with the decisions of patients' GPs. Further, we had no information on written recommendations for drug therapy changes that were provided to patients' GPs on discharge.

Implications

INHUs have just recently been established in Norway, providing a broad multidisciplinary geriatric approach to older people with complex health problems and extensive drug use. Further research is needed to evaluate how these units can contribute to reducing inappropriate prescribing in cooperation with patients' GPs, along with geriatric hospital wards and geriatric outpatient clinics. Studies, primarily designed to assess how inappropriate prescribing affects health outcomes, are needed [30].

Ethics and confidentiality

The Regional Committee for Medical and Health Research Ethics and the Norwegian Data Inspectorate approved the study. All study participants provided informed consent. We had no access to patients' identity or medical records.

Acknowledgements

The Norwegian Medical Association and the Municipality of Bergen, Norway, supported this work. The authors would like to thank all those in the Municipality of Bergen, Haukeland University Hospital and Haraldsplass Deaconess Hospital contributing to data collection for this study.

Declaration of interest

The authors report no conflict of interest. The authors alone are responsible for the content and writing of the paper.

References

[1] Barry PJ, Gallagher P, Ryan C, O'Mahony D. START (Screening Tool to Alert doctors to the Right Treatment) – an evidence–based screening tool to detect prescribing omissions in elderly patients. Age Ageing 2007;36:632–8.

[2] Brekke M, Rognstad S, Straand J, Furu K, Gjelstad S, Bjørner T, et al. Pharmacologically inappropriate prescriptions for elderly patients in general practice: how common? Baseline data from the Prescription Peer Academic Detailing (Rx-PAD) study. Scand J Prim Health Care 2008;26:80–5.

[3] Spinewine A, Swine C, Dhillon S, Lambert P, Nachega JB, Wilmotte L, et al. Effect of a collaborative approach on the quality of prescribing for geriatric inpatients: a randomized, controlled trial. J Am Geriatr Soc 2007;55:658–865.

[4] Chang CB, Chan DC. Comparison of published explicit criteria for potentially inappropriate medications in older adults. Drugs Aging 2010;27:947–57.

[5] Fick DM, Cooper JW, Wade WE, Waller JL, Maclean JR, Beers MH. Updating the Beers criteria for potentially inappropriate medication use in older adults: Results of a US consensus panel of experts. Arch Intern Med 2003;163: 2716–24.

[6] Rognstad S, Brekke M, Fetveit A, Spigset O, Wyller TB, Straand J. The Norwegian General Practice (NORGEP) criteria for assessing potentially inappropriate prescriptions to elderly patients: A modified Delphi study. Scand J Prim Health Care 2009;27:153–9.
[7] Young J. The development of intermediate care services in England. Arch Gerontol Geriatr 2009;49(Suppl 2):S21–5.
[8] Garasen H, Windspoll R, Johnsen R. Long-term patients' outcomes after intermediate care at a community hospital for elderly patients: 12-month follow-up of a randomized controlled trial. Scand J Public Health 2008;36:197–204.
[9] Garasen H, Windspoll R, Johnsen R. Intermediate care at a community hospital as an alternative to prolonged general hospital care for elderly patients: A randomised controlled trial. BMC Public Health 2007;2:7.
[10] World Health Organization (WHO) Collaborating Centre for Drug Statistics Methodology. Guidelines for ATC classification and DDD assignment. Oslo. Available from: http://www.whocc.no/atcddd/ [cited May 2011].
[11] Spigseth O. Drug Information Database (DRUID); http://www.interaksjoner.no (accessed 28 October 2011).
[12] Gallagher P, Ryan C, Byrne S, Kennedy J, O'Mahony D. STOPp (Screening Tool of Older Person's Prescriptions) and START (Screening Tool to Alert doctors to Right Treatment). Consensus validation. Int J Clin Pharmacol Ther 2008;46:72–83.
[13] Kaur S, Mitchell G, Vitetta L, Roberts MS. Interventions that can reduce inappropriate prescribing in the elderly: A systematic review. Drugs Aging 2009;26:1013–28.
[14] Brekke M, Hunskaar S, Straand J. Self-reported drug utilization, health, and lifestyle factors among 70–74 year old community dwelling individuals in Western Norway. The Hordaland Health Study (HUSK). BMC Public Health 2006;6:121.
[15] Nyborg G, Straand J, Brekke M. Inappropriate prescribing for the elderly: A modern epidemic? Eur J Clin Pharmacol 2012. Epub ahead of print 15 February 2012.
[16] Ryan C, O'Mahony D, Kennedy J, Weedle P, Byrne S. Potentially inappropriate prescribing in an Irish elderly population in primary care. Br J Clin Pharmacol 2009;68: 936–47.
[17] Aparasu RR, Mort JR. Inappropriate prescribing for the elderly: Beers criteria-based review. Ann Pharmacother 2000;34:338–46.
[18] Pitkala KH, Strandberg TE, Tilvis RS. Inappropriate drug prescribing in home-dwelling, elderly patients: A population-based survey. Arch Intern Med 2002;162:1707–12.
[19] Van der Hooft CS, Jong GW, Dieleman JP, Verhamme KM, van der Cammen TJ, Stricker BH, et al. Inappropriate drug prescribing in older adults: The updated 2002 Beers criteria – a population-based cohort study. Br J Clin Pharmacol 2005;60:137–44.
[20] Vandraas KF, Spigset O, Mahic M, Slordal L. Non-steroidal anti-inflammatory drugs: Use and co-treatment with potentially interacting medications in the elderly. Eur J Clin Pharmacol 2010;66:823–9.
[21] Zhan C, Sangl J, Bierman AS, Miller MR, Friedman B, Wickizer SW, et al. Potentially inappropriate medication use in the community-dwelling elderly: Findings from the 1996 Medical Expenditure Panel Survey. JAMA 2001; 286:2823–9.
[22] Doucet J, Chassagne P, Trivalle C, Landrin I, Pauty MD, Kadri N, et al. Drug–drug interactions related to hospital admissions in older adults: A prospective study of 1000 patients. J Am Geriatr Soc 1996;44:944–8.
[23] Egger SS, Drewe J, Schlienger RG. Potential drug–drug interactions in the medication of medical patients at hospital discharge. Eur J Clin Pharmacol 2003;58:773–8.
[24] Johnell K, Klarin I. The relationship between number of drugs and potential drug–drug interactions in the elderly: A study of over 600,000 elderly patients from the Swedish Prescribed Drug Register. Drug Saf 2007;30:911–18.
[25] Bregnhoj L, Thirstrup S, Kristensen MB, Bjerrum L, Sonne J. Prevalence of inappropriate prescribing in primary care. Pharm World Sci 2007;29:109–15.
[26] Glintborg B, Andersen SE, Dalhoff K. Drug–drug interactions among recently hospitalised patients: Frequent but mostly clinically insignificant. Eur J Clin Pharmacol 2005;61:675–81.
[27] Beijer HJ, de Blaey CJ. Hospitalisations caused by adverse drug reactions (ADR): A meta-analysis of observational studies. Pharm World Sci 2002;24:46–54.
[28] 'In safe hands': The Norwegian patient safety campaign 2011–2013. Available from: http://www.pasientsikkerhetskampanjen.no/
[29] Saltvedt I, Spigset O, Ruths S, Fayers P, Kaasa S, Sletvold O. Patterns of drug prescription in a geriatric evaluation and management unit as compared with the general medical wards: A randomised study. Eur J Clin Pharmacol 2005; 61:921–8.
[30] Page RL 2nd, Linnebur SA, Bryant LL, Ruscin JM. Inappropriate prescribing in the hospitalized elderly patient: Defining the problem, evaluation tools, and possible solutions. Clin Interv Aging 2010;5:75–87.