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POTENTIALLY INAPPROPRIATE MEDICATION USE

AMONG

COMMUNITY RESIDING ELDERLY CANADIANS

by

© Katherine Elizabeth Turcotte

Thesis submitted to
the School of Graduate Studies and Research
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ABSTRACT

The purpose of this study was to determine the prevalence of potentially inappropriate medication use among the community residing Canadian elderly. Models were constructed in order to identify characteristics of the elderly that may place an individual at a higher risk for potentially inappropriate medication use. A composite score was developed with which to rank individuals and summarize the results.

Adverse drug reactions (ADRs) are a risk of medication use, and can be the result of multiple drug use, age-related changes in pharmacodynamics and pharmacokinetics, and inappropriate medication use. Medication use is common among the elderly because of deteriorating health and the accumulation of co-morbid conditions associated with age. Inappropriate medication use is a concern for the community residing as well as the institutionalized elderly, as it can lead to morbidity, hospitalization, or death.

Drugs prescribed for elderly patients, and the manner in which they are taken, are influenced by prescribing factors. The behaviour of the prescriber, the provider and the consumer, as well as the physiological factors of the consumer have been described. These form the basis of seven types of inappropriate medication use among the elderly identified to study potentially inappropriate medication use among the elderly. Factors contributing to the development of ADRs have been summarized here in a conceptual framework.

This study is divided into two parts: the analysis of data abstracted from day-hospital admission charts, and the analysis of a nationally representative health survey. The objectives of this study are:

1. to determine the prevalence of potentially inappropriate medication use among the

elderly;

2. to examine the relationships between selected socio-demographic and health characteristics, and potentially inappropriate medication use among the elderly;

3. to construct a model with which to identify those among the elderly who are at a higher risk for potentially inappropriate medication use.

Patients attending a day-hospital represent a segment of the community residing elderly population with a high number of co-morbid conditions and increased disease severity. The Elisabeth Bruyère Day-Hospital (EBDH) study is a cross-sectional review of the health status and medication regimens of 102 day-hospital patients at the time of admission.

The National Population Health Survey (NPHS) is the most current database that allows for national estimates of drug use by the Canadian population. It is a cross-sectional review of the health status and medication regimens of a representative sample of the Canadian population.

From the literature review, predetermined criteria were selected based on the seven types of inappropriateness of medication use. Among the day-hospital patients, 11.1 (±10.3) percent of males and 23.1 (± 10.2) percent of females were classified as taking at least one potentially inappropriate medication, a total of 18.8 (± 7.6) percent of the whole sample. Univariate LR identified five variables significantly related to potentially inappropriate medication use: Smoking Status, Main Health Problem, Depression, Source of Referral and Drug Use. Multivariate LR identified five significant variables: Sex, Smoking Status, Main Health Problem, Cognitive Status and Drug Use. The composite score indicated that those at the highest risk for potentially inappropriate medication use had an odds ratio (OR) of 9.4.

Among the Canadian population, 7.3 (± 1.6) percent of elderly males and 7.1 (± 1.3) percent of females, taking at least one medication, were classified as taking at least one potentially inappropriate medication. Univariate LR identified 14 variables significantly related to potentially inappropriate medication use. Multiple LR resulted in a five-variable model: Social Support, Self-Rated Health, Dexterity, Self-esteem and Drug Use. The composite score indicated that those at the highest risk for potentially inappropriate medication use had an OR of 7.0.

This identification of high-risk elderly can be used for further studies aimed at reducing the occurrence of potentially inappropriate medication use, leading to reduced drug-related morbidity, lower health care costs, and increased quality-of-life. This study will provide a basis for the monitoring of potentially inappropriate medication use among the community residing Canadian elderly.

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LIST OF ABBREVIATIONS

ADL	activities of daily living
ADR	adverse drug reaction
ATC	Anatomic-Therapeutic-Chemical drug classification
bid	twice daily
BMI	body mass index
CAI	computer assisted interview
CNS	central nervous system
DIN	drug identification system
EBDH	Elizabeth Bruyère Day-Hospital
GAOT	Geriatric Assessment Outreach Team
GDS-SF	Geriatric Depression Scale – Short Form
HPs	Health Practitioners
IADL	instrumental activities of daily living
ICD-9	International classification of disease, version 9
kg	kilograms
LFS	Labour Force Survey
LR	logistic regression
LRT	Likelihood Ratio Test
m	meter
MD	medical doctor
MMSE	Mini-Mental Status Examination
N	population size
NPHS	National Population Health Survey
ns	not significant
NSAID	non-steroidal anti-inflammatory drug
OR	odds ratio
OTC	over the counter
PRN	pro re nata, medication prescribed "as needed"
PUP	potentially undesirable prescription
SOC	Sisters of Charity
tid	three times daily
WHO	World Health Organization
qid	four times daily

Chapter 1: INTRODUCTION

This study will examine the prevalence of potentially inappropriate medication use among the community residing Canadian elderly. Socio-demographic and health characteristics statistically associated with this problem will be identified, and models will be constructed in order to identify those at high risk for potentially inappropriate medication use. By doing this, a baseline will be established for further monitoring of the situation.

1.1 Basis for the Study

Any medication use can lead to an adverse drug reaction (ADR). ADRs range from mild to severe, and can result in hospitalization or death.[1] Several factors increase the risk of having an ADR. Inappropriate medication use is the leading cause of ADRs and can be the result of many different circumstances.[2] Concurrent use of two or more medications (polypharmacy) increases the potential for drug interactions.[3] Age-related changes in drug distribution and elimination by the body (pharmacokinetics) influence the amount of active drug present. Age-related changes in the interactions between the body and the drug(s) (pharmacodynamics) can require changes in prescribing habits.[2] Medication use is prevalent among the elderly because of deteriorating health status associated with increased age and the accumulation of co-morbid conditions associated with age.[4, 5, 6]

Traditionally defined as 65 years and older, the elderly comprise approximately 12 percent of the total Canadian population.[7] This subgroup of the population has been reported to account for one-quarter to over one-third of total prescription medication use.[8, 9, 10, 11] Of the current estimated 3.6 million elderly Canadians, eight percent are living in institutions

while the majority are community residents.[7]

The drawback of studying ADRs is that they cannot be studied until they have actually happened. As a leading cause of ADRs, inappropriate medication use may be studied to evaluate the potential for ADRs to occur within a specific population. Inappropriate prescribing for the elderly is a recurring problem for both institution and community residents.[2, 12] Researchers can approach this topic from either a clinical or a population focus. From a clinical perspective, the prescribing can be evaluated in relation to each patient's specific condition and requirements. If the population is studied, generalized criteria to identify potentially inappropriate medication use are required for elderly patients as a whole. Although medications included in generalized criteria may not be specifically inappropriate for each individual patient, they are considered to present a risk to the population as a whole. Therefore the ability to classify medication use as inappropriate exists even though explicit patient information is unavailable.

1.2 Medication Use Among the Elderly

Population estimates report that the proportion of the Canadian elderly will almost double by the year 2041.[7] Unless changes are made, health issues concerning the elderly are expected to become more and more prominent as this population increases. Describing the current trends in medication use among the elderly, and the problems associated with this use (ADRs), will promote initiatives to improve geriatric care. Tools required for this type of research include classification systems for both the medications and for the conditions for which they are prescribed.

1.2.1 Trends in medication use

Making comparisons between drug utilization studies is difficult because of differing methodologies. Common issues are sample size, sampling frame, geographic location, urban/ rural residence, participation rates, definition of variables, sources of data collection, and coding of variables.[13] Specifically, definitions of drug use and inappropriate drug use; accuracy and completeness of medical records, dependence on patient recall and proxy information; and methods of drug coding will all influence results and conclusions.

The elderly are reported to receive on average three times the number of prescription medications per year than people less than 65 years of age.[14] Elderly women are attributed with being the largest consumer group.[10, 14, 15] Because of the non-normal distribution of medication use in the population, the appropriate summary statistic to describe drug use is the median. However, in the literature, most studies were found to report the mean number of drugs taken per person. The community residing elderly have been found to take a mean number of 1.74 to 4.5 prescription drugs at any one time.[3, 4, 13, 15, 16] They have also been found to receive 8.24 prescriptions per year on average.[14] Meanwhile, the institutionalized elderly receive an average of 7.2 to 8.1 medications.[17, 18] Furthermore, it has been reported that non-prescription over-the-counter (OTC) medication is used by 52 to 76 percent of the community residing elderly population.[4, 10]

Polypharmacy can be defined as the concurrent use of two or more medications, although it has frequently been restricted to the concurrent use of five or more.[6] From 4.6 to 11.8 percent of elderly women and 6.5 to 13.9 percent of elderly men have been reported to use five or more prescription medications at any one time.[10]

The overuse of psychoactive medications by the elderly population has been a topic of particular concern.[18, 19, 20, 21] Studies of the institutionalized elderly have focused on inadequate diagnosis for psychoactive drug use.[22,23] Other studies have looked at long-term prescribing without adequate supervision;[24] polypharmacy, excessive dose and duration, therapeutic duplication and hazardous combinations;[19] and inadequate selection of the optimum drugs.[23]

1.2.2 Drug and Therapeutic classification

Describing and evaluating medication use requires a means of classifying the drugs and drug groups, as well as the medical conditions associated with medication use. Several drug coding systems exist, including the Drug Identification Number (DIN), the American Hospital Formulary Service (AHFS) Pharmacologic- Therapeutic classification, and the Anatomical-Therapeutic-Chemical (ATC) drug classification system. The AHFS is most common in the North American literature, while international research is more likely to use the ATC. The ATC system is the standard for the Therapeutic Products Program of Health Canada, and was used to report drug use in this study.

The AHFS is a numeric classification system with 30 drug classes, 24 of which are currently in use in the printed version of AHFS Drug Information.[25] The ATC drug classification system is an alpha-numeric hierarchical system which permits the identification of a specific chemical.[26] As classified by the ATC, there are 15 separate drug classes (Table 1.1).

Table 1.1: American Hospital Formulary Service and Anatomical-Therapeutic-Chemical drug classification systems.

American Hospital Formulary	Anatomical-Therapeutic-Chemical
Antihistamine Drugs	Alimentary tract and metabolism
Anti-Infective Agents	Blood and blood forming organs
Antineoplastic Agents	Cardiovascular system
Autonomic Drugs	Dermatologicals
Blood Derivatives	Genito urinary system and sex hormones
Blood Formation and Coagulation	Systemic hormonal preparations
Cardiovascular Drugs	Systemic hormonal preparations excluding sex hormones
Central Nervous System (CNS) Agents	General antiinfectives for systemic use
Diagnostic Agents	Antineoplastic and immunomodulating drugs
Electrolytic/Caloric/Water Balance	Musculo-skeletal system
Enzymes	Central nervous system
Qantitussives, Expectorants, and Mucolytic Agents	Antiparasitic products
Eye,Ear,Nose, and Throat Preparations	Respiratory system
Gastrointestinal Drugs	Sensory organs
Gold compounds	Various
Heavy Metal Antagonists	
Hormones and Synthetic Substitutes	
Local Anesthetics	
Oxytocics	
Serums, Toxoids, and Vaccines	
Skin and Mucous Membrane Agents	
Smooth Muscle Relaxants	
Vitamins	
Unclassified Therapeutic Agents	

Drug classes and subclasses commonly prescribed to the elderly are Cardiovascular Drugs, Analgesics, Gastrointestinal Drugs, Anti-infective Agents, Blood Formation and Coagulation, and Bronchodilators.[6, 9, 10, 13, 14, 15] Vitamins, antacids, and laxatives are OTC medications consumed by the elderly.[4]

The 9th revision of the World Health Organization International Classification of Disease (ICD-9) is a system frequently used for coding health conditions and medical procedures.[27] The ICD-9 was used in this study.

1.2.3 Adverse drug reactions

Inappropriate medication use is a known risk factor for ADRs,[2, 17, 28] however there is much more literature on ADRs than on inappropriate medication use. By understanding the causes and consequences of ADRs among the elderly, it has been possible to establish prescribing guidelines for the elderly. With optimum prescribing for the elderly, the occurrence of inappropriate medication use would decrease, and with it the occurrence of ADRs.

Based on the World Health Organization (WHO) definition, an ADR is "...any response to a drug that is noxious and unintended and that occurs at doses used in man for prophylaxis, diagnosis, or therapy, excluding failure to accomplish the intended purpose."[1] Two common categories for the mechanisms of ADRs are predictable extensions of known pharmacological effects, and unpredictable immunologic or unknown mechanisms.[29] Two less common types are long-term and delayed ADRs.[30]

ADR reporting systems are only as good as the quality of the reports and the consistency of the reporting. ADRs are often reported without indicating the degree of certainty that the event is actually an ADR, whether it be definite, probable, possible, conditional, or unlikely.[1] Most ADR reporting systems are spontaneous reports from health care professionals and, sometimes, from the public.[31] These systems can be used only to detect signals, and require follow-up studies.

Studies which include only definite and probable ADRs are suggested to underestimate the true occurrence, while those which also include possible ADRs are suggested to overestimate the true occurrence.[1] ADRs are often reported without indicating

the level of severity. Other missing information, such as age and sex, diminishes the quality of the ADR reports and therefore their usefulness in determining the occurrence of ADRs.

Studying the extent of ADRs is further complicated by the difficulty of accurately detecting an ADR and linking it to the use of a particular drug or drug combination.[17, 32] ADRs are not always recognized in the elderly because the signs and symptoms are easily dismissed as the consequences of ageing rather than the effects of drug use.[1, 5, 21, 33, 34] Common ADRs experienced by the elderly are headaches, nausea, gastrointestinal bleeding, and anticholinergic reactions. Anticholinergic reactions include both the peripheral and central nervous systems. Reactions of the peripheral nervous system result in dry mouth and constipation, while those of the central nervous system result in confusion, disorientation, sedation, sleep disturbances and dizziness.[35]

ADRs are commonly associated with those drug classes and subclasses most frequently prescribed: Cardiovascular, Central Nervous System (CNS), Analgesics and Gastrointestinal.[36] Practice guidelines for identifying ADRs have been published, however the studies undertaken are not in agreement.[31]

Studies reporting the occurrence of ADRs and ADR-related hospitalizations vary considerably with regard to population and setting. In general, three to eight percent of total hospitalizations are the result of ADRs,[34] and ADRs have been reported to account for ten to 20 percent of hospitalizations among the elderly.[31, 32, 37] In a different study, three percent of ADR related hospitalizations were reported to be the result of inappropriate prescriptions, unnecessary medications, and absolute contraindications.[2] General characteristics previously identified as being associated with ADR related hospitalization among the elderly are being

female, an inability to recall the medication regimen, number of physicians, number of medications prescribed, and medium income.[38]

Not only do ADRs lead to hospitalization, but being in hospital exposes patients to the chance of having an ADR. One study found an overall incidence of six percent of probable or definite ADRs during hospitalization.[39] Furthermore, another study reported that routine screening for potential drug interactions was not performed regularly by emergency department physicians before treating patients.[40]

Patients in nursing homes, most of whom are elderly, have a 20 to 53 percent chance of experiencing an ADR.[31, 36] Of all unexpected events (falls, non-fall-related injuries, medication-related events, wandering, physical assaults, aspirations, inappropriate performance of a procedure, and suicide attempts), five percent were attributed to ADRs, errors in medication dosing, and errors in administration.[41] Nursing home patients appear to be at high risk of having an ADR because of an increased number of medical conditions, little physician input, and medications prescribed on an "as needed" (pro re nata, PRN) basis.[21, 36]

Studies have reported that ten percent of the community living elderly population reported experiencing an ADR,[33] and 30 percent of elderly outpatients taking medication reported experiencing an ADR with at least one drug.[5] In both of these studies, 75 percent of those with an ADR reported these symptoms to their physicians.

1.3 Prescribing Factors

ADRs can result from inappropriate medication use.[2, 17, 28] This, in turn, can result from inappropriate prescriptions[44] or non-adherence to the medication regimen.[35, 38, 42] An

appropriate medication regimen is dependent on the behavioural characteristics of the prescribers and providers, as well as the physiological and behavioural characteristics of the consumers. All of these issues must be clearly understood and considered when studying medication use by the elderly.

1.3.1 Behavioural factors: Prescribers and providers

The common aim of physicians and pharmacists is to provide the most appropriate pharmaceutical care possible to their patients.[43] These professionals are considered to be responsible for providing information regarding the disease, consequences of neglecting medical intervention, and the benefits of complying to the prescribed regimen.[42] However the prescribing behaviour of a physician is dependent on many contributing factors: guidelines, off-label use, patient or family expectation, personal characteristics, and advertising. Guidelines have been established for the prescribing of medication. The awareness of these guidelines by the prescribers, as well as general experience in prescribing, will influence the choices made. The practice of "off-labelling", prescribing a medication to treat a condition other than that for which the drug is indicated, can lead to the inappropriate use of a medication. Patient or family expectation that a medication will be prescribed may pressure the physician to prescribe a medication that may not be needed.[6] Personal characteristics of the professionals, social and professional influences, and pharmaceutical advertising and representatives all influence prescribing behaviour.[44, 45, 46]

Furthermore, the presence of multiple prescribing physicians and multiple pharmacies involved in dispensing the medications increases the risks of potentially inappropriate

medication use.[47] Optimally, a gatekeeper would be available to monitor each patient. Either a general practitioner or pharmacist could be responsible for supervising the overall appropriateness of the complete medication regimen.[48]

1.3.2 Behavioural factors: Consumers

Not all patients comply with the medication regimen prescribed for them, and non-compliance may affect the overall appropriateness of the regimen. Non-compliance is "the failure of the patient to use the specified drug in the specified manner".[49] It has been reported to increase with age, being female, and with increasing numbers of concomitant medications.[35, 38, 42] Salzman (1995) classified non-compliance as either unintentional or intentional.[35] Unintentional non-compliance occurs when the patient forgets to take a medication, or forgets that the medication has already been taken and consequently repeats the dose. Confusion over the dose or frequency of the medication regimen, as well as not understanding the clinical relevance and importance of each medication prescribed, can also lead to unintentional non-compliance.

Intentional non-compliance is suggested to be the result of two separate causes, ADRs and the cost of medications. Experiencing an ADR may cause the patient to choose to alter or terminate the medication regimen, thereby purposefully not complying. Secondly, some patients may view pharmacotherapy as expensive and unaffordable, and not purchase all or any of the prescribed medication. Furthermore, intentional non-compliance may be the result of passive resistance, whereby the patient simply refuses to comply with the doctor's orders.[35]

Eraker (1984) developed a Health Decision Model to evaluate and improve patient compliance.[50] Factors included as influencing compliance to a regimen were general and specific health beliefs, experience, knowledge, social interaction and socio-demographic variables. The level of patient debility in vision, hearing, activities of daily living (ADLs), and specific diseases such as diabetes, congestive heart failure and arthritis have also been suggested to interfere with compliance.[42]

Studies have been conducted to estimate the prevalence of non-compliance and to determine reasons for its occurrence.[38, 51] Methods for determining how closely a patient is following the medical regimen range from interviews, to pill counts, to laboratory tests. Interviewing the patient directly is not considered to be the most reliable method for determining compliance. Compliance may be exaggerated if the patient is embarrassed to admit that the medication regimen has not been followed properly. Alternatively the patient may be afraid to admit that she has not been complying, fearful that she will be perceived as incompetent.[50] A history of non-compliance in the elderly has been associated with living alone, a lack of assistance with taking medications, polypharmacy with two or more medications, patronizing two or more pharmacies, high monthly cost of medications, and the perception that medications are expensive.[38]

There is also recognition that, under certain circumstances, non-compliance is an appropriate action. Intelligent non-compliance occurs when the patient is aware of potential ADRs, and decides to discontinue medication use because of serious adverse symptoms.[42] In a case such as this, the patient should report back to the physician. Similarly, it is not always correct to assume that the treatment prescribed by a physician is the most appropriate,

or that an appropriate treatment will indeed be effective.[50]

1.3.3 Physiological factors: Pharmacokinetics

Pharmacokinetics involve the absorption, distribution, metabolism and excretion of drugs by the body.[52] Although the age-related changes that occur to these mechanisms are not easy to generalize, they need to be taken into consideration when prescribing for the elderly. Associated with an increase in age are an increase in gastric pH, a decrease in intestinal blood flow, a change in gastric emptying time, and a change in gastric motility.[52]

The elderly also tend to have a general decrease in body size, accompanied by a decrease in lean body mass and total body water, and an increase in body fat. This can lead to a decrease in the volume of distribution of water soluble drugs, and an increase for lipid soluble drugs.[34, 52] Furthermore, a decrease in plasma albumin can increase the concentration of free active drug.[52]

Drug metabolism is dependent on liver function.[53] Hepatic metabolism works to convert the drug from a lipophilic form to a more hydrophilic metabolite. First-pass metabolism occurs when the drug absorbed from the gastrointestinal tract is transported directly to the liver via the hepatic portal system, where some or all the drug is metabolized. Any change in hepatic function can significantly reduce the bioavailability of some drugs, requiring an alternate route of administration to be used. For many drugs, metabolism occurs after the drug has entered the circulatory system, reached the target site, and is then returned to the liver via the hepatic vein.[53]

A decrease in functional liver volume, in the rate of hepatic metabolism, in hepatic

blood flow, and in first pass metabolism of drugs by the liver are all associated with increased age.[52] None the less, changes in hepatic metabolism in the elderly are variable[54] and have not been consistently associated with the incidence of ADRs.[34]

Drug excretion is dependent on free active drug, drug half-life, and kidney function.[52, 53] A decrease in plasma albumin can increase the concentration of free active drug thus decreasing the elimination time by altering the plasma half-life.[52]

The kidneys function to eliminate both active drugs and drug metabolites by glomerular filtration and tubular secretion.[53] Lipophilic molecules are readily reabsorbed into the circulatory system, while hydrophilic molecules are eliminated. By the age of 65 years, glomerular filtration rate has decreased on average by 30 percent, accompanied by a decrease in tubular function. Therefore active drugs with a low toxic/therapeutic ratio that are eliminated by the kidney are likely to adversely affect the elderly if not carefully monitored.[34,54]

1.3.4 Physiological factors: Pharmacodynamics

Pharmacodynamics concern the manner in which drugs react with the body and with each other once they have been absorbed.[52] Changes in drug receptor sensitivity and density occur with increased age. For example, beta-adrenoceptors have a decreased response while CNS receptors have an increased response.[34] Homeostatic mechanisms also become less efficient with increased age. Impaired baroreceptor function leaves the elderly more vulnerable to postural hypotension, decreased thermoregulation can lead to hypothermia; and decreased maintenance of posture increases the risk of falls.[52, 54] Furthermore the

maintenance of normal intellectual function, blood sugar levels, and bladder and bowel function become less efficient with increased age, and are therefore more sensitive to the effects of ADRs.

1.4 Applying Criteria for Determining Appropriate Medication Use

The basic aim of pharmacotherapy is to provide treatment in the manner that will most benefit the patient's health. The drugs used must be appropriate for the patient, the disease, and the complete drug regimen. From studies of the appropriateness of drug treatment in the elderly, seven categories of medication use considered to be inappropriate were identified for the purpose of this study.[9, 19, 20, 55] These are:

1. specific drugs inappropriate for geriatric use (eg. Long-acting benzodiazepines);
2. drugs inappropriate for the indication (eg. Cardiac medication to treat diabetes);
3. drugs contraindicated by a medical condition (eg. ß-adrenergic blocking agent to treat hypertension for patients with a history of asthma);
4. excessive dose (any single dose), frequency (daily, bid, tid, qid) or duration (days, weeks, months) of drug use (eg. short-acting benzodiazepine use nightly for > 4 weeks);
5. insufficient dose (any single dose), frequency (daily, bid, tid, qid) or duration (days, weeks, months) of drug use (eg. insufficient dose of antihypertensive medication);
6. concomitant use of more than one drug in the same class (eg. Two sedatives);
7. concomitant use of contraindicated drugs (eg. Potassium-sparing diuretic + potassium supplement).

Criteria developed for judging inappropriate medication use are sets of rules based on

some or all of these seven categories. These criteria can be used in two types of studies: studies of individual patient records and studies of population data.

1.4.1 Studies of patient records

Studies of patient records are those in which each patient record is scrutinised directly with all of the chart information and notes available to the researcher. Data are not abstracted from the chart and are not recorded in a computer database. In this type of study the specific circumstances of each individual patient are available for consideration, and the researcher makes a professional judgement based on clinical knowledge.[56] A medication generally considered to be inappropriate for an elderly person may be judged to be optimal for any particular patient.

The evaluation process in this type of study is difficult to standardize. Sets of criteria for the identification of inappropriate medication use as determined directly from patient records have been developed by several investigators.[2, 45, 57, 58, 59, 60] Specific sets of criteria produced include the Medication Misuse Index,[58] the Medication Appropriateness Index,[61] and the Geriatric Medication Algorithm.[60]

The Medication Misuse Index identified 15 percent of the community elderly with drug misuse based on drug utilization, drug-drug and drug-alcohol interactions, and the redundant use of drugs.[58] The Medication Appropriateness Index is a series of ten criteria supplemented by operational definitions and detailed instructions.[61] The areas of concern include indication for use, effectiveness, dosage, correct and practical directions, clinically significant drug-drug and drug-disease interactions, duplication and duration of therapy, and

cost of medications.

The Geriatric Medication Algorithm attempts to reduce inappropriate prescribing by educating physicians.[60] Each drug is evaluated for indication, risks, and dosage. The medication regimen is examined for drug interactions, additive side effects, and the potential for simplification. Compliance is assessed in terms of knowledge of the patient or caregiver, and need of a compliance aid.

The occurrence of potentially inappropriate medication use has been investigated in several different settings with the use of patient records. In one study, potentially inappropriate prescribing was reported for 43.4 percent of outpatients, including inappropriate daily dose, duplication of therapy, and interacting drug combinations.[57] Another study linked inappropriate prescribing to the occurrence of ADRs in 27 percent of hospitalized elderly patients.[2] Inappropriate prescriptions were defined in terms of unnecessary drugs and those with absolute contra-indications. Interacting drugs, ADRs, and drug-related admissions were also identified.[2] Clinically significant drug problems were identified in 88 percent of elderly hospital patients through the use of summary prescribing scores based on criteria for indication, drug choice, dose, schedule, drug-drug interactions, therapeutic duplication, and drug allergy.[45]

1.4.2 Studies of population data

Studies of population data, such as obtained from administration databases or national surveys, allow researchers to study and compare the potential risks of drugs as used in large populations. These studies can be limited in the amount and detail of clinical information

available on each individual, and often rely on self-reporting. The researcher cannot make decisions for each individual patient, therefore a standardized set of rules, summarizing drugs and drug regimens generally considered to be inappropriate for the elderly population, is required to evaluate these data.[56] Although specific circumstances can validate the appropriateness of a high-risk medication regimen, the potential exists for it to be inappropriate in the general population. However, no one set of criteria have attempted to incorporate all seven of these identified categories (section 4.1) for use with population data.

Sets of criteria to determine potentially inappropriate medication use among the elderly for use with population data and surveys have been developed by several investigators. Ferguson (1990) extracted from the literature a list of cardiovascular, CNS, and antihypertensive drugs (including diuretics) considered to reflect potentially undesirable prescribing (PUP) for elderly persons.[9] These criteria included:

1. more than one drug in the same class;
2. drug classes not to be combined;
3. drugs serving as sub-optimal treatment;
4. drugs and diagnoses not to be combined.

Beers et al. (1991) assembled a list of drugs considered potentially harmful to the institutionalized elderly (Table 1.2).[55] Initial criteria were extracted from guidelines published in English since 1983. In order to produce the final version, consensus was reached by a 13-member panel of judges from the areas of psychopharmacy, pharmaco-epidemiology, clinical geriatric pharmacology, general clinical geriatrics, and long-term care. Inappropriate drug combinations were not considered in this study. These criteria cover:

1. individual drugs or drug classes which should generally be avoided at all times;
2. drugs which should be limited by dose, duration and frequency of use.

It was not implied that toxicity would occur or that a resulting ADR would be severe if these potentially inappropriate medications were consumed by an elderly patient.[46]

The Beers criteria were subsequently revised to allow for the assessment of medication appropriateness among the community residing elderly when detailed information of drug use is not available.[11, 28] This list was limited to drugs that should generally be avoided among older community residing persons, regardless of drug dose, duration or frequency. Methyldopa and propranolol, generally considered inappropriate for use by the institutionalized elderly, were not included in this revised list. As with the original list, detailed clinical information is not required in order to apply these criteria.

Table 1.2: Drug groups included in the Beers et al. 1991 criteria for potentially inappropriate medication use among the elderly. [55]

sedatives-hypnotics	antidepressants
antipsychotics	antihypertensives
NSAIDs	oral hypoglycemics
analgesics	dementia treatments
platelet inhibitors	histamine2 blockers
antibiotics	decongestants
iron	muscle relaxants-antispasmodics
GI antispasmodics	anti-emetics

Tamblyn et al. (1994) focused on the drug groups most commonly implicated in drug-related morbidity: cardiovascular drugs, psychotropic drugs, and nonsteroidal anti-inflammatory drugs (NSAIDs).[20] They restricted their investigation to:

1. inadvisable prescribing of drug combinations;

2. benzodiazepine use for more than a 30-day duration;

3. long-acting benzodiazepine use;

4. use of phenylbutazone.

A distinction was made between rational and questionable high-risk prescribing.

McLeod et al. (1997) recently published an article describing a consensus-based list of inappropriate practices in prescribing for elderly people.[62] Loosely based on the Beers criteria, this list includes 71 prescribing practices grouped into three categories:

1. drugs generally contraindicated for elderly people;

2. drug-disease interactions;

3. drug-drug interactions.

These criteria include common prescribing practices with the risk of serious ADRs where reasonable alternative therapy is available and the practice is likely to occur often. In their present form, these criteria require clinical information concerning indication for drug use and past medical history, and are of little use to survey data.

Each of the sets of criteria presented here for use in population studies incorporate only some of the seven categories of medication use considered as inappropriate. Combining two or more of these previously developed sets would result in a more comprehensive tool with which to evaluate medication use among the elderly. The Beers et al.[55, 28] and the Tamblyn et al.[20] sets of criteria appear to be compatible for this type of pairing. They cover different areas of potentially inappropriate medication use, specific drug use and drug combinations respectively. The only overlap is of two types of benzodiazepine use and the use of phenylbutazone. Even by combining these sets of criteria, three of the seven categories

are not included: drugs inappropriate for the indication; drugs contraindicated by a medical condition; and insufficient dose, frequency or duration of drug use.

1.5 Rationale for this Study

The goal of health care should be to achieve the highest level of quality-of-life possible while using health care resources in a conservative and intelligent manner. Despite concern for quality-of-life, drug-related morbidity, and health-care costs associated with inappropriate medication use, limited data are available on the current drug use patterns of the community residing Canadian elderly. By determining the current prevalence of potentially inappropriate medication use among this subgroup of the Canadian elderly, a baseline will be set, against which future trends can be compared and the effects of improving the appropriateness of prescribing can be monitored. Quality assurance for this target population requires constant updating of new medications being introduced onto the market, new physicians involved in the care of geriatrics, and new initiatives aimed at providing optimum health care for the elderly.

Furthermore, identification of specific socio-demographic and health characteristics of the elderly population at risk for potentially inappropriate medication use, and consequently for ADRs, is an important step towards the goal of providing optimum drug therapies. Few studies have focused on the identification of patients receiving potentially inappropriate medication, and fewer still have investigated the relationships between socio-demographic and health characteristics and potentially inappropriate medication use. By identifying those at high risk for this problem, initiatives can be developed to focus health care services in the area

they will be most effectively used.

The community residing Canadian elderly who are at high risk for polypharmacy, a known risk factor for both potentially inappropriate medication use and ADRs,[37,38] are those who are of poorer health. Therefore, patients attending a day-hospital are expected to be a sub-group of this population who are at higher risk for potentially inappropriate medication use. If this is true, day-hospitals are ideal settings for initiatives aimed at decreasing the prevalence of potentially inappropriate medication use. Comparing the analyses of potentially inappropriate medication use between day-hospital data and nationally representative data will provide a more detailed image of this problem in Canada.

Future studies of potentially inappropriate medication among the elderly will be able to use the methodology and results of this study as a starting point. As described here, sets of criteria for judging the appropriateness of medication use are available in the literature for use as research tools. Measurement scales requiring the interpretation of clinical information are not appropriate for use with large or previously collected databases. However, without detailed clinical knowledge, it is still possible to study medication use using generalized criteria. Developing and updating the criteria that measure the potential appropriateness of medication use is ongoing, yet the existing sets of criteria each address only a portion of the problem. By combining two or more complementary sets of criteria, a broader spectrum of potentially inappropriate medication use among the elderly can be captured.

This study will describe the prevalence of potentially inappropriate medication use among community residing elderly Canadians as defined by predetermined criteria. Abstracted day-hospital patient records and nationally representative survey data of elderly

Canadians will be analyzed for potentially inappropriate medication use. High-risk socio-demographic and health characteristics for potentially inappropriate medication use will be identified. Models will be constructed with which to identify those at highest risk, those most in need of immediate attention for this problem.

1.6 Conceptual Framework for this Study

For the purpose of this study, a conceptual framework was assembled to visualize the potential relationships among those factors that may contribute to the appropriateness of medication use, and ultimately to an ADR (Figure 1.1). The Individual Determinants and Health Services Utilization variables are taken from a framework published by Anderson and Newman in 1973, in which they outlined how societal and individual determinants influence health services utilization (Appendix A).[63] Although this framework was conceived 25 years ago, it has provided a lasting foundation which many studies have used and built upon. From the January to May 1998 social studies citation index, it is cited by no fewer than 20 recently published articles.[64-83] The framework appearing here is presented as a guideline only and has not been formally validated.

As presented in the Anderson and Newman model, the Individual Determinants are divided into Predisposing, Enabling, and Illness Level variables. Predisposing factors for Medical Care Utilization include demographics (age, sex, marital status, and past illness), social structure (education, race, occupation, family size, ethnicity, religion, and residential

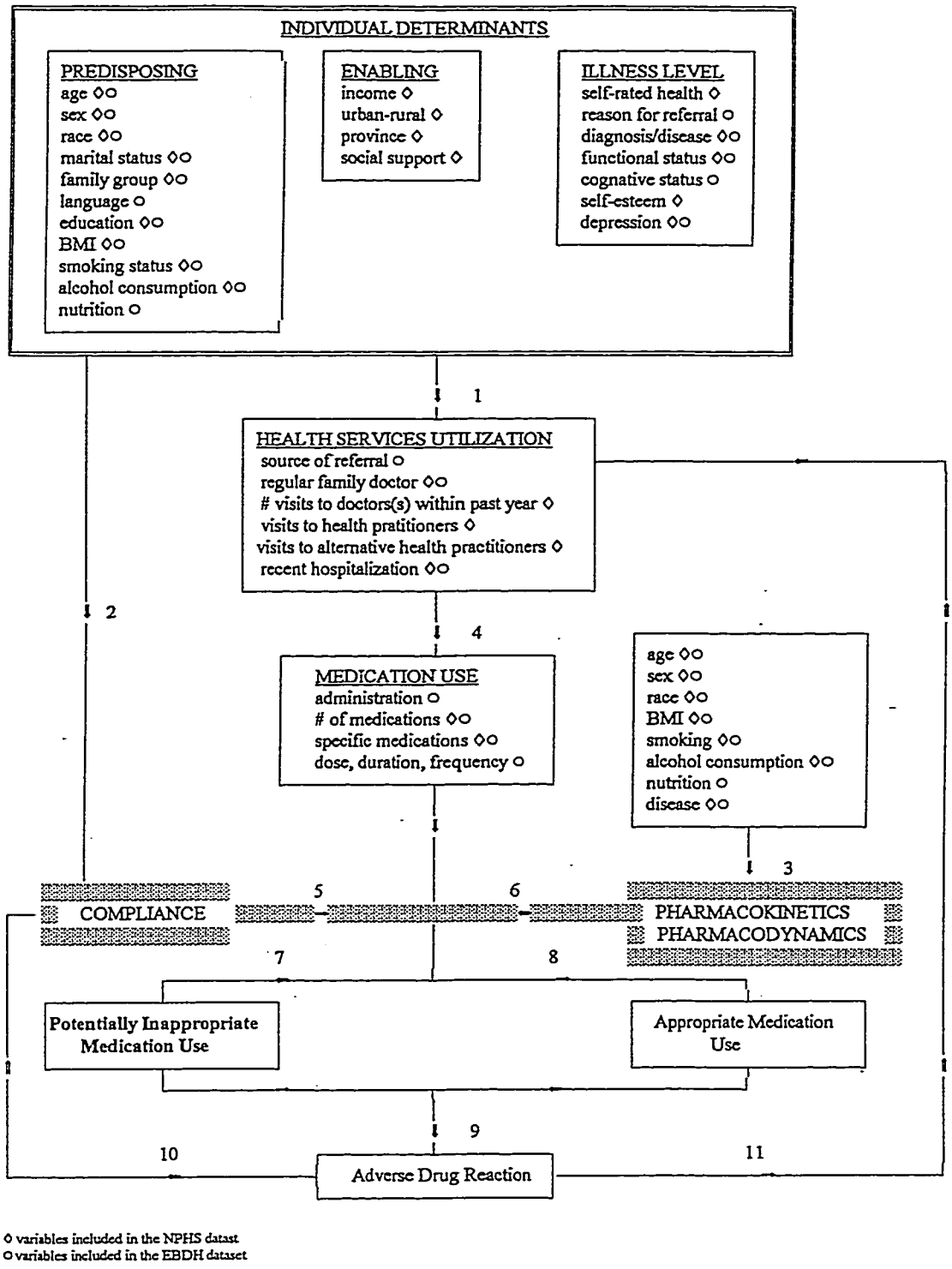


Figure 1.1: Conceptual Framework. Factors contributing to potential inappropriate medication use, and ultimately to an adverse drug reaction.

mobility), and beliefs (values concerning health and illness, attitudes toward health services, and knowledge about disease). Enabling factors for Medical Care Utilization include family (income, health insurance, type of regular source) and community dynamics (ratio of health personnel and facilities to population, price of health services, region of country, and urban-rural character). Illness Level factors for Medical Care Utilization included perceived (disability, symptoms, diagnoses and general state), and evaluated health status (symptoms and diagnoses).

For this study of potentially inappropriate medication use among the Canadian elderly, some variables were not available as listed in the original article by Anderson and Newman.[63] Furthermore, available variables considered important in the study of potentially inappropriate medication use have been added to the original framework. Race has been used in place of ethnicity. Also, Body-Mass Index (BMI), Smoking Status, Alcohol Consumption, and Diet have been added to the Predisposing factors. Province distinguishes region of the country; Social Support has been added to the Enabling factors; and Self-Rated Health, Functional Status, Self-esteem, and Depression have been included with Illness Level factors.

Only the variables available for each of the two parts of this study are listed in Figure 1.1. The complex inter-relationships among the Individual Determinants factors have not been considered, and are therefore contained within a "black box" indicated by the double lines.

Medical Care Utilization from the original model has been divided for this study into Health Services Utilization and Medication Use. Health Services Utilization includes having a Regular MD, the number of Visits to an MD within the past year, Visits to Health

Professionals and Visits to Alternative Health Practitioners within the past year or not, and Recent Hospitalization. The number of pharmacies patronized is another factor of Health Care Utilization, but was not available for this study. Medication Use includes the total Drug Use (number of medications being taken); a list of these Specific Drugs; and Dose, Duration and Frequency of use.

Individual Determinants not only have the potential to influence the Health Services Utilization of the patient (pathway 1), but also the mechanism of Compliance of the patient to the medication regimen (pathway 2), as presented in section 1.3.2. Also, a subset of Individual Determinants has the potential to influence the mechanisms of Pharmacokinetics and Pharmacodynamics (pathway 3), as outlined in sections 1.3.3 and 1.3.4.

The Health Service Utilization variables are the means by which an individual comes into contact with medication use (pathway 4). Medication Use, Compliance (pathway 5), and Pharmacokinetics/ Pharmacodynamics (pathway 6) all contribute towards the potential appropriateness of the medication use (pathways 7 and 8). While the possibility of an ADR is present with medication use (pathway 9), an increased risk is associated with inappropriate use. Furthermore, the occurrence of an ADR can affect subsequent Compliance (pathway 10) or Health Services Utilization (pathway 11), which may further alter the potential appropriateness of the medication use.

Hypotheses suggesting how each of the interrelating variables may influence one another have been conceived for this study, and are summarized in tabular form (Appendix B). Health Services Utilization have been suggested to be increased ($\uparrow$), decreased ($\downarrow$), or different (Δ) for each level of the predictor variable, either Individual Determinants or ADR

(Table B.1). Similarly, these types of predicator variables may also influence the mechanism of Compliance of the patient to the drug regimen (Table B.2). The mechanisms of Pharmacokinetics and Pharmacodynamics may be influenced by some of the Individual Determinants (Table B.3), and finally Potentially Inappropriate Medication Use may be influenced by Individual Determinants, Health Service Utilization, and Medication Use (Table B.4). These hypotheses will not be extensively tested in this study, but are presented as guidelines only.

1.7 Research Objectives

Potentially inappropriate medication use among the community residing community elderly will be described through the analyses of two complementary data sets. The first part of this study involves day-hospital patients admitted to the Elisabeth Bruyère Day-Hospital, Ottawa Ontario, from October 1996 to July 1997. The second part of this study involves data collected for the National Population Health Survey by Statistics Canada, 1994. The common objectives for these two parts of the study are as follows.

1. to determine the prevalence of potentially inappropriate medication ;
2. to examine the relationships between selected socio-demographic and health characteristics, and potentially inappropriate medication use ;
3. to construct a model identifying those at a higher risk for potentially inappropriate medication use.

Chapter 2 METHODS: ELISABETH BRUYERE DAY-HOSPITAL

To meet the objectives of this study, data were collected and analyzed from a day-hospital setting, the Sisters of Charity (SOC), Elisabeth Bruyère Pavilion Day-Hospital, Ottawa Ontario. Two subsets of the elderly population at a higher risk for potentially inappropriate medication use are those with severe disease and those with multiple chronic conditions. Day-hospital patients represent a subset of the community residing elderly who are in poor health, yet not impaired enough to have been institutionalized. This data set contains detailed clinical and drug use information. Drug dose, frequency and duration are available for an assessment of potentially inappropriate drug use.

2.1 Study Setting

The setting for this first part of the study was the Sisters of Charity, Elisabeth Bruyère Day-Hospital, Ottawa Ontario. Older patients from the Ottawa area are referred to this facility by health care workers, physicians, hospitals, or the Geriatric Assessment Outreach Team (GAOT) for assessment, rehabilitation or placement. Patients must require intervention in several health and functional dimensions by an interdisciplinary team to be referred to this day-hospital.

2.2 Study Subjects

Patients newly admitted to the Elisabeth Bruyère Day-Hospital (EBDH), aged 65 years and older, were enrolled in this study. Over 90 percent of patients referred to this day-hospital within the collection period were within this age category. Those who did not

meet the age criteria were older adults in their late fifties and early sixties.

2.3 Sources of Data

Patient data from the EBDH were abstracted from admissions records using a data collection form (Appendix C). The principal investigator was solely responsible for all the chart abstractions; there was no direct contact between the investigator and the day-hospital patients. Admissions records included referral reports, admission forms completed by the head nurse, and examination records completed by the day-hospital physician. All information, including drug use, was recorded directly from the admission charts and entered into the study database. All information was collected and recorded prior to any determination of potentially inappropriate medication use. Every effort was made to complete the collection form as accurately and as fully as possible from the chart available. No consideration of the outcome of interest, potentially inappropriate medication use, was given at the time of data collection. Data were coded and entered into Epi Info,[85] and later converted to create a SAS database as an ASCII file.

The collection period extended from November 1, 1996 to July 31, 1997. Charts were abstracted retrospectively to include admissions which had occurred between October 31 to 1, 1996. The remainder of the chart abstractions was performed prospectively between November 1, 1996 and April 30, 1997, data being collected as they became available. The original study period had to be extended to July 31, 1997 to attain the predetermined sample size because the rate of admission to the day-hospital was lower than expected.

2.4 Study Variables

Predictor variables available in the EBDH data set included Individual Determinants, Health Services Utilization, and Medication Use, as presented in the Conceptual Framework (Figure 1.1). Individual Determinants were divided into Predisposing, and Illness Level factors (Table 2.1).

Table 2.1: Predictor variables available in the EBDH study.

Individual Determinants		
Predisposing:	Age	Sex
	Race	Marital Status
	Family Group	Language
	Education	Body-Mass Index (BMI)
	Smoking Status	Alcohol Consumption
	Diet (Nutrition)	Drug Allergies
Illness Level:	Main Health Problem	Functional Status
	Cognitive Status	Depression
Health Service Utilization		
	Source of Referral	Regular MD
	Recent Hospitalization	
Medication Use		
	Drug Administration	Drug Use (number of medications)
	Specific Medications	Dose, Duration, Frequency

2.4.1 Individual Determinants: Predisposing factors

In the EBDH admission charts, Marital Status was grouped into four categories: (1) married, (2) single, (3) widowed, and (4) divorced (or separated). Limited sample size and power required that these be re-organized into married and other (widowed, single, divorced) for the purpose of reporting and analysis. The Family Group variable was condensed in order

to indicate whether the subject lived alone or lived with others. The highest level of education attained was developed as a four-level variable: (1) less than secondary school, (2) some secondary school, (3) secondary school graduation, or (4) beyond high school. Again because of sample size and power limitations, this variable was condensed into two levels: less than high school and high school or beyond.

Weight and height were recorded in the admissions charts. BMI was calculated for this study using the equation:

$$BMI = weight / (height)^2, \text{ measured in } kg/m^2.$$

BMI was grouped into four levels:

1. less than 20 was rated underweight;
2. 20 to 25 was rated acceptable weight;
3. 26 to 27 was rated possibly overweight;
4. greater than 27 was rated overweight.

2.4.2 Individual Determinants: Illness Level factors

For this study, Main Health Problem was grouped into four areas, based on the ICD-9 classification system:

1. nervous system;
2. heart and circulatory, and respiratory;
3. musculo-skeletal, including arthritis;
4. other (infectious and parasitic diseases, neoplasms, endocrine, digestive system, genitourinary system, skin and subcutaneous tissue, congenital anomalies, and ill defined

conditions).

The Main Health Problem was determined by the order presented on the chart, the first diagnosis being the main diagnosis, as directed by the day-hospital physician.

Instrumental Activities of Daily Living (IADL), as measured by a modified version of the Lawton-Brody scale[86], were recorded in the admission charts as a measure of Functional Status. This self reported scale covers the areas of transfer, walking, dressing, bathing, feeding, cleaning, laundry, grooming, finances, medications, cooking, groceries, and transportation. The scale does not include toileting or continence. This does not appear to be among the more commonly used tools, and should be regarded cautiously as a measurement of IADLs among the elderly.

A three level rating system for IADLs was recorded in the charts. For this study, scores have been applied to these pre-existing levels: independent, able to perform the activity without help (three points); assistant, able to perform the activity with help provided by someone else (two points); and dependent, unable to contribute effort towards the activity (one point). The scores for the available levels were summed. This total was divided by the relevant number of contributing areas (one to 13). The sample was divided into tertiles based on the IADL scores, dividing the sample into lower, middle, and upper thirds of the score range. A high score indicates good Functional Status. This method of dividing the distribution into equal counts was used in order to attain sufficient numbers in each cell for analysis. These boundaries are not being used for diagnostic purposes, and so predetermined cut-off points were not available.

Cognitive Status was recorded in the chart as determined by an administered mental

status test used to screen for dementia or to monitor its progression. The most common brief scales used among the elderly include the Mental Status Questionnaire,[87] the Abbreviated Mental Test Score,[88] and the Mini- Mental Status Examination (MMSE).[89, 90] Several studies have tested the validity of the MMSE,[91, 92, 93] and it has been found to be valid for use in hospital settings.[94] The MMSE is part of the referral report provided by the GAOT. Patients who were not referred in this manner were administered the examination as part of the admissions process to the day-hospital. Among the tasks of this scale are: date orientation, place orientation, recall three objects, repeating a phrase, verbal commands, written commands, writing, and drawing. The same procedure used to group the IADL scores into tertiles was applied to the Cognitive Status. A high score indicates a high level of Cognitive Status. To conserve sample size, those who did not receive an exam during either the referral or the admission process were subsequently added to the highest score group. This was done under the assumption that these patients were alert and coherent, and that impaired cognitive status was not a concern.

Depression was identified by either a recorded diagnosis for depression, for which the patient was receiving ongoing treatment at the time of admission to the day-hospital, or by administration of the Geriatric Depression Scale-Short Form (GDS-SF). The GDS-SF was administered either at the time of referral or admission to the day-hospital. The short form of this scale has been validated and found to be an good substitute for the longer version,[95] and is an effective screening tool for use with the medically ill or those with dementia.[96] Those with a diagnosis of depression had not been subjected to a depression test during the referral and admission procedures, but were included in the analysis as suffering from

depression. For the purpose of this study, no efforts were made to verify diagnoses of depression. If a depression test was not performed, and a diagnosis of depression was not present, the patient was classified as not suffering from depression.

2.5 Sample Size and Confidence Intervals

Sample size calculations were performed to estimate the minimum number of day-hospital patients required for determining the prevalence of potentially inappropriate medication use (Appendix D). Calculations were based on the following information:

1. approximately 110,000 community residing elderly in the Ottawa region;
2. an expected frequency of 5.5 percent of inappropriate drug use among this population;
3. if 5.5 percent is the true frequency, a worst acceptable frequency of 2.5 percent either higher or lower would be accepted, therefore detecting a difference of 3.0 percent.

For a 95 percent confidence level, a minimum sample size of 222 day-hospital patients is required.[85] However, lower than expected admission rates led to a smaller than expected sample size, limited by time restraints. The difference of 3 percent was too small to be detected therefore this difference was increased to 4 and 5 percent (Appendix D).

A 95 percent confidence interval table was constructed for varying assumptions of prevalence of potentially inappropriate medication use within the available variables, and for varying sample sizes. These are presented in Table 2.2.

Table 2.2: 95 % Confidence Intervals for the varying prevalence of potentially inappropriate medication use among elderly day-hospital patients for varying sample sizes.

		Prevalence of Potentially Inappropriate Medication Use						
		0.05	0.10	0.15	0.20	0.30	0.40	0.50
Sample Size		0.95	0.90	0.85	0.80	0.70	0.60	0.50
10	±	0.135	0.186	0.221	0.248	0.284	0.304	0.310
20	±	0.096	0.131	0.156	0.175	0.201	0.215	0.219
30	±	0.078	0.084	0.128	0.143	0.164	0.175	0.179
40	±	0.068	0.093	0.111	0.124	0.142	0.152	0.155
50	±	0.060	0.083	0.099	0.111	0.127	0.136	0.138
60	±	0.055	0.076	0.090	0.101	0.116	0.124	0.126
70	±	0.051	0.070	0.084	0.094	0.107	0.115	0.117
80	±	0.048	0.066	0.078	0.088	0.100	0.107	0.110
90	±	0.045	0.062	0.074	0.083	0.095	0.101	0.103
100	±	0.043	0.059	0.070	0.078	0.090	0.096	0.098
200	±	0.030	0.042	0.049	0.055	0.064	0.068	0.069
300	±	0.025	0.034	0.040	0.045	0.052	0.055	0.056

2.6 Generalizability to Others

The patients admitted to the EBDH are representative of elderly patients living in the Ottawa-Carleton region who are in need of medical supervision and intervention yet are currently living in the community. They are a narrow sample of the community residing elderly, those who have multiple health or functional problems and who are likely to be receiving treatment.

2.7 Ethics

An ethics proposal was submitted and approved by the Elisabeth Bruyère ethics review board. Confidentiality has been assured to the patients whose records were included in the day-hospital medical chart abstractions. The data set, as entered on the computer, does not contain any personal indicators that could jeopardize this confidentiality. All medical files

are stored separately in a locked cabinet. Participants were not placed under any personal risk by having taken part in this study.

2.8 Analysis

Data analysis was accomplished using the PC SAS statistical package.[97] When performing logistic regression analysis, only the elderly currently taking at least one medication were included. Otherwise the at-risk population would be overestimated because the criteria do not include inappropriate under-use of pharmacotherapy.[10] Persons who are not taking a drug cannot receive an inappropriate classification.

2.8.1 Criteria for determining potentially inappropriate drug use

To address the three objectives of this study, potentially inappropriate medication use among the elderly needed to be identified. Sets of criteria from the literature review were judged for their feasibility for use in this day-hospital study. Selection was based on the ability to apply the criteria to the data in order to produce a systematic summary of potentially inappropriate medication use comparable with other studies.

Two previously determined sets of criteria were selected for use with the EBDH data set: the original version of Beers et al. (1991)[55] inappropriate criteria and the Tamblyn et al. (1994)[20] questionable inadvisable prescribing (Appendix E). These sets of criteria have been validated for use with community residing elderly, which includes day-hospital patients. These two sets of criteria were combined and applied to the EBDH data set through the use of a SAS computer program, thereby eliminating any possible bias being introduced by the

investigator (Appendix F). Any patient receiving any medication or combination of medications stipulated by either of these two sets of criteria was identified as a positive case for potentially inappropriate medication use.

Primary analysis of the data was performed for the outcome of potentially inappropriate medication use as defined by combining the Beers and Tamblyn criteria. Analyses were also carried out on the Beers and Tamblyn criteria separately in order to compare results with the literature.

2.8.2 Descriptive analysis

Data cleaning of the continuous variables was accomplished using univariate analysis and normal probability plots to check for outliers and possible coding mistakes. Age distribution by sex was tested using the t-test. Differences of median drug use between those aged 65-74 and 75 years and over, and between the sexes, were tested for using the Median test.

Correlation between variables was tested for prior to modelling. Multicollinearity occurs when two highly correlated variables are both contained within a particular model.[98] In this case, the relation of a strong predictor variable may be weakened in the presence of another variable, masking the true effects. Correlation between continuous variables was tested for using Pearson's correlation coefficient. Continuous variables were transformed into categorical variables, and correlation between all variables was tested for using Spearman's correlation coefficient. Only Spearman's correlation coefficients were reported, as the results of the Pearson's correlation were very similar to the Spearman's after the continuous variables

had been transformed.

A description of the data set is provided, by sex. To satisfy the first objective, the prevalence of potentially inappropriate medication use among the day-hospital patients is described for each variable.

2.8.3 Modelling

Addressing the second and third objectives, modelling was used to investigate relationships between predictor variables and potentially inappropriate medication use. The prediction variables were those describing Individual Determinants, Health Services Utilization and Medication Use. Based on the structure developed in the Conceptual Framework, path analysis was considered for analyzing the complex relationship between predictor variables (demographic, health service utilization, medication use) and potentially inappropriate medication use. ANOVA and MANOVA procedures are appropriate for normally distributed continuous dependent variables. For this study, the potentially inappropriate medication use outcome variable was dichotomous, yes or no. This variable was determined to have a skewed distribution, and the numbers of those with two, three or more counts of potentially inappropriate medication use declined dramatically.

Therefore, non-parametric methods, logistic regression (LR) methods, were used to model predictor variables associated with a higher risk of potentially inappropriate medication use in those aged 65 years and older. The dependent variable for the LR was whether or not an individual was classified as receiving one or more potentially inappropriate medications or not.

Objective two was addressed through the use of univariate LR performed on each of the predictor variables, identifying those statistically associated with potentially inappropriate medication use. Multivariate analysis in the form of stepwise LR was then performed on the data in order to produce a parsimonious model of predictor variables, satisfying the third objective. The goodness of fit of this model was tested for using the Likelihood Ratio Test:

$$LRT = -2 \ln LL_{\text{full model}} - (-2 \ln LL_{\text{parsimonious model}})$$

Statistical improvement over the null model was also assessed. The overall agreement of the model to the actual prevalence of potentially inappropriate medication use was determined. The probability cutpoint was set to the actual prevalence of potentially inappropriate medication use.

The stepwise process moves variables in and out of the model based on a level of significance of 0.05. Within the SAS program, adjusted chi-square statistics are calculated for each of the variables, and that variable with the largest of these statistics is examined for entry into the model. Each forward step is followed by one or more backwards steps, removing variables no longer demonstrating statistical significance. This process continues until no more variables can be entered into the model.[99] Age (age groups) and Sex were forced into the model. This was done to adjust for possible confounding affects both age and sex may have on drug use. Any variables no longer attaining statistical significance were subsequently removed (Figure 2.1).

Univariate and multivariate LR procedures were also carried out for the Beers and Tamblyn criteria separately, allowing for the comparison with other research (Appendices H & I).

An attempt was made to further summarize the results for the third objective. A composite score for potentially inappropriate medication use was developed to rank the patients by using the odds ratios (ORs) produced in the parsimonious model. Scores were calculated for each individual by summing the relevant OR values of each predictor variable identified through multivariate LR. These scores are not intended as a metric determination of the risk for potentially inappropriate medication use, but as a means to rank the sample in terms of risk.

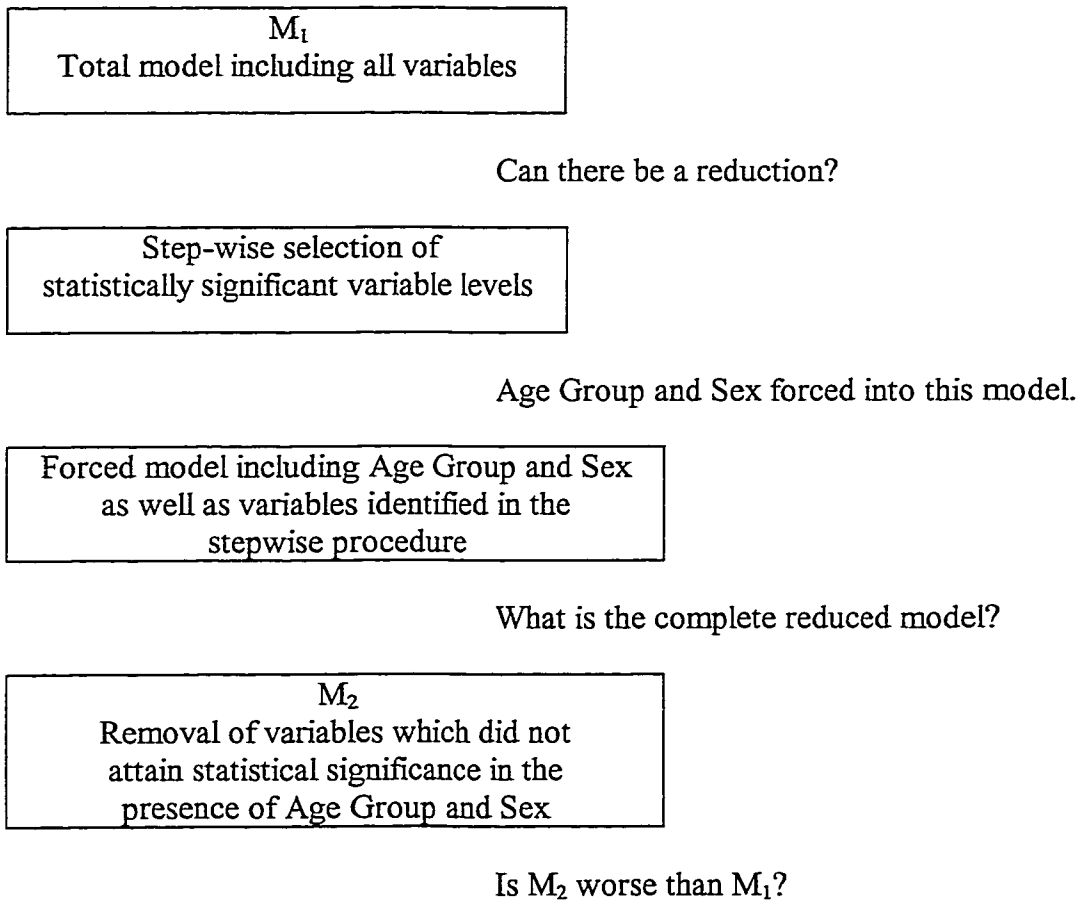


Figure 2.1: Process for developing model for identifying those at risk of potentially inappropriate medication use among the elderly.

The sample was then split into quintiles based on these scores. The lower quintiles contain those patients with a lower risk of potentially inappropriate medication use and higher quintiles contain those with a higher risk. Experimental use of univariate LR was attempted on these quintiles as a means of summarizing the results, indicating the ranks at greatest risk for potentially inappropriate medication use, and the differences between the ranks. Comparison to the null model was reported, along with the overall percentage of agreement between actual and predicted prevalence of potentially inappropriate medication use. Again the probability cutpoint was set at the actual prevalence of potentially inappropriate medication use.

Chapter 3 RESULTS: ELISABETH BRUYERE DAY-HOSPITAL

3.1 Descriptive Results

Charts of one hundred and two patients newly admitted to the Elisabeth Bruyère day-hospital were abstracted for the investigation potentially inappropriate medication use.

3.1.1 Individual Determinants: Predisposing

Approximately half of the sample was 80 years of age or older, and approximately two-thirds were female (Table 3.1). The mean age of both men and women was 80.2 years (SD 7.2). Two-thirds were classified with a Race of white. The remaining Race categories of black, oriental and other were grouped together as "other". This variable was dropped from further analysis because of problems in its determination, as later outlined in section 7.3.1.

Of the sample, 32.4 percent were married. Three-quarters of the women were either single or widowed. Nearly 45 percent of the men were married. Over half of the women were living alone, one-quarter of the men lived alone.

Over half of the sample spoke English, and approximately one-third spoke French or were bilingual for French and English. Education attained was not available for half of the population. Of the rest, 18.6 percent did not complete high school, and only 22.5 percent had progressed beyond high school.

BMI was not available for 16.7 percent of the sample because of missing height and weight information. For those available, over 40 percent rated underweight; 24.7 percent rated acceptable weight; 7.1 percent rated possibly overweight; and 27.1 percent rated

Table 3.1: Descriptive results of elderly day-hospital patients, Predisposing Individual Determinants.

Variable	Sex			
	Male	Female	Total	(%)
Age Group				
65-69	4	7	11	(10.8)
70-79	13	23	36	(35.3)
80 +	19	36	55	(53.9)
Marital Status				
married	17	16	33	(32.4)
other	19	50	69	(67.6)
Family Group				
alone	9	36	45	(44.1)
not alone	27	30	57	(55.9)
Language				
English	16	41	57	(58.8)
French	7	17	24	(24.7)
other	10	6	16	(16.5)
Education				
< high school	9	19	28	(54.9)
> high school	9	14	23	(45.1)
Body-Mass Index				
under weight	10	24	34	(40.0)
acceptable	6	15	21	(24.7)
possible overweight	2	4	6	(7.1)
overweight	9	15	24	(28.2)
Smoking Status				
never	10	39	49	(51.0)
former	18	11	29	(30.2)
current	4	14	18	(18.8)
Alcohol Consumption				
never	11	34	45	(51.7)
former	6	2	8	(9.2)
current	14	20	34	(39.1)
Diet				
regular	17	43	60	(65.9)
other	14	17	31	(34.1)
Drug Allergies				
yes	6	15	21	(21.0)
no	29	50	79	(79.0)

overweight. Less than 20 percent of the population were current smokers, and one-third were current alcohol consumers.

Charts indicated that nearly 60 percent of the sample followed a regular or normal diet. Other patients followed either a special diet (diabetic, low fat) or were judged to have poor dietary intake. Under one-quarter of the EBDH sample was found to have drug allergies.

3.1.2 Individual Determinants: Illness Level factors

Approximately 43 percent of the day-hospital patients were categorized with a nervous system Main Health Problem, 20 percent with heart and respiratory, 12 percent with musculo-skeletal, and 23 percent with other diagnoses (Table 3.2).

Table 3.2: Descriptive results of elderly day-hospital patients, Predisposing Illness Level.

Variable	Sex			
	Male	Female	Total	(%)
Main Health Problem				
nervous system	18	23	41	(43.2)
heart and respiratory	8	12	20	(21.0)
musculo-skeletal	2	10	12	(12.6)
other	7	15	22	(23.2)
Functional Status				
poor	8	23	31	(30.7)
moderate	13	26	39	(38.6)
good	15	16	31	(30.7)
Cognitive Status				
poor	12	15	27	(26.5)
moderate	9	19	28	(27.4)
good	15	32	47	(46.1)
Depression				
not depressed	23	34	57	(55.9)
depressed	13	32	45	(44.1)

Functional Status (IADL) scores were available for 99.0 percent of the sample, and were divided into approximate thirds: lower 30.7 percent, middle 38.6 percent, and upper 30.7 percent. Cognitive Status (MMSE) and Depression (GDS-SF) screening was performed on 78.4 percent and 44.1 percent of the sample respectively. Cognitive Status groupings contained 26.5 percent in the lower group, 27.4 percent in the middle group, and 46.1 percent in the upper group. Of all the day-hospital patients, 44.1 percent were identified as being depressed.

3.1.3 Health Services Utilization

Over 70 percent of this sample were referred to the day-hospital by the Geriatric Assessment Outreach Team (GAOT), the remainder referred by physicians, hospitals or other sources (Table 3.3). Over 80 percent of the total sample were found to have a Regular MD. Information concerning Recent Hospitalization was available for 94 percent of the sample. Approximately one-third of these had been hospitalized overnight or longer within the past year.

Table 3.3: Descriptive results of elderly day-hospital patients, Health Services Utilization.

Variable	Sex			
	Male	Female	Total	(%)
Source of Referral				
GAOT	23	50	73	(71.6)
other	13	16	29	(28.4)
Regular MD				
no	1	0	1	(1.1)
yes	34	59	93	(98.9)
Recent Hospitalization				
no	18	42	60	(62.5)
yes	17	19	36	(37.5)

3.1.4 Medication Use

Medication was self administered by 55 percent of the sample, the rest either receiving assistance or using a dosette (Table 3.4). Approximately five percent of the sample was taking either none or one medication only. Two to five concomitant medications were being taken by 45.1 percent of the sample, and 50.0 percent were taking six or more.

Table 3.4: Descriptive results of elderly day-hospital patients, Medication Use.

Variable	Sex			
	Male	Female	Total	(%)
Drug Administration				
self	8	35	43	(55.1)
assistant & dosette	17	18	35	(44.9)
Drug Use				
0-1	1	4	5	(4.9)
2-5	11	35	46	(45.1)
6+	24	27	51	(50.0)

Table 3.5: Percentages of elderly day-hospital patients taking medication within each drug category by sex.

Drug Category	Men	Women
Alimentary tract and metabolism	69.4	66.7
Blood and blood forming organs	25.0	12.1
Cardiovascular system	66.7	60.6
Dermatological	16.7	7.6
Genito-urinary system and sex hormones	13.9	4.5
Systemic hormonal preparations, excluding sex hormones	22.2	16.7
General anti-infectives for systemic use	8.3	1.5
Antineoplastic and immunomodulating drugs	5.6	6.1
Musculo-skeletal system	25.0	15.2
Nervous system	80.6	74.2
Antiparasitic products	0.0	0.0
Respiratory system	19.4	22.7
Sensory organs	13.9	6.1
Various	0.0	1.5

The median number of medications for those aged 65 to 74 years was five, and the median for those aged 75 years and older was six (p=0.0392). The median number of medications for men was 6.5, and for women it was five (p=0.0154). Medication use by drug category is presented in Table 3.5.

3.2 Prevalence of Potentially Inappropriate Medication Use

Addressing the first objective, the Beers and Tamblyn combined criteria classified 11.1 (± 10.3) percent of men and 23.1 (± 10.2) percent of women as taking at least one potentially inappropriate medication, a total of 18.8 (± 7.6) percent of the whole sample. The Beers criteria classified 5.6 (estimated CI ± 7.5, actual CI from tables 0.7, 18.7)[100] percent of men and 20.0 (± 9.6) percent of women as taking a potentially inappropriate medication. The Tamblyn criteria classified 8.3 (± 9.0) percent of men and 7.7 (± 6.4) percent of women as taking a potentially inappropriate combination of drugs. Frequencies for the Beers and the Tamblyn criteria are listed in Appendix G.

The Spearman correlation test was performed on all pairs of variables to determine the percentage of variation of one variable explained by the other variable (Appendix H). This was statistically significant between seven pairs of variables at p<0.001:

1. Age Group and Source of Referral, 21%;
2. Age Group and Recent Hospitalization, 14%;
3. Source of Referral and Marital Status, 12%;
4. Source of Referral and Recent Hospitalization, 18%;
5. Marital Status and Family Group, 24%;

6. Family Group and Functional Status, 11%;

7. Drug Administration and Functional Status, 24%.

Potentially inappropriate medication use among the day-hospital patients is presented in Table 3.6. Particularly high rates are found for those possibly overweight, current smokers, musculo-skeletal main health problems, and low cognitive status.

3.3 Modelling Results

Only those taking at least one medication were included in the analysis. Overall potentially inappropriate medication use (Beers and Tamblyn combined criteria) was analyzed. Models were also fitted for the Beers criteria (Appendix I) and for the Tamblyn criteria (Appendix J) separately.

3.3.1 Univariate modelling

Addressing the second objective, univariate LR was performed on selected EBDH variables in order to identify predictors of potentially inappropriate medication use in day-hospital patients aged 65 years and older (Table 3.6). Variable levels which attained statistically significance were: current smokers, Main Health Problem of musculo-skeletal, not depressed, referral by GAOT, and concurrent use of over 6 medications.

Table 3.6: Prevalence of Potentially Inappropriate Medication Use and Univariate logistic regressions modelling potentially inappropriate medication use among elderly day-hospital patients taking at least one medication.

Variables	Pot. Inap. Med. Use n	>=1 (%)	Odds Ratio	95% Confidence Intervals
Age Group				
65-69	11	16.7	1.0	
70-79	36	19.4	1.1	0.2 - 6.2
80+	55	11.1	1.0	0.2 - 5.5
Sex				
male	36	11.1	1.0	
female	66	22.7	2.4	0.7 - 7.9
Marital Status				
married	33	12.5	1.4	0.5 - 4.4
other	69	21.4	1.0	
Family Group				
alone	45	22.2	1.6	0.6 - 4.3
not alone	57	15.8	1.0	
Education				
high school	28	22.2	2.6	0.8 - 8.7
college/university	23	4.4	1.0	
Body-Mass Index				
underweight	34	23.5	2.0	0.6 - 6.9
acceptable	21	19.0	1.0	
possibly overweight	6	33.3	3.3	0.5 - 23.0
over weight	24	16.7	1.4	0.3 - 5.8
Smoking Status				
never	49	12.2	1.0	
former	29	13.8	0.9	0.2 - 3.4
current	18	38.9	3.6	1.1 - 12.2
Alcohol Consumption				
never	45	15.9	1.0	
former	8	12.5	0.5	0.0 - 4.5
current	34	14.7	0.6	0.2 - 1.9
Diet				
regular	60	18.3	1.0	
other	31	23.3	1.5	0.5 - 4.3
Main Health Problem				
nervous system	41	14.6	1.0	0.3 - 4.0
heart & respiration	20	15.0	1.0	0.2 - 5.4
musculo-skeletal	12	50.0	6.0	1.3 - 28.2
other	22	18.2	1.0	

continued

Table 3.6: Prevalence of Potentially Inappropriate Medication Use and Univariate logistic regressions modelling potentially inappropriate medication use among elderly day-hospital patients taking at least one medication.

Variables	Pot. Inap. Med. Use		Odds Ratio	95% Confidence Intervals
	n	>=1 (%)		
Functional Status				
poor	31	19.4	1.0	
moderate	39	18.0	0.9	0.3 - 3.0
good	31	19.4	1.0	0.3 - 3.5
Cognitive Status				
poor	27	33.3	2.8	0.9 - 8.7
moderate	28	10.7	0.7	0.2 - 2.8
good	47	14.9	1.0	
Depression				
not depressed	57	10.5	1.0	
depressed	45	28.9	3.6	1.2 - 10.3
Source of Referral				
GAOT	73	24.7	9.3	1.2 - 73.6
other	29	3.4	1.0	
Recent Hospitalization				
yes	36	14.3	1.0	
no	60	21.8	1.7	0.6 - 4.9
Drug Administration				
self	43	17.1	1.0	
assistant & dosette	35	23.5	1.9	0.7 - 5.3
Drug Use				
0	1	0.0	(not included in LR)	
1-5	50	10.0	1.0	
6+	51	27.4	3.4	1.1 - 10.3

3.3.2 Multivariate modelling

Addressing the third objective, results from the multivariate LR are listed in Table 3.7. Potentially inappropriate medication use was more likely to occur in women, in current smokers; in those with a musculo-skeletal Main Health Problem; in those with a Cognitive Status score in the lower third; and in those with six or more concomitant medications.

Table 3.7: Multivariate logistic regression modelling potentially inappropriate medication use among elderly day-hospital patients taking at least one medication.

Variables	Odds Ratio	95% Confidence Intervals
Age Group		
65-69	1.0	
70-79	1.0	0.1 - 9.1
80 +	0.8	0.1 - 7.7
Sex		
male	1.0	
female	6.8	1.0 - 44.4
Smoking Status		
never	1.0	
former	1.3	0.2 - 7.9
current	6.5	1.2 - 34.7
Main Health Problem		
nervous system	1.1	0.2 - 6.3
heart & respiration	2.9	0.3 - 25.4
musculo-skeletal	13.4	1.7 - 108.1
other	1.0	
Cognitive Status		
poor	16.6	2.6 - 105.6
moderate	0.5	0.1 - 3.5
good	1.0	
Drug Use		
1-5	1.0	
6 +	11.3	2.2 - 58.2

This model was compared to the full model using the Likelihood Ratio Test. The reduced was found not to be significantly worse over a model including all of the possible predictor variables:

$$LRT = -2 \ln LL_{\text{full model}} - (-2 \ln LL_{\text{parsimonious model}})$$

$$= 64.285 - 57.903$$

$$= 6.382, \text{ with 7 degrees of freedom, } p = 0.496144$$

However, this parsimonious model is a statistically significant improvement over the null model ($p = 0.0005$). Table 3.8 is a classification table showing the accurately predicted

outcomes of potentially inappropriate medication use. Overall agreement was seen to occur in 67.3 percent of the sample.

Table 3.8: Classification table for the multivariate logistic regression model, predicting potentially inappropriate medication use among elderly day-hospital patients taking at least one medication.

	Predicted Outcome	
Actual Outcome	negative	positive
negative	60 (59.4%)	22 (21.8%)
positive	11 (10.9%)	8 (7.9%)

3.3.3 Summary modelling

The results of the univariate LR using the first (OR) composite score variable are presented in Table 3.9 Statistically significant ORs are indicated for the fifth quintile only, patients with the highest overall risk of taking a potentially inappropriate medication. They were found to be at 9 times the risk for potentially inappropriate medication use than those in the first quintile. This model is a statistically significant improvement over the null model ($p = 0.0011$).

Table 3.9: Logistic regression modelling potentially inappropriate medication use among elderly day-hospital patients taking at least one medication, based on a composite score created from the sums of multivariate logistic regression odds ratios.

Composite Score	Odds Ratio	95% Confidence Intervals
first quintile	1.0	
second quintile	0.6	0.0 - 7.4
third quintile	0.5	0.0 - 5.9
fourth quintile	4.8	0.8 - 27.7
fifth quintile	9.4	1.7 - 52.1

The values of predicted versus actual cases of potentially inappropriate medication use are presented in Table 3.10. Overall agreement occurred in 65.3 percent of the sample.

Table 3.10: Classification table of the composite score model, predicting potentially inappropriate medication use among elderly day-hospital patients taking at least one medication.

	Predicted Outcome	
Actual Outcome	negative	positive
negative	55 (54.4%)	27 (26.7%)
positive	8 (7.9%)	11 (10.9%)

Chapter 4 METHODS: NATIONAL POPULATION HEALTH SURVEY

To meet the objectives of this study, the National Population Health Survey (NPHS) was analyzed, a survey conducted biannually by Statistics Canada to collect nationally representative information on the current health of Canadians.[84] The target population of this survey is household residents in all provinces, excluding populations on Indian Reserves, Canadian Forces Bases, and some remote areas of Quebec and Ontario.

Two of the formal objectives of the NPHS are: "to provide data for analytic studies that will assist in understanding the determinants of health", and "to increase the understanding of the relationship between health status and health care utilization, including alternative as well as traditional services".[84] Initiated in 1994, the NPHS used a two-stage stratified sample of households, based on the sampling frame of the Labour Force Survey. Approximately 19,600 households were surveyed, selecting one person at random per household, providing a subset of 2,996 Canadians aged 65 years and older. This data set contains drug use information over a two-day period. Demographic and health variables are available for secondary analysis of current potentially inappropriate drug use.

4.1 Study Setting

The setting for this second part of the study was Canada. The National Population Health Survey (NPHS) was stratified to include a minimum of 1200 households per province, and the sample was allocated according to the 1991 Census proportion of households per province.[84] A buy-in option was offered to allow provinces to increase their sample size for further research. The sub-samples of parents and youths were purposely over sampled

because residents of larger households tend to be under represented when selected at random.

All provinces used the sampling methodology of the redesigned Labour Force Survey (LFS), with the exception of Quebec. Here the sampling method of Santé Québec: 1992-93 Enquête sociale et de santé was used. This method is similar to that of the LFS. The LFS is a multi-stage sampling design. The first stage is to select clusters. A "cluster weight" was then calculated as the inverse probability of selecting a cluster. The second stage is to select samples within each of the selected clusters. A "dwelling weight" was then calculated as the inverse probability of selecting a sample. The "LFS basic weight" is the product of the cluster weight and the dwelling weight. In this way, the weights provided with the NPHS account for the sampling methods used.

4.2 Study Subjects

The NPHS is a cross-sectional sample of the Canadian population ages 12 and over. A total of 19,600 households were surveyed, including 2,996 people aged 65 years and over. This is representative of 3, 250, 966 elderly Canadians.

4.3 Sources of Data

Survey data were collected using Computer Assisted Interviewing (CAI), tested both by focus groups and by field studies. Every effort was made to obtain the interviews and sampled dwellings were not replaced for non-response.[84]

Several methods of quality assurance were employed to reduce non-sampling errors. These included employing highly skilled interviewers and providing them with extensive

survey and questionnaire training. Observation of the interviewers was used to detect problems with the CAI questionnaire or misunderstood instructions. Other procedures to ensure that data collection errors were minimized were also employed. There was very little partial non-response, and total non-response was adjusted for by weighting the households.[84]

4.4 Study Variables

To reflect the Conceptual Framework (Figure 1.1), the subset of the variables selected from the NPHS for analysis included demographic, health, and drug use information (Table 4.1). Once this data set was compiled, the drug data were re-coded using the ATC system.[26]

Table 4.1: NPHS predictor variables available for determining potentially inappropriate medication use.

Individual Determinants		
Predisposing:	Age	Sex
	Race	Marital Status
	Family Group	Education
	Body-Mass Index (BMI)	Smoking Status
	Alcohol Consumption	
Enabling:	Income Adequacy	Household Income
	Urban/Rural	Province
	Social Support	
Illness Level:	Self-Rated Health	Main Health Problem
	Dexterity	Restriction of Activity
	Self-esteem	Depression
Health Service Utilization		
Regular MD		
number of Visits to MD within last year		
number Visits to Health Professionals within last year		
Visits to Alternative Health Practitioners within last year		
Hospitalization overnight within last year		
Health Services composite score		
Medication Use		
Drug Use (number of medications)		
Specific Medications		

4.4.1 Individual Determinants: Predisposing factors

Race, recorded as the best self-description, was regrouped into two categories: white and other. These "other" races include Black, Korean, Filipino, Japanese, Chinese, Aboriginal People of North America, South Asian, South East Asian, West East Asian and North African, and Multiple Race Category.

Marital Status was divided into seven categories: (1) now married, (2) common law, (3) living with a partner, (4) single (never married), (5) widowed, (6) separated, and (7) divorced.

These have been re-organized into:

1. single (single (never married)),
2. widowed (widowed, separated, divorced),
3. married (now married, common law, living with a partner).

The Family Group variable, the arrangement of family members living within the same household, was condensed in order to indicate whether the patient lived alone or not.

Education was recorded as the highest level of education attained, and was derived as a four-level variable: (1) less than secondary, (2) secondary school graduation, (3) beyond high school, (4) college or university degree.

Body-Mass Index (BMI) was calculated from the available weight and height variables. BMI was calculated using the equation:

BMI = weight / (height)2, measured in kg/m2.

BMI was grouped into four levels:

1. less than 20 was rated underweight;
2. 20 to 25 was rated acceptable weight;
3. 26 to 27 was rated possibly overweight;
4. greater than 27 was rated overweight.

4.4.2 Individual Determinants: Enabling factors

Income Adequacy was divided into five categories: (1) low, (2) lower-middle, (3) middle, (4) upper-middle, and (5) high. This variable was calculated based on total household income and the total number of family members living within the household (Table 4.2).

Household Income was recorded as an 11 level scale ranging from no income to $80,000 and over. This variable was transformed into a three-level variable: (1) zero to $14,999; (2) $15,000 to $39,999; and (3) $40,000 and over.

Table 4.2: Scale for determining income adequacy, NPHS.[84]

Income Bracket	Household Income	# Persons in Household
low	< $10,000	1-4
	< $15,000	> 4
lower-middle	$10,000 - $14,000	1-2
	$10,000 - $19,999	3-4
	$15,000 - $39,999	> 4
middle	$15,000 - $29,999	1-2
	$20,000 - $39,999	3-4
	$30,000 - $59,999	> 4
upper-middle	$30,000 - $59,999	1-2
	$40,000 - $79,999	3-4
	$60,000 - $79,999	> 4
high	$60,000 +	1-2
	$80,000 +	> 2

Provincial distribution was grouped into the five regions of Canada: Atlantic Canada (Newfoundland, Nova Scotia, New Brunswick, and Prince Edward Island), Quebec, Ontario, the Prairies (Manitoba, Saskatchewan, and Alberta), and British Columbia.

Social Support was a score included in the NPHS that was derived from a series of four questions, contributing one point each for a positive response. These recorded the subjects perceived resources in terms of (1) having someone they can confide in, (2) having someone they can count on, (3) having someone who can give them advice, and (4) having someone who makes them feel loved.[84] For use in this study, this score was transformed into a three-level variable based on the frequencies attained: zero (none), one to three (low), and four (high).

4.4.3 Individual Determinants: Illness Level factors

Self-Rated Health was recorded as a five-level variable: (1) poor, (2) fair, (3) good, (4) very good and (5) excellent. This was subsequently reduced to three categories by coupling the two lowest ratings together and the two highest ratings together. The Main Health Problem was regrouped into seven main categories based on the classification system used in the NPHS:

1. nervous system (mental retardation, mental disorders, sight disorder, hearing disorder and other diseases of nervous system),
2. heart and circulation (hypertensive disease, ischaemic heart disease, other heart conditions, other circulatory disorders),
3. respiratory (bronchitis and emphysema, asthma, other respiratory disorders),
4. arthritis (lower limbs, upper limbs, back and spine, other and unspecified),
5. musculo-skeletal (lower limbs, upper limbs, back, other),
6. other (such as disorders of the digestive system; infections and parasites; neoplasms, endocrine, nutritional),
7. no health problem.

Dexterity was grouped into three levels:

1. no dexterity problems,
2. dexterity problems: no help,
3. dexterity problems: help (includes equipment, person help some, most and all tasks).

The Restriction of Activity variable as included in the NPHS data set is dichotomous, yes or no, based on two questions pertaining to limited activity caused by long-term physical

or mental conditions or health problems.[84] A positive response to any limited activity at home, at school, at work, with transportation to and from an activity, or any long-term disabilities or handicaps resulted in a restriction of activity.

Self-esteem was scored based on questions from the Rosenberg Scale (1969), and work by Pearlin and Schooler (1978).[84] Self-esteem scores were divided into thirds based on frequencies to distinguish low, medium and high self-esteem. Depression was scored and grouped into two levels: zero, and one to eight. The questions were based on work by Kessler and Mroczek (from the University of Michigan), and the subset of Composite International Diagnostic Interview.[84] Scores of one to eight correspond to a probability of receiving a diagnosis of clinical depression, therefore this variable compares no probability (not depressed) and any probability (depressed) of depression.[99]

4.4.4 Health Service Utilization

Regular MD is a dichotomous variable, yes or no. The number of visits to a medical doctor (MD) within the past year was divided into three levels: none, one to five, and six or more. Visits to Health Professionals within the past year included visits to eye specialists, nurses, dentist/orthodontists, chiropractors, physiotherapists, social worker/counsellors, psychologists, speech therapists and other physicians. Visits to Health Professionals and Visits to Alternative Health Practitioners were both dichotomous variables, yes or no. The Health Services composite score is a four-point scale, created for use in this study only. One point was given to yes responses to: Regular MD, Visits to Health Professionals, Alternative Health Practitioners, and Hospitalization. The scores were regrouped into three levels based

on the frequencies: zero or one, two, and three or four.

4.4.5 Medication Use

Medication use (Drug Use) was determined for the previous two days at the time of interview (Appendix K). The names of all medications consumed during this period were recorded. No information concerning dose, duration or frequency of the drug regimen was collected for the NPHS.

4.5 Sample Size and Confidence Intervals

Calculations were performed to estimate the sample size required to detect the prevalence of potentially inappropriate medication use among the community residing Canadian elderly when using the NPHS (Appendix L). A sub-sample of 2,996 individuals aged 65 years and older participated in the NPHS. This represents a national population of 3,250,966. Of these, 2,519 (84%) individuals were currently taking medications, representing a national population of 2,712,538.

Sample size calculations were performed using an expected frequency of potentially inappropriate medication use of 5.5 percent. If this is the true prevalence, a worst possible result of 2.5 percent above or below this value would be acceptable.[85] The sample size available in the NPHS is more than large enough to study the prevalence of potentially inappropriate medication use in the community residing Canadian elderly. Confidence Interval (95%) calculations for different levels of prevalence of potentially inappropriate medication use among the community residing Canadian elderly and for different sample sizes

are presented in Table 4.3.

Table 4.3: 95 % Confidence Intervals for the varying prevalence of potentially inappropriate medication use among the Canadian elderly for varying sample sizes.

		Prevalence of Potentially Inappropriate Medication Use						
		0.05	0.10	0.15	0.20	0.30	0.40	0.50
Sample Size		0.95	0.90	0.85	0.80	0.70	0.60	0.50
200	±	0.030	0.042	0.049	0.055	0.064	0.068	0.069
400	±	0.021	0.029	0.035	0.039	0.045	0.048	0.049
600	±	0.017	0.024	0.028	0.032	0.037	0.039	0.040
800	±	0.015	0.021	0.025	0.028	0.032	0.034	0.035
1000	±	0.014	0.018	0.022	0.025	0.028	0.030	0.031
2000	±	0.010	0.013	0.016	0.018	0.020	0.021	0.022
3000	±	0.008	0.011	0.013	0.014	0.016	0.018	0.018
4000	±	0.007	0.009	0.011	0.012	0.014	0.015	0.015
5000	±	0.006	0.008	0.010	0.011	0.013	0.014	0.014

4.6 Generalizability to Others

When analyzed with the use of the appropriate weights, the results are generalizable to the non-institutionalized Canadian elderly population. The target population of the NPHS is household residents in all provinces. Populations on Indian Reserves, Canadian Forces Bases, and some remote areas of Quebec and Ontario were excluded in this study.

4.7 Ethics

Confidentiality has been assured to individuals who participated in the NPHS (1994).[84] NPHS data were only released to Health Canada with the permission of the participants. The data set provided for analysis does not contain any personal indicators that could jeopardize confidentiality. In this study, all data are presented in summarized form,

thereby preventing the possibility of identifying individuals. Participants were not placed under any personal risk by having taken part in this study.

4.8 Analysis

The PC SAS statistical package was used for all analyses.[97] To maintain the conditions of confidentiality while reporting the descriptive statistics of this study, no fewer than 30 members of the study sample were included in each cell. Only the elderly currently taking at least one medication were included in the logistic regression analysis, so that the at-risk population was not overestimated. This is only true because the criteria chosen for use in this study do not include inappropriate under use of pharmacotherapy.[10]

4.8.1 Criteria for Determining Potentially Inappropriate Drug Use

The NPHS identified drugs taken within the past two days (yesterday and the day before) at the time of interview, but it did not record information concerning dose, duration or frequency of drug use. Based on the literature review, the Beers modified inappropriate criteria[28] were selected for use with this data set combined with those of Tamblyn's questionable inadvisable prescribing criteria, excluding benzodiazepine use for more than a 30 day duration.[20] Although the Beers modified criteria for analyzing the NPHS data set are not as complete as those which were applied to the EBDH data set, these criteria have been used previously as a means of determining potentially inappropriate medication use in a community setting.[11]

Analysis of the data was performed based on the combined Beers (modified) and

Tamblyn criteria. Potentially inappropriate medication use was identified through the use of a SAS computer program, eliminating the risk of bias. Analysis was also performed on the data for the Beers (modified) criteria and the Tamblyn criteria separately, to allow for possible comparison with other research (Appendices P & Q).

4.8.2 Descriptive Analysis

Statistics for describing the elderly Canadian population are presented as expansion weighted frequencies and proportions. Univariate analysis and normal probability plots were used for the purpose of data cleaning, no irregularities with the data set were found. Differences in the age distribution between the sexes was tested using the t-test. The Median test was used to test for differences of median drug use between age groups 65 -74 and 75 years and older, and between the sexes.

Correlation between variables was tested for prior to modelling. Two highly correlated variables appearing in the same model will influence the true relation between the predictor variables and the outcome of interest. These relations will be weakened, obscuring the estimate of effects.[98] Pearson's correlation coefficient was used for the continuous variables. These variables were then transformed into categorical variables, and Spearman's correlation coefficient was used to test for correlation between all variables. The results of the two tests were very similar following the transformation of the continuous variables, therefore only Spearman's correlation coefficients are reported here.

The sample is described by sex. Addressing the first objective, the prevalence of potentially inappropriate medication use among the community residing elderly is described

for each variable.

4.8.3 Modelling

Addressing objectives two and three, the relationships between predictor variables and potentially inappropriate medication use were assessed through modelling. Path analysis was first considered, however the ANOVA and MANOVA procedures require continuous dependent variables, not dichotomous. Logistic regression (LR) was therefore used to analyse possible predictor variables of potentially inappropriate medication use among the elderly. The prediction variables were those presented in the Conceptual Framework.

Relative weights were used when analyzing the data. The expansion weight variable provided in the NPHS adjusts for non-response and specifies the number of persons in the population the sampled individual represents. The relative weight is used in statistical testing to avoid the false impression of a large sample size given by the expansion weights. It is equal to the expansion weight multiplied by the ratio of the sample sized divided by the size of the represented population:

$$\text{relative weight} = \text{expansion weight} * (n/N)$$

To conserve sample size during the analyses, a fifth rating category was added to the BMI variable. By adding an "unknown" rating level, the low response rate was controlled for and BMI could be included in the LR analyses. No further means were taken to control for non-response in this data set.

Univariate LR was used to address the second objective, to identify variables statistically associated with potentially inappropriate medication use. The third objective was

addressed by multivariate analysis in the form of stepwise LR, performed on the data to produce a parsimonious model of predictor variables. The SAS program for stepwise LR calculates chi-square statistics for each of the variables, and considers that with the largest statistic for entry into the model based on a level of significance of 0.05. Following each entry into the model, variables already in the model are removed if they are no longer significant. This process continues until no further variables can be entered into the model.[99] Age (age groups) and Sex were forced into this model, and any variables no longer attaining statistical significance were subsequently removed (Figure 4.1).

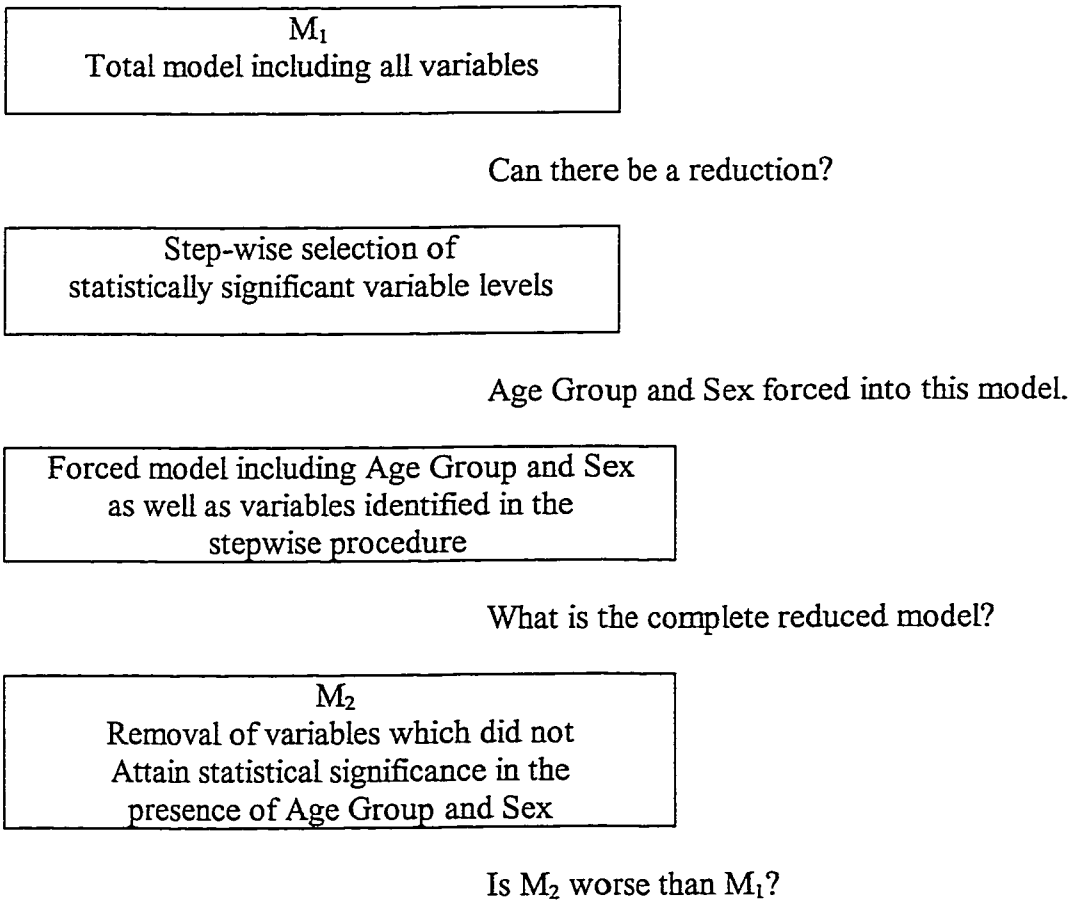


Figure 4.1: Process for developing model for identifying those at risk of potentially inappropriate medication use among the elderly.

The final model was tested using the Likelihood Ratio Test:

$$LRT = -2 \ln LL_{\text{full model}} - (-2 \ln LL_{\text{parsimonious model}})$$

Statistical comparison was made to the null model, and overall agreement between the predicted and the actual occurrence of potentially inappropriate medication use was reported. The true prevalence of potentially inappropriate medication use was used for the probability cutpoint.

Univariate and multivariate LR procedures were also performed on the NPHS data using the Beers (modified) criteria and the Tamblyn criteria separately.

A composite score for potentially inappropriate medication use was developed using ORs produced for the predictor variables included in the parsimonious model. Scores were calculated for each individual by summing the relevant OR values of each predictor variable identified through multivariate LR. These scores are not intended as a metric determination for potentially inappropriate medication use, but as a means of ranking the sample for this outcome. The sample was grouped into quintiles based on these scores, low scores representing lower risk of potentially inappropriate medication use and high scores representing higher risk. In an attempt to summarize these results, univariate LR was performed on these grouped scores to identify those at highest risk for potentially inappropriate medication use. Comparison to the null model was made, and overall agreement between the predicted and actual cases of potentially inappropriate medication use was made, again using the true prevalence as the probability cutpoint.

Chapter 5 RESULTS: NATIONAL POPULATION HEALTH SURVEY

5.1 Descriptive Results

The national household response rate for the NPHS was 88.7 percent, ranging from 85.2 percent in Ontario to 93.2 percent in Alberta. The selected person response rate at the national level was 96.1 percent, ranging from 94.7 percent in Nova Scotia to 97.6 percent in Saskatchewan. The manner in which Statistics Canada calculated these numbers does not allow for the overall response rate to be calculated by multiplying these two percentages together.[84]

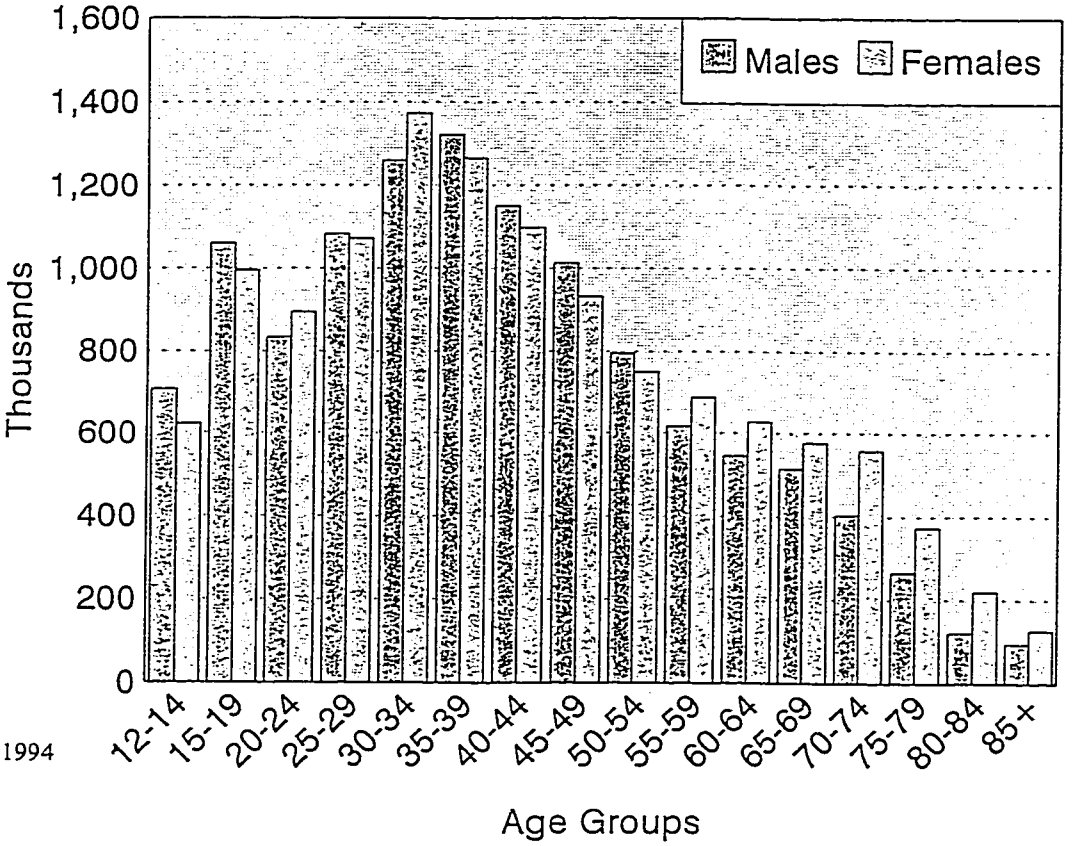
The NPHS contains information relating to the health of community residing Canadians, aged 12 and over. A total sample of 17,011 individuals contributed to this data set, representing a population of 23,948,600 with the expansion weights applied (Appendix M). Tables 5.1 to 5.4 describe the NPHS elderly sample in terms of the Individual Determinants, Enabling and Illness Level factors, and Health Services Utilization. Most variables are broken down by sex, although variables with levels containing few individuals have not.

5.1.1 Individual Determinants: Predisposing factors

This population consisted of 49.2 percent males and 50.8 percent females. The complete age and sex profile is presented in Figure 5.1: approximately 14 percent were 65 years and older; 43.0 percent of these were male and 57.0 percent were female. For those aged 65 and over, the mean age of men was 73.2 years (SD 6.3)while the mean age of women was 74.3 years (SD 6.6). Although statistically significantly different using the t-test

($p<0.0001$), this is not a meaningful difference.

Of those aged 65 years and older, 95.3 percent were classified as white, while 4.7 percent were classified as other. Five percent of this elderly population were single, 35.7 percent were widowed, and 59.3 percent were married (Table 5.1). Over half of these women were either single or widowed. More than three-quarters of the men were married. The proportion of women living alone increased from 35.0 percent of the 65-74 years age group, to 49.2 percent of the 75-84 years age group, to 61.7 percent of the 85 years and older age group. Corresponding proportions for men living alone in these same age groups are 18.9, 17.6, and 22.4 percent.



Source: NPHS 1994

Figure 5.1: Community residing Canadian population distribution by age and sex, 1994.

High school was not completed by 53.4 percent, and 17.6 percent graduated from college or university. Ratings of either possibly overweight or overweight were given to 37.1 percent of men and 36.0 percent of women. Also, 7.4 percent of men and 14.8 percent of women were considered to be underweight.

Table 5.1: Descriptive results of community residing elderly Canadians, Predisposing Individual Determinants. (X100)

Variable	Sex			
	Male	Female	Total	(%)
Age Group				
65-69	5139	5766	10905	(33.5)
70-79	6684	9300	15984	(49.2
80+	2163	3457	5620	(17.3)
Marital Status				
single	814	801	1615	(5.0)
widowed	2506	9114	11620	(35.4)
married	10666	8608	19275	(59.3)
Family Group				
alone	2622	7653	10275	(31.6)
not alone	11351	10842	22193	(68.4)
Education				
< high school	7263	10018	17281	(53.4)
high school grad	1548	2561	4109	(12.7)
high school	2234	3022	5255	(16.2)
college/university	2821	2884	5705	(17.6)
Body-Mass Index				
underweight	867	2317	3185	(12.0)
acceptable	5978	7715	13392	(50.3)
possible overweight	1260	1141	2401	(9.0)
overweight	3115	4507	7622	(28.6)
Smoking Status				
never	2923	10172	13095	(40.3)
former	8718	5946	14664	(45.1)
current	2345	2384	4729	(14.6)
Alcohol Consumption				
never	1002	3901	4903	(15.1)
former	2977	4624	7601	(23.5)
current	9945	9942	19887	(61.4)

Of all elderly women, 55.0 percent had never been smokers, while 32.1 percent were former smokers and 12.9 percent were current smokers. Correspondingly, 20.9 percent of elderly men had never smoked, 62.3 percent were former smokers, and 16.8 percent were current smokers. Over 60 percent of the community residing elderly were current alcohol consumers. Of the remainder, 23.5 percent were former consumers and 15.1 percent never consumed alcohol.

5.1.2 Individual Determinants: Enabling factors

Of those aged 65 years and older, 81.8 percent of men fell within the middle Income Adequacy category or higher, while 30.8 percent of women fell within the low and lower-middle categories (Table 5.2). Also, 23.2 percent of men and 19.2 percent of women had a Household Income of $40,000 or more. Of the elderly population, 17.6 percent lived in a rural area. Of the total community residing population 65 years and older, 38.1 percent resided in Ontario, and 24.3 percent resided in Quebec at the time of interview.

Table 5.2: Descriptive results of community residing elderly Canadians, Enabling Individual Determinants. (X100)

Variable	Sex			
	Male	Female	Total	(%)
Income Adequacy				
low	513	1360	1873	(6.0)
lower-middle	1907	4060	5967	(19.3)
middle	6040	7262	13302	(43.1)
upper-middle	3711	3976	7687	(24.9)
high	1091	945	2037	(6.6)

continued

Table 5.2: Descriptive results of community residing elderly Canadians, Enabling Individual Determinants, continued. (X100)

Variable	Sex			
	Male	Female	Total	(%)
Household Income				
<$10,000	513	1360	1873	(6.1)
$10,000-$29,999	7587	10783	18370	(59.5)
$30,000-59,999	3984	4134	8118	(26.3)
>$60,000	1178	1326	2505	(8.1)
Urban/Rural				
urban	11051	15691	26742	(82.4)
rural	2894	2799	5693	(17.6)
Province				
Atlantic Canada	1174	1548	2722	(8.4)
Quebec	3268	4621	7889	(24.3)
Ontario	5337	7039	12376	(38.1)
Prairies	2283	2888	5170	(15.9)
British Columbia	1924	2428	4352	(13.4)
Social Support				
none			226	(0.8)
low			6568	(21.9)
high			23220	(77.4)

High Social Support was attained for 77.4 percent of the elderly population, and low Social Support was attained for 21.9 percent.

5.1.3 Individual Determinants: Illness Level factors

The proportion of both males and females within the lowest health rating increased with each advancing age group. For those aged 65 years and over, 39.3 percent of men and 39.9 percent of women had a Self-Rated Health status of very good or excellent (Table 5.3). For elderly men with health problems, the most common Main Health Problems were ranked other, heart and circulatory, and musculo-skeletal. For women, the most common Main Health Problems were ranked arthritis, heart and circulatory, and musculo-skeletal. Of those

aged 65 years and over, 97.3 percent did not have dexterity problems, and only 1.1 percent received help for their problems. For those aged 65 years and over, 38.5 percent of men and 40.7 percent of women were identified as having Restricted Activity. The proportion of individuals with this restriction increased with age from 33.5 percent of men and 33.4 percent of women aged 65-69 years, to 51.2 percent of men and 51.8 percent of women aged 80-84 years.

Table 5.3: Descriptive results of community residing elderly Canadians, Illness Level Individual Determinants. (X100)

Variable	Sex			
	Male	Female	Total	(%)
Self-Rated Health				
poor/fair	3696	4921	8617	(26.5)
good	4792	6204	10996	(33.8)
very good/excellent	5498	7398	12897	(39.7)
Main Health Problem				
nervous system	507	1066	1573	(12.5)
heart & circulatory	1144	1380	2524	(20.0)
respiratory	615	347	962	(7.6)
arthritis	716	1759	2475	(19.6)
musculo-skeletal	1094	1406	2500	(19.8)
other	1235	1323	2558	(20.3)
Dexterity				
no problem			31596	(97.3)
problem, no help			512	(1.6)
problem, help			378	(1.2)
Restriction of Activity				
no	8604	10982	19586	(60.2)
yes	5382	7542	12923	(39.8)
Self-esteem				
low			11916	(36.2)
medium			9318	(28.4)
high			11234	(35.3)
Depression				
not depressed	13107	16572	29679	(91.6)
depressed	866	1923	2789	(8.4)

Self-esteem scores were grouped into three levels: one to 18 (low), 19 to 22 (medium) and 22 to 24 (high). This divided the frequency distribution for those aged 65 years and over into approximate thirds: 36.2 percent (low), 28.4 percent (medium), and 35.3 percent (high). Only 6.2 percent of all men and 10.4 percent of all women had a Depression score above zero.

5.1.4 Health Services Utilization

The majority of community residing elderly Canadians claimed to have a Regular MD. Aged 65 to 74 years, 10.9 percent of men and 10.8 percent of women did not visit an MD within the past year, declining to 6.5 percent of men and 9.8 percent of women aged 75 years and older. The greatest proportion of men and women had one to five visits to an MD within the past year (Table 5.4).

Table 5.4: Descriptive results of community residing elderly Canadians, Health Services Utilization. (X100)

Variable	Sex			
	Male	Female	Total	(%)
Regular MD				
yes	13230	17505	30735	(94.5)
no	756	1018	1774	(5.4)
Visits to MD				
None	1312	1923	3235	(10.0)
1-5	7719	9928	17647	(54.5)
6+	4894	6605	11499	(35.5)
Visits to Health Professionals				
no	583	747	1330	(4.1)
yes	13390	17775	31165	(95.9)

continued

Table 5.4: Descriptive results of community residing elderly Canadians, Health Services Utilization, continued. (X100)

Variable	Sex			
	Male	Female	Total	(%)
Visits to Alternative HPs				
no			31575	(97.1)
yes			934	(2.9)
Recent Hospitalization				
no	11705	15411	27116	(83.4)
yes	2281	3113	5394	(16.6)

The majority of community residing Canadians visited a health professional within the past year, 4.2 percent of men and 4.0 percent of women did not. Few of the community residing elderly population consulted an alternative health practitioner within the last year. Also within the past year, 16.6 percent of the community residing elderly were hospitalized overnight or longer.

5.1.5 Medication Use

Of the 2,996 elderly in the NPHS sample, 15.9 (476) percent did not consume any medications, prescription or OTC, within a two-day period prior to interview, while 84.1 percent (2,520) consumed one or more medications during this period. With the appropriate weights applied, 16.6 percent of the Canadian elderly were classified as non-drug users, and 83.4 percent were classified as drug users. Of all drug users aged 65 years and older, 19.6 percent took only one medication, 20.6 percent took two, 14.7 percent took three, 9.4 percent took four, 7.4 percent took five, and 11.7 percent took more than five medications.

The sample median numbers of medications for those aged 65 to 74 years and for those 75 years and older were both two. The sample median numbers of medications for men

and for women aged 65 years and over were both two. Among drug users only, the sample median numbers of medications for those aged 65 to 74 years and for those 75 years and older were both three. The sample median number of medications for elderly men was two, and for elderly women was three (p=0.0003). Medication Use by drug category is presented in Table 5.5.

Table 5.5: Percentage of community residing elderly Canadians taking medication within each drug class (X100), NPHS 1994.

Drug Category	Men	Women
Alimentary tract and metabolism	38.7	45.2
Blood and blood forming organs	8.4	8.2
Cardiovascular system	35.8	42.5
Dermatological	2.9	3.2
Genito-urinary system and sex hormones	1.2*	6.3
Systemic hormonal preparations, excluding sex hormones	4.4	11.7
General anti-infectives for systemic use	2.7	2.1
Antineoplastic and immunomodulating drugs	1.1*	1.4*
Musculo-skeletal system	11.0	9.7
Nervous system	33.0	36.6
Antiparasitic products	0.8*	0.9*
Respiratory system	6.0	5.8
Sensory organs	2.8*	2.0
Various	0.5*	0.0*
Other	2.6*	2.5*

* numbers based on a sample of less than 30 occurrences, therefore the weighted population estimates are not considered to be accurate

5.2 Prevalence of Potentially Inappropriate Medication Use

Addressing the first objective, potentially inappropriate medication use among the community residing Canadian elderly aged 65 years and over was determined using two separate criteria. The Beers (modified) criteria for inappropriate use of single drugs classified

5.1 (± 1.4) percent of male drug users and 4.2 (± 1.0) percent of female drug users as having taken at least one potentially inappropriate medication. The Tamblyn questionable prescribing classified 4.1 (± 1.2) percent of male drug users and 4.6 (± 1.0) percent of female drug users as having taken questionable high-risk medication. Combining both criteria, a total of 7.3 (± 1.6) percent of male drug users and 7.1 (± 1.3) percent of female drug users were classified as having taken potentially inappropriate medication. For the entire population aged 65 years and older, including non-drug users, the combined criteria resulted in 6.0 (± 0.9) percent of the population taking at least one potentially inappropriate drug. Frequencies for the Beers (modified) criteria and the Tamblyn criteria are listed in Appendix N.

The Spearman correlation test was performed on all pairs of variables to determine the percentage of variation of one variable explained by the other variable (Appendix O). Variation between the following pairs was found:

1. Family Group and Marital Status, 48 percent;
2. Household Income and Income Adequacy, 92 percent;
3. Restriction of Activity and Main Health Problem, 92 percent;
4. Health Services and Recent Hospitalization, 66 percent.

Only two variables were excluded from further analysis in favour of the possible inclusion of another. The Family Group variable was excluded from further analysis in favour of using Marital Status, as this is a more common variable in research. The Health Services composite score was excluded from further analysis in favour of Hospitalization, being a score created for this study, and because this is not a common variable. Although the other two sets of variables have much higher correlations, it was decided to provide the opportunity for the

step-wise procedure to include either Household Income or Income Adequacy, and Restriction of Activity or Main Health Problem. The final model was checked to assure both variables of each pair were not included.

The prevalence of potentially inappropriate medication use ranged from 1.3 percent of those without a Regular MD to 19.0 percent of those taking six or more concomitant medications (Table 5.6). Noticeably high percentages are seen for:

1. former alcohol consumers;
2. the Atlantic provinces;
3. no and low Social Support;
4. poor Self-Rated Health;
5. nervous system, heart and circulatory, respiratory, arthritis and other Main Health Problems;
6. dexterity problems with and without help required;
7. Restricted Activity;
8. Depression;
9. six or more concomitant medications.

5.3 Modelling Results

Only those taking at least one medication were included in the analyses. Overall potentially inappropriate medication use was modelled with the use of relative weights. Similar analysis without the use of relative weights was also performed (Appendix P). Models using relative weights were also fitted for the Beers (modified) criteria (Appendix Q)

and for the Tamblyn criteria (Appendix R) separately.

5.3.1 Univariate modelling

Addressing the second objective, univariate LR was performed on each of the NPHS variables in order to identify predictors of potentially inappropriate medication use in Canadians aged 65 years and older (Table 5.6). Variable levels with statistically significant ORs were:

1. less than high school education;
2. a BMI rating of possibly overweight or overweight;
3. former alcohol consumption;
4. middle Income Adequacy
5. a Household Income from $0 to $39,999;
6. low Social Support;
7. poor, fair and good Self-Rated Health;
8. nervous system, heart and circulatory, respiratory, arthritis, and other Main Health Problems;
9. Dexterity problems with no help and with help;
10. Restricted Activity;
11. low and high Self-esteem;
12. Depression;
13. having a Regular MD;
14. one to five, and six or more Visits to MD within the past year;

15. two to five, and six or more medications taken concomitantly.

Table5.6: Prevalence of Potentially Inappropriate Medication Use and Univariate logistic regressions modelling potentially inappropriate medication use among elderly Canadians taking at least one medication (NPHS 1994).

Variables	Pot. Inap. Med. Use n	>=1 (%)	Odds Ratio	95% Confidence Interval
Age Group				
65-69	817.0	3.7	1.0	
70-79	1254.5	6.8	0.9	0.6 - 1.2
80+	447.5	5.1	0.6	0.4 - 1.0
Sex				
male	1013.7	7.3	1.0	
female	1505.3	7.1	1.0	0.7 - 1.3
Marital Status				
married	1481.5	7.7	1.3	0.6 - 2.9
single	125.5	5.9	1.0	
widowed	766.8	6.8	1.2	0.5 - 2.6
divorced	145.2	4.9	0.8	0.3 - 2.4
Education				
< high school	1319.5	8.8	1.9	1.2 - 3.1
high school grad	328.6	7.8	1.7	0.9 - 3.0
> high school	420.6	3.9	0.8	0.4 - 1.6
college/university	436.1	5.0	1.0	
Body-Mass Index				
underweight	251.6	6.7	1.3	0.7 - 2.2
acceptable	1001.5	5.4	1.0	
possibly overweight	202.7	7.8	1.5	0.8 - 2.7
overweight	594.0	8.9	1.7	1.2 - 2.6
unknown			1.7	1.1 - 2.5
Smoking Status				
never	1018.6	6.3	1.0	
former	1158.9	7.8	1.3	0.9 - 1.8
current	339.6	7.5	1.2	0.8 - 1.9
Alcohol Consumption				
never	380.5	7.8	1.3	0.8 - 2.0
former	638.6	9.4	1.6	1.2 - 2.3
current	1498.0	6.0	1.0	

continued

Table 5.6: Prevalence of Potentially Inappropriate Medication Use and Univariate logistic regressions modelling potentially inappropriate medication use among elderly Canadians taking at least one medication (NPHS 1994), continued.

Variables	Pot. Inap. Med. Use n	>=1 (%)	Odds Ratio	95% Confidence Interval
Income Adequacy				
low	148.6	5.4	1.0	0.4 - 2.4
lower-middle	475.2	8.7	1.7	0.9 - 3.0
middle	1021.0	8.8	1.7	1.0 - 2.9
upper-middle	596.0	4.4	0.8	0.4 - 1.5
high	161.7	8.6	1.0	
Household Income				
0 - 14,999	569.2	7.8	1.6	1.0 - 2.6
15,000 - 39,999	1321.5	7.9	1.6	1.1 - 2.5
40,000 +	511.9	5.8	1.0	
Urban / Rural				
urban	433.5	6.7	1.0	
rural	2080.1	7.2	0.9	0.6 - 1.4
Province				
Atlantic	205.4	9.6	1.5	0.9 - 2.6
Quebec	608.2	8.6	1.3	0.9 - 2.0
Ontario	965.3	6.5	1.0	
Prairies	407.5	6.0	0.9	0.6 - 1.5
British Columbia	332.7	6.2	0.9	0.6 - 1.6
Social Support				
none	18.2	12.6	2.2	0.5 - 8.9
low	522.4	10.7	1.8	1.3 - 2.6
high	1806.7	6.0	1.0	
Health Status				
poor	174.6	18.6	7.9	3.4 - 18.2
fair	578.8	7.7	2.9	1.3 - 6.4
good	876.1	7.8	2.9	1.3 - 6.4
very good	637	4.3	1.6	0.7 - 3.6
excellent	252.5	2.8	1.0	
Main Health Problem				
nervous system	138.4	9.4	2.0	1.0 - 3.6
heart and circulatory	229.7	12.3	2.6	1.7 - 4.2
respiratory	82.4	9.8	2.0	1.0 - 4.4
arthritis	214.9	10.4	2.2	1.3 - 3.6
musculo-skeletal	205.7	7.0	1.4	0.8 - 2.5
other	213.7	10.7	2.1	1.3 - 3.5
none	1412.8	5.1	1.0	

continued

Table 5.6: Potentially Inappropriate Medication Use and Univariate logistic regressions modelling potentially inappropriate medication use among elderly Canadians taking at least one medication (NPHS 1994), continued.

Variables	Pot. Inap. Med. Use n	>=1 (%)	Odds Ratio	95% Confidence Interval
Restricted Activity				
no	1412.8	5.1	1.0	
yes	1106.2	9.7	2.0	1.5 - 2.7
Dexterity				
no problem	2441.8	6.8	1.0	
problem, no help	42.9	16.1	2.6	1.1 - 6.0
problem, help	33.2	17.9	3.0	1.2 - 7.3
Self-esteem				
low	856.0	7.9	1.5	1.0 - 2.2
medium	668.6	4.5	1.0	
high	805.6	8.3	1.6	1.1 - 2.4
Depression				
not depressed	2231.7	6.6	1.0	
depressed	116.0	15.8	2.6	1.5 - 4.4
Regular MD				
no	100.6	1.3	1.0	
yes	2418.4	7.4	6.2	1.1 - 36.3
Visits to MD				
0	173.6	2.6	1.0	
1-5	1333.8	6.8	2.8	1.1 - 7.5
5+	1001.7	8.5	3.7	1.4 - 9.6
Visits to Health Professionals				
no	66.0	6.9	1.0	
yes	2451.7	7.2	1.1	0.4 - 2.8
Visits to Alternative HPs				
no	2436.2	7.2	1.5	0.6 - 4.3
yes	82.8	4.8	1.0	
Recent Hospitalization				
no	2056.0	6.8	1.0	
yes	463.0	8.8	1.3	0.9 - 1.9
Drug Use				
1	593.0	2.3	1.0	
2-5	1571.8	6.3	2.9	1.6 - 5.2
6+	354.1	19.0	10.1	5.5 - 18.4

5.3.2 Multivariate modelling

Addressing the third objective, results from the multivariate procedure are listed in Table 5.7. A higher risk of potentially inappropriate medication use was more likely to occur with:

1. low Social Support;
2. poor and good Self-Rated Health;
3. Dexterity problems with no help;
4. high Self-esteem score of 22 to 24;
5. two to five, and six or more concomitant medications.

Table 5.7: Multivariate logistic regression modelling potentially inappropriate medication use among elderly Canadians taking at least one medication (NPHS 1994).

Variables	Odds Ratio	95% Confidence Intervals
Age Group		
65-69	1.0	
70-79	0.8	0.6 - 1.1
80 +	0.5	0.3 - 0.9
Sex		
male	1.0	
female	0.9	0.7 - 1.3
Social Support		
none	2.9	0.7 - 12.1
low	1.7	1.2 - 2.4
high	1.0	
Health Status		
poor	4.1	1.7 - 10.1
fair	1.9	0.8 - 4.4
good	2.2	1.0 - 4.9
very good	1.5	0.6 - 3.5
excellent	1.0	
Dexterity		
no problem	1.0	
problem, no help	3.6	1.5 - 8.7
problem, help	2.2	0.8 - 5.8

continued

Table 5.7: Multivariate logistic regression modelling potentially inappropriate medication use among elderly Canadians taking at least one medication (NPHS 1994), continued.

Variables	Odds Ratio	95% Confidence Intervals
Self-esteem		
low	1.4	0.9 - 2.1
medium	1.0	
high	1.9	1.2 - 2.8
Drug Use		
1	1.0	
2-5	2.7	1.5 - 4.8
6 +	8.4	4.4 - 15.9

This model was tested using the Likelihood Ratio Test, and was found to be not as good a model as that containing all of the possible predictor variables:

$$LRT = -2 \ln LL_{\text{full model}} - (-2 \ln LL_{\text{parsimonious model}})$$

$$= 1162.158 - 1110.697$$

$$= 51.461, \text{ with 34 degrees of freedom, } p = 0.027847$$

The large sample size of the NPHS may be an influencing factor in this result. However, this model is a statistically significant improvement over the null model ($p = 0.0001$). A classification of predicted versus actual outcome is presented in Table 5.8. Overall agreement between predicted and actual potentially inappropriate medication use among the community residing elderly is 74.2 percent using this model.

Table 5.8: Classification table for the multivariate logistic regression model, predicting potentially inappropriate medication use among the community residing elderly taking at least one medication.

	Predicted Outcome	
Actual Outcome	negative	positive
negative	1762 (69.9%)	550 (21.8%)
positive	99 (3.9%)	108 (4.3%)

5.3.3 Summary modelling

The results of the univariate LR, using the composite score variable, are presented in Table 5.9: statistically significant odds ratios are indicated for the four highest quintiles. Those individuals in the highest risk quintile are seven times more likely to have a potentially inappropriate medication than in the lowest quintile. This model is a statistically significant improvement over the null model ($p = 0.0001$).

Table 5.9: Logistic regression modelling potentially inappropriate medication use among elderly Canadians taking at least one medication, based on a composite score created from the sums of multivariate logistic regression odds ratios (NPHS 1994).

Composite Score	Odds Ratio	95% Confidence Intervals
first quintile	1.0	
second quintile	2.3	1.2 - 4.3
third quintile	2.0	1.1 - 3.9
fourth quintile	1.9	1.0 - 3.7
fifth quintile	7.0	4..0 - 12.3

The composite model produced an overall agreement between 63.6 percent of the predicted and the actual potentially inappropriate medication use among the community residing elderly (Table 5.10).

Table 5.10: Classification table for the composite score model, predicting potentially inappropriate medication use among the community residing elderly taking at least one medication.

	Predicted Outcome	
Actual Outcome	negative	positive
negative	1492 (59.2%)	820 (32.6%)
positive	96 (3.8%)	111 (4.4%)

Chapter 6 COMPARISON OF THE STUDY SAMPLES

6.1 Socio-demographic and Health Characteristics

The EBDH data set is a cross-sectional review of the health status and medication regimens of 102 day-hospital patients at the time of admission to the day-hospital. The NPHS data set is a sub-set of a national population health survey, undertaken by Statistics Canada in 1994, of a random sample of Canadians living independent lives.

The mean age for the EBDH data set was higher than that of the NPHS sub-sample (80.2 years, SD 7.2 vs. 73.8 years, SD 9.1). This was as expected since the EBDH patients are a group in between living totally independently and being institutionalized. The proportion of females was 66 percent for the EBDH patients and 57 percent for the NPHS respondents. The literature reflects these proportions. Studies of ambulatory elderly reported a range of mean age from 68 years to 75.7 years and a proportion of females ranging from 53 to 71.6 percent.[5, 16, 58] One study of institutionalized patients found a higher percentage of female patents (80%) and an older mean age (84 years).[17]

The EBDH sample contains more single or widowed individuals than the NPHS, and more of the day-hospital patients were found to be living alone. This is consistent with increased morbidity with increased age, and with a larger proportion of women than men in the older age categories.[3, 10, 14, 15]

The EBDH sample has a higher percentage of underweight individuals than the NPHS, again reflecting the older age distribution and poorer health status of the day-hospital patients. The bimodal distribution of the BMI for the EBDH emphasises that this is a selected group of the elderly, rather than the random population survey of the NPHS. Current

smokers are slightly more prevalent in the EBDH sample, however the proportion of those who had never smoked was greater among the day-hospital patients. Smoking can contribute to poorer health and need for medical attention, however the day-hospital data may indicate a longer survival time for those who do not smoke. Current consumers of alcohol are three times as prevalent among the NPHS sample, possibly reflecting the younger age distribution or better overall health status.

The most common main health problem among the EBDH patients are conditions of the nervous system, whereas the NPHS sample has a more even distribution among heart and circulatory, musculo-skeletal, arthritis, and other health problems. Problems with balance, mobility and gait were common reasons for referral to the day-hospital, elements which could limit an individual's ability to continue living independently in the community.

Just under half of the day-hospital patients are identified as depressed, whereas depression scores indicating any level depression are present in less than 10 percent of the NPHS sample. Depression has been shown to increase with chronic strain, recent negative events, and low self-esteem.[100] Day-hospital patients are likely to suffer from strain because of their declining health status and unmet need for interventions.

Hospitalization within the past year had occurred for approximately one third of the EBDH sample, and for 16 percent of the NPHS sample. This again reflects the lower health status of the day-hospital patients, increased need for medical care, and general vulnerability of their health. Furthermore, changes in drug regimens that occur during hospitalization have been suggested to contribute to potentially inappropriate medication use,[39] and may be a problem for this sub-sample of the Canadian population.

6.2 Medication Use

The median number of medications taken by the day-hospital patients is five, while for the NPHS respondents taking at least one medication it is three. This is consistent with the higher level of morbidity, disease severity, and increased potential for inappropriate medication use. Results of the NPHS data indicate that drug users accounted for 83.4 percent of the Canadian elderly community residing population.

Polypharmacy, a known risk factor for potentially inappropriate medication use,[28] of six or more concomitant medications is approximately five times more prevalent among the EBDH sample than the Canadian population of community residing elderly (NPHS). This again is reflective of poor health.

6.3 Potentially Inappropriate Medication Use

Medication use in general, and inappropriate medication use in particular, tends to be greater among the institutionalized and those seeking medical care than among the general population. Using the Beers and Tamblyn combined criteria nearly 20 percent of the day-hospital sample subjects are classified as taking at least one potentially inappropriate medication. Of the NPHS elderly population drug users, just over seven percent are classified as taking at least one potentially inappropriate medication. The criteria used for the NPHS study are less complete than those used for the day-hospital study, yet these proportions demonstrate a large difference in the amount of potentially inappropriate medication use between these two samples. No other studies using these combined criteria are available for comparison with these results.

Using the Beers criteria alone, 15 percent of the EBDH sample are found to be currently taking at least one potentially inappropriate medication, approximately three times that of the NPHS sample (4.6%). A study of institutionalized patients using the complete Beers criteria classified 40 percent of the sample as taking at least one potentially inappropriate medication.[17] These results could indicate the differences between community residing elderly and the institutionalized in their health care needs and medication use.

Two studies have used the modified Beers criteria for determining the inappropriateness of drug use. One study of community residing persons aged 75 years and over reported 14.0 percent of the sample as taking at least one potentially inappropriate medication,[28] while an American national survey classified 23.5 percent of the elderly population as taking at least one potentially inappropriate medication.[11] The results of the NPHS study show a substantially lower prevalence of potentially inappropriate medication use, likely a reflection of the difference in time frames. Both of these studies had longer time frames: drug use over a period of four weeks,[28] and four interviews conducted at four month intervals.[11] The NPHS asked about drug-use over the last two day period. Differences between health care services in Canada and the USA may also contribute to this difference in potentially inappropriate medication use.

The Tamblyn criteria classifies approximately eight percent of the EBDH sample as taking a questionable high-risk drug combination, and approximately half as many (4.4%) of the NPHS collection. These criteria have been used previously, and classified just over 45 percent of the Quebec elderly population as taking a questionable drug combination over a one-year period.[20] The lower prevalence found by the day-hospital and NPHS studies may

again be explained by the longer time frame used in the Quebec study. The EBDH collected drug use information at the time of admission only. These criteria have not been used elsewhere.

6.4 Modelling Results

6.4.1 Univariate Modelling

Univariate LR identifies several socio-demographic and health characteristics that are associated with potentially inappropriate medication use among the community residing Canadian elderly. The EBDH data produced five statistically significant variables, and the NPHS data fifteen (Table 6.1) Main Health Problem, Depression and Drug Use are common to both studies.

Table 6.1: Variables found to be statistically associated with potentially inappropriate medication use among the elderly, EBDH vs. NPHS.

EBDH	NPHS	NPHS	NPHS
Smoking Status	Education	Social Support	Self-esteem
Main Health Problem	Body-Mass Index	Health Status	Depression
Depression	Alcohol Consumption	Main Health Problem	Regular MD
Source of Referral	Income Adequacy	Restricted Activity	Visits to MD
Drug Use	Household Income	Dexterity	Drug Use

Education was not available for all of the day-hospital patients, and was classified into two levels rather than the four levels available for the NPHS participants. Only those with less than high school are identified as being at a higher risk for potentially inappropriate medication use in the NPHS study. These types of individuals would have been lost among all those who had less than college or university for the day-hospital patients in the EBDH study.

BMI ratings were only available for a portion of the day-hospital patients, and statistical significance could not be attained because of a lack of power. The NPHS study found that those who are overweight, or have an unknown weight rating are at higher risk for potentially inappropriate medication use.

Current smoking is identified among the day-hospital patients as an important risk factor for potentially inappropriate medication use. Among the NPHS sample, current smokers produced a slightly elevated OR, but it did not reach significance. However, as described previously (Section 6.1), the similar proportions of never and former smokers among the NPHS are markedly different than those among the day-hospital patients. As smoking status is an important factor in health status, and the day-hospital patients are of poorer health than the general population, this difference in distribution of smoking status in the two data sets may account for the differing results.

The NPHS study found former consumers of alcohol to be at a higher risk for potentially inappropriate medication use, yet the EBDH data did not attain statistical significance. Alcohol status was available for just over 80 percent of the sample, and over half of those known never consumed alcohol. Sample size and power may be a limiting factor with this variable.

The EBDH data set does not contain any Enabling Individual Determinants. Those identified as risk factors from the NPHS data include middle Income Adequacy, low and middle Household Income, and low Social Support. These results indicate differences in the availability and access to health services, and to pharmacotherapy. Those with less financial or social resources may not visit their health care providers as frequently, or may not have a

regular health care provider. Therefore there would be less opportunity for revisions and updating of the medication regimens.

Two Illness Level Individual Determinants are identified among the day-hospital patients, where as all six of the NPHS Illness Level variables are found to be statistically significant for potentially inappropriate medication use. Poor, fair and good Health Status (NPHS) are all strong predictors. The Main Health Problem variable had to be grouped into different levels for the two data sets because of the limited sample size of the EBDH study. The NPHS Main Health Problem variable also included a "none" category. This level of the variable did not exist for the day-hospital patients therefore the reference level was different for the LR analyses, making comparison between the data sets difficult. The NPHS data provides a more complete picture, and shows elevated risks for many of the health conditions, reflecting the medication use among persons in ill health. For the day-hospital only musculo-skeletal conditions attained significance, possibly reflecting the types of drugs used to treat these conditions. Restricted Activity and Dexterity, only available for the NPHS, are both found to be significant, indicating medical conditions that would make adhering to a medication regimen difficult. Both data sets found Depression to be a risk factor, possibly reflecting the types of medications used to treat this condition, or its symptoms.

The NPHS data set contains more Health Service Utilization variables than the EBDH. Having a regular MD, and visiting the doctor once to five times, or more than five times during the past year are all statistically significant for potentially inappropriate medication use, and point towards poorer health and a need for pharmacotherapy. Source of Referral for the day-hospital patients was primarily through the Geriatric Assessment

Outreach Team. This variable is found to be a statistically significant risk factor for these patients, and suggests that this system is acting as intended by referring these individuals to the day-hospital.

Drug use was grouped into different levels for the two study data sets because of the limited number of day-hospital patients. Both studies found an increased risk for those taking six or more concomitant medications. The NPHS data also found an increase for those receiving two to five medications. Polypharmacy is a known risk factor for ADRs, and was expected to be the most relevant variable in potentially inappropriate medication use.[37]

6.4.2 Multivariate Modelling

Multivariate LR produced parsimonious models for potentially inappropriate medication use (Table 6.2). The day-hospital study produced a six-variable model, the NPHS study produced a seven-variable model. The only variable common to the two models is Drug Use. This difference reflects the different variables available for modelling.

Table 6.2: Variables included in multivariate modelling for potentially inappropriate medication use among the elderly, EBDH vs. NPHS.

EBDH	NPHS
Age Group	Age Group
Sex	Sex
Smoking Status	Social Support
Main Health Problem	Health Status
Cognitive Status	Dexterity
Drug Use	Self-esteem
	Drug Use

6.4.3 Summary Modelling

The composite score is a new attempt to summarize the results of the multivariate produced model. In order to develop a predictive model for potentially inappropriate medication use, a score was calculated for each contributor to the data sets based on the variables included in the parsimonious models. A range of scores was produced, with low scores indicating a lower risk of potentially inappropriate medication use. Only one fifth of the day-hospital patients, those with the highest scores, attained statistical significance when univariate LR was performed. This is likely due to limited sample size and lack of power. All four of the higher score quintiles of the NPHS data set attained statistical significance when the lowest score group was used as the reference. In both cases, the highest score quintiles produced an OR greater than the others. This scoring method requires further work in validation and predictive value.

This type of predictive score can be used to rank individuals in terms of their risk for potentially inappropriate medication use. Those with the highest risk should be the people receiving the most attention in terms of medication review and evaluation. By directing these resources towards those in most need, the health care services will be used in the most efficient manner possible. This will lead to a decrease in the prevalence of potentially inappropriate medication use among the elderly, and a subsequent decrease in ADRs.

Chapter 7 DISCUSSION

7.1 Introduction

The purpose of this study was to determine the prevalence of potentially inappropriate medication use among community residing Canadian elderly, as well as its relationship with selected socio-demographic and health characteristics. Two samples of the Canadian elderly population were examined. A day-hospital sample provided a subgroup of community residing elderly who are of poorer health, and therefore likely to be at a higher risk for potentially inappropriate medication use than the general population. A national survey available for secondary analysis provided the means to determine the extent of this problem in Canada, and to produce results generalizable to community residing Canadian elderly.

The main findings of this study are as follows. For the day-hospital patients the prevalence of potentially inappropriate medication use is 11.1 percent among men and 23.1 percent among women. Five variables were individually identified by univariate LR as being significantly related to potentially inappropriate medication use. Multivariate LR constructed a six-variable model, and found that potentially inappropriate medication use is more likely to occur among women, among current smokers, among patients with a musculo-skeletal Main Health Problem, among patients with low Cognitive Status; and among patients taking six or more concomitant medications. Age Group did not attain statistical significance in this model. An attempt was made to further summarize these results into a composite score, which can be used to predict which elderly day-hospital patients are at high risk for potentially inappropriate medication use. Those at the highest risk were found to have an OR of 9.4.

The prevalence of potentially inappropriate medication use among community residing

elderly Canadians (NPHS) taking at least one medication is 7.3 percent among men and 7.1 percent among women. For the entire population aged 65 years and older including non-drug users, 6.0 percent were classified as taking at least one potentially inappropriate medication. Univariate LR identified fourteen variables as being significantly related to potentially inappropriate medication use. The seven-variable model constructed by multivariate LR methods suggests that potentially inappropriate medication use is more likely to occur among elderly Canadians with low Social Support, poor or good Self-Rated Health, Dexterity problem receiving no help, high Self-esteem, and drug use of two or more concomitant medications. Age Group and Sex did not attain statistical significance in this model. These results were further summarized into a composite score. The OR for those at the highest risk is 7.0.

The results of this study must be treated cautiously. The limitations of this study have most likely lead to minimal estimates of the true prevalence of potentially inappropriate medication use. The following sections will discuss the implications of this study, outline the limitations associated with these two data sets, and discuss the future directions for research in this area.

7.2 Implications

The prevalence of potentially inappropriate medication use was found to be more than three times greater among new admissions to a day-hospital than among the general Canadian elderly population (19% vs. 6%). This is consistent with the concept that patients attending a day-hospital represent a narrow segment of the community residing elderly who suffer from

increased severity of disease and greater number of co-morbid conditions. The NPHS data indicate that the prevalence of potentially inappropriate medication use is just over seven percent among those currently taking at least one medication. Because the NPHS data is based on self-reported drug use, and lacks indication for drug use, it is difficult to evaluate how high or low this prevalence of seven percent is, and by how much it could be reduced. This is a topic for further investigation.

7.2.1 Elisabeth Bruyère Day-Hospital

General hypotheses predicting how each of the EBDH study variables would influence potentially inappropriate medication use (Appendix B) which are supported by the univariate or multivariate LR results are: current smokers, low Cognitive Status, depression, and concurrent use of six or more medications. Each of these variables will be discussed below.

Smoking is a detriment to health, and elderly persons who smoke are at risk of developing medical conditions such as coronary atherosclerosis,[103] chronic bronchitis and emphysema.[104] This is expected to increase the use of medications, thereby exposing smokers to the potential of inappropriate medication use. One study found that former elderly smokers were most likely to be taking at least one medication when compared to those who had never smoked, and that one half to one third of current elderly smokers took at least one medication.[10]

Poor cognitive functioning may be attributed to declining health or to the effects of aggressive pharmacotherapy. Salzman (1995) reported that confusion may lead to difficulty in properly following a drug regimen.[35] Depression and polypharmacy (of three medications

or more) have been previously identified as associated with potentially inappropriate medication use. Depressive patients, if treated for sleep and anxiety problems, have been found to receive long acting benzodiazepines rather than more appropriate therapy for their depressive state.[28] Polypharmacy is thought to increase the probability of receiving an inappropriate medication, and may reflect an over-eagerness in the prescriber or the patient to treat with many, and possibly higher risk, medications.[28]

Source of Referral is also identified as being associated with potentially inappropriate medication use. Referral by the Geriatric Assessment Outreach Team was the most common Source of Referral (70 %). This service currently focuses on overall patient evaluation, including the drug regimen. However easy identification of those at a higher risk for potentially inappropriate medication use could result in earlier detection of a problem, and prompter action to change the overall treatment plan.

The identification of the Main Health Problem of musculo-skeletal conditions as a factor contributing to potentially inappropriate medication use may be reflective of the types of medications prescribed for this condition, such as NSAIDs used to treat arthritis.[105]

In conclusion, none of the results from the analysis of the EBDH data for potentially inappropriate medication use are unexpected or counter to the proposed hypotheses (Appendix B). These results are supported by reports in the literature.

7.2.2 National Population Health Survey

Most of the hypotheses predicting how each of the NPHS variables would influence potentially inappropriate medication use (Appendix B) are supported by the results of the

univariate and multivariate LRs. The variables identified include Education, BMI, Household Income, Self-Rated Health, Restriction of Activity and Dexterity, Depression, Visits to an MD within the past year, and Drug Use. These results will be discussed below.

Lower education levels could influence a patient's needs and expectations of treatment, thereby leading to polypharmacy. Low education has previously been reported to be associated with health risk factors, such as smoking, high blood pressure and high cholesterol levels.[106] Being over or underweight may also be an indication of poor health status, leading to multiple conditions, and again to polypharmacy. Lower Household Income may result in access to fewer preventative health resources, such as diet and exercise programs, or counselling for stress and mental health. A recent study identified household income, as well as education, as a variable in the socio-economic gradient that is a predictor of health.[107]

Lower Self-Rated Health status may indicate the involvement of more than one physician, again leading to polypharmacy and possibly unnecessary drug use. A study found that persons with poor health status were more likely to report ADRs.[33] Restricted Activity, increased physical disability (dexterity problems), may be an indication of disability due to poor health, leading to multiple drug use. One study reported severe functional limitations to be a predictor of inappropriate medication use.[108] Alternatively, an individual's physical ability to handle pills and their dispensers may inhibit the ability to take the medications as directed. For example, childproof containers may also be elderly proof.

Again, as in the EBDH results, Depression is identified as being significantly related to potentially inappropriate medication use, having also been identified by a previous study.[28]

A high number of Visits to an MD during the past year could be indicative of a chronic medical problem, successive complaints from multiple health conditions, or a patient's desire to receive pharmacotherapy with or without adequate medical cause. Polypharmacy has been reported to occur when there are multiple symptoms and more than one prescribing physician.[48] Furthermore, potentially inappropriate drug combinations have also been reported to occur more often with more than one treating physician.[47]

Similar to the EBDH findings, Main Health Problem is identified as a characteristic significantly associated with potentially inappropriate medication use. The problems identified for the NPHS data are nervous system, heart and circulatory, respiratory, arthritis, and other (a miscellaneous group of diagnoses). This Main Health Problem variable is noticeably different than that of the EBDH data set in that it also classified members of the community residing elderly who were not suffering from a health problem. This category of healthy individuals was the reference used for the LR analyses, rather than the "other" (a miscellaneous group of diagnoses) group used in the EBDH study. Many of the health problem categories are identified as being significantly related to potentially inappropriate medication use, likely because individuals who are suffering from a health condition must be at a higher risk of receiving a medication.

There were two variables included in the multiple LR that were contrary to the proposed hypotheses (Appendix B): Alcohol Consumption and Self-esteem.

Being a former consumer of alcohol is statistically significant for potentially inappropriate medication use, yet being a current consumer is not. Continued consumption of alcohol, if not excessive, could be an indication of better health among the elderly. At least

one study reported that men and women who consumed alcohol were significantly less likely to be taking medications.[10] Conversely, those currently consuming alcohol have been identified as positively correlated with having an ADR,[39] however drug-alcohol interactions are not included in the criteria as applied in this study. The exact nature of how alcohol use is associate with potentially inappropriate medication use will require further investigation.

Also unexpected, this study found High Self-esteem to be associated with potentially inappropriate medication use. This may be an indicator of the perception of good health, implying that these individuals may be perceived to be more robust, less vulnerable to ADRs, and therefore more likely to receive a high risk medication as the result of aggressive treatment. As an unexpected finding, this again would be a good subject for future studies.

7.3 Limitations

Limitations of this study will lead to an error in the estimation of the prevalence of potentially inappropriate medication use among the Canadian elderly. However most of these limitations serve to underestimate potentially inappropriate medication use. Both the Beers and Tamblyn criteria used in this study estimated potentially inappropriate medication use among the community residing Canadian elderly to be much lower than in previous studies. This may be the result of a more representative sample of the population, including the healthy elderly. Alternatively, it may indicate a limitation of the drug data of the EBDH and NPHS samples, for example, by collecting drug data over a shorter time frame, or excluding certain drug classes from the criteria.

7.3.1 Elisabeth Bruyère Day-Hospital

Having an adequate sample size is a limiting factor in many studies. The power of a study is related to sample size, and the size of the difference of the outcome between groups to be detected. These three factors determine the level of confidence in the validity of the results. The original collection period for the day-hospital study was six months, but was extended because of lower than expected admission rates. The sample size of 102 patients was sufficient to detect a difference of 30 percent with a power of 80 percent.

The primary limiting factor concerning medical chart abstraction is the completeness and accuracy of the information recorded in the chart. Incomplete medical chart information, especially drug dose and duration, was a limiting factor for the analysis of the EBDH data. Other variables often missing from the charts were Education, Smoking Status, Alcohol Consumption, Weight, and Height. Race was not recorded in the EBDH admission charts, and was consequently derived from place of origin, language, and an attached colour photograph if available. None the less, it was decided to drop the variable Race from analysis of the EBDH data because the method of measure was deemed too uncertain. Furthermore, it is difficult to conceptualize how race is associated with potentially inappropriate medication use, and how it relates to genetic composition, ancestry, ethnicity, culture, religion, behaviour, place of birth, and language spoken.

Participation of a Regular MD in the ongoing care of the patient was often recorded on the application and referral forms to the EBDH, included in the admission charts. Other variables not included in the EBDH chart review were: Income Adequacy; Urban-Rural residence; Social Support; Self-Rated Health; Self-esteem; and number of Visits to MD, visits

to Health Professionals, or visits to Alternative Health Practitioners within the past year.

Detailed medication use by 70 percent of the day-hospital patients was recorded during an intensive at home interview with the Geriatric Outreach Assessment Team. It was not always certain whether the drug use was actual use, or whether it included all medications found in the home. Those patients who were not referred to the day-hospital by this method provided drug use information when first assessed at the day-hospital. For these patients, information concerning drug name, dose and duration of use may have been less detailed. This limitation may have affected the results of this study because of the relatively small sample size.

7.3.2 National Population Health Survey

The NPHS is the most current database that allows for national estimates of drug use by the Canadian population. An advantage of using household survey data for estimating drug use was described by Helling et al. (1987) as follows , "...household surveys can provide data on the drug taking habits of less-frequent users of the health care system, and can be more readily extrapolated to other populations or to estimate the population impact of a particular drug-taking behaviour."[13] A limitation of survey data, however, is the accuracy of self-reported and proxy information. Proxy information was only collected for approximately four percent of the NPHS sample, so that limitations inherent in proxy information would not unduly affect these data. A study of self-reported drug use information collected from community residents found that drug use was underestimated by 20 to 30 percent.[28] This was attributed to poor memory, as well as pressure to conform to social expectations.

Furthermore, cross-sectional studies that record drug use within a limited time frame are more likely to catch the long duration medication use than the short duration regimens for acute conditions.[4] However by collecting drug use information for the last two days only, under reporting as a result of poor memory should be reduced.

Sample size is a common limiting factor in secondary data analysis. The NPHS included a sample of nearly 3,000 elderly, thereby ensuring adequate sample size and power for studies of this population. However clinical, or practical, significance is an important consideration when explaining the results, as the sample size is likely to provide statistical significance for even small differences among the subjects. This study had enough power (> 80%) to detect a difference in potentially inappropriate medication use of 10 percent.

The ability to characterize subjects is dependent on the variables included in the data set.[102] Unless specifically requested, information pertaining to such information as disease severity, co-morbidity, indication for drug use, drug dosage, duration of drug use, frequency of drug use, or whether the drug is prescription or OTC medication may well not be included. In fact, analysis of the data is limited to the available information. Specifically, criteria for potentially inappropriate drug use may not include inappropriate indication for drug use, drug-disease interaction, under use of the indicated drug therapy, or excessive dose, duration or frequency of use.

7.3.3 Criteria for Determining Potentially Inappropriate Medication Use

Criteria describing potentially inappropriate medication use require ongoing updating. Several criticisms have been made regarding the Beers criteria, yet it remains one of the few

current criteria that is being applied to computerized health databases.[21] Many of the implicit criteria in existence account for the severity of the potential ADR, an area that could be included when updating the Beers criteria. Furthermore, questions involving the inclusion of the antihypertensive agents propranolol, methyldopa, and reserpine have been raised by several investigators,[12, 21] as well as an incomplete addressing of NSAIDs.[21] Areas not included in the Beers criteria, which have also been remarked upon, include: drug interactions; "appropriate" medications being used inappropriately; and under use of appropriate medications.

Although the McLeod criteria (1997) are the most recent development of inappropriate practices in prescribing for elderly people, these criteria require detailed knowledge of the conditions for which the specific medications are prescribed (eg. beta-blockers to treat hypertension versus to treat angina).[62] They also require a complete history of past medical conditions. The McLeod criteria disagree with the Beers criteria with regards to reserpine, chlorthalidone, chlorpropamide and amitriptyline. They also removed isoxsuprine, cyclandelate and propoxyphene, stating that these drugs have recently fallen into disuse, a further reminder of the need for continued review of the criteria.

Tamblyn et al. (1994) did not rank their drug groupings for comparative severity of the potential ADR, but included only those drug combinations for which there was evidence that the interaction "could result in significant deterioration in patient health or death." [20] A further limitation is that these criteria are restricted to only three drug classes: Cardiovascular, Psychotropic and NSAIDs.

Updated criteria for determining potentially inappropriate medication use, for use in

non-clinical studies, are required in order to accurately assess and compare prevalence in the population. None the less, immediately available criteria allow for investigating current drug prescribing.

The criteria used to define potentially inappropriate medication use were more detailed for the EBDH sample than those applied to the NPHS data for the general elderly population. The availability of more detailed data and criteria would serve to identify more potentially inappropriate medication use and further support the indisputable need for improvement of pharmacotherapy among the elderly. Although explanatory variables were fewer for the EBDH study than for the NPHS study, the sub-sample of day-hospital patients has shown to be an ideal starting point for monitoring and improving drug use safely, as both the need and the means exist in the same setting. The NPHS data could be used as a monitoring system for potentially inappropriate medication use among the Canadian elderly.

7.4 Future Directions

In 1994, the Canadian elderly aged 65 years and older comprised 12 percent of the total population. Projected population estimates for the year 2016 estimate an increase of this proportion to 16 percent; and to 23 percent for the year 2041.[7] Therefore, the importance of providing appropriate medical care to the elderly, and the consequences of inappropriate care, will only increase with time.

Although inappropriate drug use is a recognized problem among the institutionalized elderly, the health needs of the community residing elderly are not as closely monitored. Patients admitted to a day-hospital are a subgroup of the population that has the advantage

of closer supervision than that of the general community residing elderly. This closer contact with the health care system provides an opportunity for the revision and updating of current drug regimens, assessment of patient compliance, and monitoring for ADRs and a decrease in the potential for inappropriate medication use.

With the NPHS being updated every two years, the potential exists to continue to monitor the prevalence of potentially inappropriate medication use among the community residing Canadian elderly, and to study the impact of any actions to promote appropriate prescribing. Furthermore, the NPHS also comprises a database for the institutionalized. Therefore the prevalence of potentially inappropriate medication use among the institutionalized elderly could also be determined and monitored using these methods.

Several socio-demographic and health characteristics have been identified in this study as being associated with potentially inappropriate medication use. Further investigation to determine the underlying relationships between these variables and this outcome may lead to new directions for initiatives to provide safer pharmacotherapy to those at increased risk for potentially inappropriate medication use and, consequently, for ADRs.

Continued changes to the prescribing and monitoring practices of drug use in the elderly population are being, and must continue to be, addressed. Reduced exposure to potentially inappropriate medication use should lead to a reduction in drug-related morbidity, lower health care costs, and increased quality of life.

Another important step is to continue to review and update criteria with which to identify potentially inappropriate medication use among the elderly. The Beers set of criteria appear to be one of the more widely used tools, and work has been done to address concerns

for its content.[62] The Tamblyn criteria currently focus on three major drug categories, and could be expanded to contain questionable drug combinations from all drug categories.

7.5 Conclusion

Adverse drug reactions are more common among the elderly because deteriorating health associated with advanced age can lead to co-morbidity and polypharmacy. Changes in pharmacokinetics and pharmacodynamics, as well as reduced resistance to stress, leave the elderly more vulnerable to adverse events resulting from medication use. Furthermore, appropriate prescribing for the indication, compliance to the drug regimen and adequate surveillance are necessary to ensure safe and effective therapy, by decreasing the potential for inappropriate prescribing.

Although the permissible level of potentially inappropriate medication use is unknown, it would seem that the prevalence of six percent does not indicate a serious problem among the general Canadian population of community residing elderly. Elderly patients admitted to a day-hospital were found to be three times more likely to require a medication review for this problem. Several socio-demographic and health characteristics were identified through univariate and multivariate LR methods as being associated with potentially inappropriate medication use. A method for ranking individuals in terms of their risk for this problem has been suggested, and requires further work to determine its validity and usefulness in predicting those at risk.

The need for ongoing initiatives to improve geriatric health care requires monitoring and quality assurance, both of which can be provided by the methods used in this study.

High-risk sub-groups, such as day-hospital patients, are an ideal target for medication review projects aimed at reducing potentially inappropriate medication use among the community residing Canadian elderly. With ongoing work toward updating the criteria for determining potentially inappropriate medication use among the elderly, and projects such as the National Population Health Survey, current national levels of drug use and the prevalence of potentially inappropriate medication use can be easily determined at low cost.

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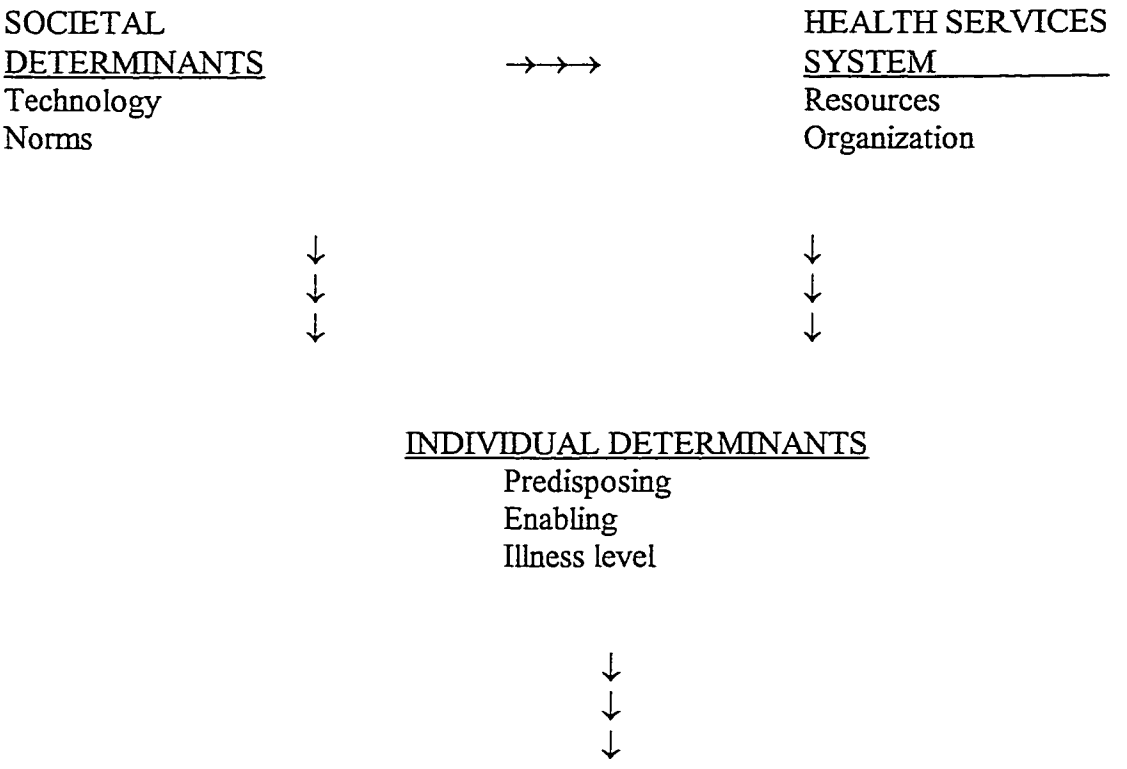
APPENDIX A

Health Services Utilization Framework
Anderson & Newman, 1973.

Framework for viewing health service utilization.[63]



Characteristics of health services utilization.[63]

TYPE	PURPOSE	UNIT OF ANALYSIS
Hospital	Primary care	Contact
Physician	Secondary care	Volume
Drug and medications	Tertiary care	Episodic care
Dentist	Custodial care	
Nursing home		
Other		

Individual determinants of health service utilization.[63]

PREDISPOSING	ENABLING	ILLNESS LEVEL
Demographic	Family	Perceived
Age	Income	Disability
Sex	Health insurance	Symptoms
Marital status	Type of regular source	Diagnoses
Past Illness	Access to regular source	General state
Social Structure	Community	Evaluated
Education	Ratios of health personnel and facilities to population	Symptoms
Race		Diagnoses
Occupation	Price of health services	
Family Size	Region of country	
Ethnicity	Urban-rural character	
Religion		
Residential mobility		
Beliefs		
Values concerning health and illness		
Attitudes toward health services		
Knowledge about disease		

APPENDIX B

Hypotheses for the Conceptual Framework

Table B.1: General hypotheses indicating how Individual Determinants and ADR variables may influence Health Service Utilization, from the conceptual framework for potential appropriateness of medication use and adverse drug reactions (pathway 1).

INDIVIDUAL DETERMINANTS	HEALTH SERVICES UTILIZATION
age	↑ with ↑ age α ↓ health
sex	↑ by females α Δ attitudes
race	Δ between races α Δ attitudes
marital status	↑ if married α ↑ social support
family group	↑ if not living alone
language	Δ between language α Δ comprehension & confidence
education	↑ with ↑ education α ↑ awareness
body-mass index (BMI)	↑ with other than acceptable BMI α ↓ health
smoking status	↑ with cigarette use α ↓ health
alcohol consumption	↑ with alcohol consumption α ↓ health
nutrition	↑ with poor nutrition α ↓ health
income	↑ with ↑ income α ↑ resources
urban-rural	↑ by urban communities α ↑ accessibility
province	Δbetween provinces α Δ practices
social support	↑ with ↑ social support
self-rated health	↑ with ↓ self-rated health
reason for referral	↑ with severity of reason for referral
diagnosis/disease	↑ with ↑ disease α ↑ health
functional status	↑ with ↑ physical disability α ↓ health
cognitive status	↑ with ↑ cognitive disability α ↓ health
self-esteem	↓ with ↑ self-esteem α ↑ health
depression	↑ with ↑ depression α ↓ health
ADR	↑with ↑ ADRs α ↓ health

Table B.2: General hypotheses indication how Individual Determinants and ADR variables might influence Compliance, from the conceptual framework for potential appropriateness of medication use and adverse drug reactions (pathway 2).

INDIVIDUAL DETERMINANTS	COMPLIANCE (mechanism)
age	↓ with ↑ age α ↑ complexity
sex	↑ by females α Δ attitudes
race	Δ between races α Δ attitudes
marital status	↑ if married α ↑ social support
family group	↑ if not living alone
language	Δ between language α comprehension
education	↑ with ↑ education α ↑ awareness
smoking status	↓ with cigarette use α ↓ awareness
alcohol consumption	↓ with alcohol use α ↓ awareness
income	↑ with ↑ income α ↑ resources
social support	↑ with ↑ social support
self-rated health	↑ with ↓ self-rated health
diagnosis/disease	↑ with ↑ disease α ↓ health
functional status	↓ with ↑ physical disability α ↑ difficulty
cognitive status	↓ with ↑ cognitive disability α ↑ difficulty
self-esteem	↑ with ↑ self-esteem α ↑ motivation
depression	↓ with ↑ depression α ↓ motivation
ADR	Δ with ADRs α Δ symptoms

Table B.3: General hypotheses indicating how Individual Determinant variables may influence Pharmacokinetics and Pharmacodynamics, from the conceptual framework for potential appropriateness of medication use and adverse drug reactions (pathway 3).

INDIVIDUAL DETERMINANTS	PHARMACOKINETICS/PHARMACODYNAMICS (mechanism)
age	Δ pharmaco- with age
sex	Δ pharmaco- between sexes
race	Δ pharmaco- between races
body-mass index (BMI)	Δ pharmaco- with Δ BMI
smoking status	Δ pharmaco- with cigarette use
alcohol consumption	Δ pharmaco- with alcohol consumption
nutrition	Δ pharmaco- with Δ nutrition
disease	Δ pharmaco- with disease

Table B.4: General hypotheses indication how all potential predictor variables may influence potentially inappropriate medication use (pathway 7).

INDIVIDUAL DETERMINANTS	POTENTIALLY INAPPROPRIATE MEDICATION USE
age	↑ with ↑ age α ↓ health
sex	↑ by females α ↑ medication use
race	Δ between races α Δ levels of medication use
marital status	↓ if married α ↑ social support
family group	↓ if not living alone
language	Δ between languages α Δ levels of comprehension
education	↑ with ↓ education α ↓ awareness
body-mass index (BMI)	↑ with acceptable BMI α ↓ perceived risk
smoking status	↑ with cigarette use α ↓ health & ↑ medication use
alcohol consumption	↑ with alcohol α ↓ health & ↑ medication use
nutrition	↑ with ↑ nutrition α ↓ perceived risk
income	↑ with ↓ income α ↓ education & ↓ awareness
urban-rural	↑ by urban communities α ↑ accessibility
province	Δ between provinces α Δ practices
social support	↓ with ↑ social support
self-rated health	↑ with ↓ self-rated health
diagnosis/disease	↑ with ↑ disease α ↓ health
functional status	↑ with ↑ physical disability α ↓ health
cognitive status	↑ with ↑ cognitive disability α ↓ health
self-esteem	↓ with ↑ self-esteem α ↑ health
depression	↑ with ↑ depression α ↓ health
HEALTH SERVICES UTILIZATION	
regular MD	↓ with regular MD α ↑ supervision
# visits to MD	↑ with ↑ # visits to MD α ↑ medication use
visits to HP	↑ with visits to other HP α ↑ medication use
visits to Alter HP	↓ with visits to alternative HP α ↓ medication use
hospitalization	↑ with recent hospitalization α ↓ health ↓ supervision
MEDICATION USE	
administration	↑ with self administration α ↑ mistakes
# medications	↑ with ↑ # medications
specific medications	↑ with use of specific inappropriate medications
dose, duration, frequency	↑ with inappropriate dose, duration, frequency

APPENDIX C

EBDH data collection form

DATA COLLECTION SHEET #_____

FILE #_____ ADMISSION DATE _____ RELEASE DATE _____

AGE _____ DATE OF BIRTH _____ SEX _____

REFERRED BY _____ FOR _____

MARTIAL STATUS: Married _____ Widowed _____ Single _____ Divorced _____

LIVES: Alone _____ With _____

RACE: Caucasian Black Oriental Other _____

EDUCATION _____ LANGUAGE _____

SMOKER _____ ETOH _____

ADLs	ACTIVITY	INDEPENDENT	ASSISTANT	DEPENDENT
	Transfers			
	Walking			
	Dressing			
	Bathing			
	Feeding			
	Cleaning			
	Laundry			
	Grooming			
	Finances			
	Medications			
	Cooking			
	Groceries			
	Transport			

NUTRITION _____

FOLSTEIN _____ DONE BY _____

DEPRESSION _____ DONE BY _____

WEIGHT _____ HEIGHT _____

HOSPITALIZATION WITHIN LAST YEAR: Yes _____ No _____

HOW LONG AGO: < 1 month _____ 1-6 months _____ > 6 months _____

REASON FOR HOSPITALIZATION _____

REGULAR MEDICAL DOCTOR: YES _____ NO _____

PRIMARY DIAGNOSIS _____

OTHER CONDITIONS _____

_____

_____

ALLERGIES _____

_____

DRUG DATA: ADMINISTERED: SELF / SUPERVISED/ DOSETTE

1. NAME:_____

   DOSE:_____

   DURATION: < 1 month ____ 1-6 months ____ 6-12 months ____ >1 yr ____

2. NAME:_____

   DOSE:_____

   DURATION: < 1 month ____ 1-6 months ____ 6-12 months ____ >1 yr ____

3. NAME:_____

   DOSE:_____

   DURATION: < 1 month ____ 1-6 months ____ 6-12 months ____ >1 yr ____

4. NAME:_____

   DOSE:_____

   DURATION: < 1 month ____ 1-6 months ____ 6-12 months ____ >1 yr ____

5. NAME:_____

   DOSE:_____

   DURATION: < 1 month ____ 1-6 months ____ 6-12 months ____ >1 yr ____

6. NAME:_____

   DOSE:_____

   DURATION: < 1 month ____ 1-6 months ____ 6-12 months ____ >1 yr ____

7. NAME:_____

   DOSE:_____

   DURATION: < 1 month ____ 1-6 months ____ 6-12 months ____ >1 yr ____

8. NAME:_____

   DOSE:_____

   DURATION: < 1 month ____ 1-6 months ____ 6-12 months ____ >1 yr ____

9. NAME:_____

DOSE:_____

DURATION: < 1 month ____ 1-6 months ____ 6-12 months ____ >1 yr ____

10. NAME:_____

DOSE:_____

DURATION: < 1 month ____ 1-6 months ____ 6-12 months ____ >1 yr ____

11. NAME:_____

DOSE:_____

DURATION: < 1 month ____ 1-6 months ____ 6-12 months ____ >1 yr ____

12. NAME:_____

DOSE:_____

DURATION: < 1 month ____ 1-6 months ____ 6-12 months ____ >1 yr ____

13. NAME:_____

DOSE:_____

DURATION: < 1 month ____ 1-6 months ____ 6-12 months ____ >1 yr ____

14. NAME:_____

DOSE:_____

DURATION: < 1 month ____ 1-6 months ____ 6-12 months ____ >1 yr ____

APPENDIX D

EBDH sample size calculations

Population Survey or Descriptive Study Using Random (Not Cluster) Sampling

Population Size	110,000
Expected Frequency	5.50 %
Worst Acceptable	2.50 %

Difference to Detect	Sample Size
3.0%	222
4.0	125
4.5%	99
5.0%	80
6.0%	54

Formula: Sample Size = n/(1- (n/population))

n = Z*Z (P(1-P)) / (D*D)

Reference: Kish L. Survey Sampling. John Wiley & Sons, NY, 1965.

For a confidence level of 95%, the Z-value = 1.96
P, the expected prevalence of the outcome = 0.055
D, the difference to detect = 0.055 - 0.025 = 0.03

n = Z * Z (P(1-P)) / (D*D)
= 1.96 * 1.96 (0.055(1 - 055)) / (0.03 * 0.03)
= 3.8416 (0.055 * 0.945) / 0.0009
= 3.8416 * 0.051975 / 0.0009
= 221.85

Sample Size = n / (1- (n / population))
= 221.85 / (1 - (221.85 / 110,000))
= 221.85 / (1-0.0020168)
= 221.85 / 0.9979832
= 222.30

APPENDIX E

Beers et al. 1991 & Tamblyn et al. 1994 criteria

Beers et al. criteria for potentially inappropriate medication use

Sedative-hypnotics	
Long acting benzodiazepines: chlordiazepoxide, diazepam, flurazepam	All use should be avoided
Meprobamate	All use should be avoided, unless addicted
Oxazepam	Any single dose > 30mg should be avoided
Short acting benzodiazepines: oxazepam, triazolam	Nightly use for > 4 weeks should be avoided
Short-duration barbiturates: pentobarbital, secobarbital	All use should be avoided, unless addicted
Triazolam	Any single dose > 0.25 mg should be avoided
Antidepressants	
Amitriptyline	All use should be avoided
Combination antidepressants-antipsychotics	All use should be avoided
Antipsychotics	
Haloperidol	Doses > 3 mg/d should be avoided
Thioridazine	Doses > 3mg/d should be avoided
Antihypertensives	
Hydrochlorothiazide	Doses > 50 mg/d should be avoided
Methyldopa	All use should be avoided
Propranolol	All use should be avoided, unless to control violent behaviour
Reserpine	All use should be avoided
NSAIDs	
Indomethacin	All use should be avoided
Phenylbutazone	All use should be avoided
Oral hypoglycemics	
Chlorpropamide	All use should be avoided
Analgesics	
Propoxyphene	All use should be avoided
Pentazocine	All use should be avoided

Dementia treatments	
Cyclandelate	All use should be avoided
Isoxsuprine	All use should be avoided
Platelet inhibitors	
Dipyridamole	All use should be avoided
Histamine$_2$ blockers	
Cimetidine	Doses > 900 mg/d should be avoided Therapy beyond 12 weeks should be avoided
Ranitidine	Doses > 300 mg/d should be avoided Therapy beyond 12 weeks should be avioded
Antibiotics	
Oral antibiotics	Therapy > 4 weeks should be avoided, except when treating osteomyelitis, prostatitis, tuberculosis, or endocarditis
Decongestants: oxymetazoline phenylephrine pseudoephedrine	Daily use for > 2 weeks should be avoided
Iron	Doses > 325 mg/d should be avoided
Muscle relaxants-antispasmotics: cyclobenzaprine orphenidrate methocarbamol carisoprodol	All use should be avoided
GI antispasmodics	All long-term uare should be avoided
Antiemetics	
Trimethobenzamide	All use should be avoided

Cardiovascular drug combination
- two ß-blockers
- two calcium-channel blockers
- two ACE inhibitors
- thiazide + thiazide
- ß-blocker + theophylline
- ß-blocker + verapamil
- ethacrynic acid + furosemide
- furosemide + furosemide
- two potassium-sparing diuretics
- potassium sparing diuretic + potassium supplement
- indapamide + thiazide

Psychotropic drug combination
- clonazepam + other benzodiazepine
- other benzodiazepine + benzodiazepine
- clonazepam + clonazepam
- benzodiazepine + sedative
- sedative + barbiturate
- two sedatives
- two tranquillizers
- two barbiturates
- barbiturate + opiate
- barbiturate + antidepressant
- MAO inhibitor + levodopa
- MAO inhibitor + meperidine
- MAO inhibitor + antidepressant
- two MAO inhibitors
- two tricyclic antidepressants

NSAID drug combination
- ASA + warfarin
- two NSAIDs
- ASA + ASA

Benzodiazepine > 30 d

Long-acting benaodiazepine

Phenylbutazone

NSAID: non-steroidal anti-inflammatory drug
MAO: monoamine oxidase
ACE: angiotensin-converting enzyme

APPENDIX F

SAS programming for potentially inappropriate medication use

```
*DEFINE drug use*;

LABEL use = 'drug use';
use = 0;
ARRAY u[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9
DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF u[I] NE '999999' THEN use = use+1;
END;
DROP I;

*DEFINE SINGLES*;

LABEL sing1 = 's1 pentobarbital';
SING1 = 0;
ARRAY S1[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9
DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF S1[I] EQ 'N05CA05' THEN SING1 = SING1+1;
IF S1[I] EQ 'N05CA65' THEN SING1 = SING1+1;
END;
DROP I;

LABEL sing2 = 'S2 secobarbital';
SING2 = 0;
ARRAY S2[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9
DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF S2[I] EQ 'N05CA04' THEN SING2 = SING2+1;
END;
DROP I;

LABEL sing3 = 'S3 chlordiazepoxide';
SING3 = 0;
ARRAY S3[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9
DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF S3[I] EQ 'N05BA02' THEN SING3 = SING3+1;
IF S3[I] EQ 'N05BA50' THEN SING3 = SING3+1;
```

```
END;
DROP I;

LABEL sing4 = 'S4 diazepam';
SING4 = 0;
ARRAY S4[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9
DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF S4[I] EQ 'N05BA01' THEN SING4 = SING4+1;
END;
DROP I;

LABEL sing5 = 'S5 flurazepam';
SING5 = 0;
ARRAY S5[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9
DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF S5[I] EQ 'N05CD01' THEN SING5 = SING5+1;
END;
DROP I;

LABEL sing6 = 'S6 meprobamate';
SING6 = 0;
ARRAY S6[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9
DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF S6[I] EQ 'N05BC01' THEN SING6 = SING6+1;
END;
DROP I;

LABEL sing7 = 'S7 amitriptyline';
SING7 = 0;
ARRAY S7[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9
DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF S7[I] EQ 'N06AA05' THEN SING7 = SING7+1;
IF S7[I] EQ 'N06AA65' THEN SING7 = SING7+1;
END;
DROP I;
```

```
LABEL sing10 = 'S10 reserpine';
SING10 = 0;
ARRAY S10[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9 DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF S10[I] EQ 'C02AA01' THEN SING10 = SING10+1;
IF S10[I] EQ 'C02AA61' THEN SING10 = SING10+1;
END;
DROP I;

LABEL sing11 = 'S11 indomethacin';
SING11 = 0;
ARRAY S11[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9 DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF S11[I] EQ 'M01AB01' THEN SING11 = SING11+1;
IF S11[I] EQ 'S01BC01' THEN SING11 = SING11+1;
END;
DROP I;

LABEL sing12 = 'S12 phenylbutazone';
SING12 = 0;
ARRAY S12[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9 DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF S12[I] EQ 'M01AA01' THEN SING12 = SING12+1;
IF S12[I] EQ 'M01AA61' THEN SING12 = SING12+1;
END;
DROP I;

LABEL sing13 = 'S13 chlorpropamide';
SING13 = 0;
ARRAY S13[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9 DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF S13[I] EQ 'A10BB01' THEN SING13 = SING13+1;
END;
DROP I;

LABEL sing14 = 'S14 propoxyphene';
SING14 = 0;
ARRAY S14[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
```

```
DRUG9 DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF S14[I] EQ 'N02AC02' THEN SING14 = SING14+1;
END;
DROP I;

LABEL sing15 = 'S15 pentazocine';
SING15 = 0;
ARRAY S15[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9 DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF S15[I] EQ 'N02AD01' THEN SING15 = SING15+1;
END;
DROP I;

LABEL sing16 = 'S16 cyclandelate';
SING16 = 0;
ARRAY S16[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9 DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF S16[I] EQ 'C04AX01' THEN SING16 = SING16+1;
END;
DROP I;

*LABEL sing17 = 'S17 isoxsuprine';*
*SING17 = 0;*
*ARRAY S17[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7
DRUG8
DRUG9 DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;*
*DO I = 1 TO 14;*
*IF S17[I] EQ '' THEN SING17 = SING17+1;*
*END;*
*DROP I;*;

LABEL sing18 = 'S18 dipyridamole';
SING18 = 0;
ARRAY S18[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9 DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF S18[I] EQ 'B01AC02' THEN SING18 = SING18+1;
IF S18[I] EQ 'B01AC62' THEN SING18 = SING18+1;
END;
DROP I;
```

```
LABEL sing19 = 'S19 cyclobenzaprine';
SING19 = 0;
ARRAY S19[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9 DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF S19[I] EQ 'M03BX02' THEN SING19 = SING19+1;
END;
DROP I;


LABEL sing20 = 'S20 orphenadrine';
SING20 = 0;
ARRAY S20[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9 DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF S20[I] EQ 'M03BC01' THEN SING20 = SING20+1;
END;
DROP I;

LABEL sing21 = 'S21 methocarbamol';
SING21 = 0;
ARRAY S21[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9 DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF S21[I] EQ 'M03BA02' THEN SING21 = SING21+1;
IF S21[I] EQ 'M03BA50' THEN SING21 = SING21+1;
IF S21[I] EQ 'M03BA62' THEN SING21 = SING21+1;
END;
DROP I;

LABEL sing22 = 'S22 carisoprodol';
SING22 = 0;
ARRAY S22[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9 DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF S22[I] EQ 'M03BA01' THEN SING22 = SING22+1;
END;
DROP I;

*LABEL sing23 = 'S23 trimethobenzamide';*
*SING23 = 0;*
```

```
*ARRAY S23[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7
DRUG8
DRUG9 DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;*
*DO I = 1 TO 14;*
*IF S23[I] EQ '' THEN SING23 = SING23+1;*
*END;*
*DROP I;*;

*DEFINE DOSE*;
if drug1 = 'N05BA03' then dosage1 =  dose1d;
if drug2 = 'N05BA03' then dosage1 =  dose2d;
if drug3 = 'N05BA03' then dosage1 =  dose3d;
if drug4 = 'N05BA03' then dosage1 =  dose4d;
if drug5 = 'N05BA03' then dosage1 =  dose5d;
if drug6 = 'N05BA03' then dosage1 =  dose6d;
if drug7 = 'N05BA03' then dosage1 =  dose7d;
if drug8 = 'N05BA03' then dosage1 =  dose8d;
if drug9 = 'N05BA03' then dosage1 =  dose9d;
if drug10 = 'N05BA03' then dosage1 = dose10d;
if drug11 = 'N05BA03' then dosage1 = dose11d;
if drug12 = 'N05BA03' then dosage1 = dose12d;
if drug13 = 'N05BA03' then dosage1 = dose13d;
if drug14 = 'N05BA03' then dosage1 = dose14d;

if drug1 = 'N05CD03' then dosage2 =  dose1d;
if drug2 = 'N05CD03' then dosage2 =  dose2d;
if drug3 = 'N05CD03' then dosage2 =  dose3d;
if drug4 = 'N05CD03' then dosage2 =  dose4d;
if drug5 = 'N05CD03' then dosage2 =  dose5d;
if drug6 = 'N05CD03' then dosage2 =  dose6d;
if drug7 = 'N05CD03' then dosage2 =  dose7d;
if drug8 = 'N05CD03' then dosage2 =  dose8d;
if drug9 = 'N05CD03' then dosage2 =  dose9d;
if drug10 = 'N05CD03' then dosage2 = dose10d;
if drug11 = 'N05CD03' then dosage2 = dose11d;
if drug12 = 'N05CD03' then dosage2 = dose12d;
if drug13 = 'N05CD03' then dosage2 = dose13d;
if drug14 = 'N05CD03' then dosage2 = dose14d;

if drug1 = 'N05AD01' then dosage3 =  dose1d;
if drug2 = 'N05AD01' then dosage3 =  dose2d;
if drug3 = 'N05AD01' then dosage3 =  dose3d;
if drug4 = 'N05AD01' then dosage3 =  dose4d;
```

```
if drug5 = 'N05AD01' then dosage3 =  dose5d;
if drug6 = 'N05AD01' then dosage3 =  dose6d;
if drug7 = 'N05AD01' then dosage3 =  dose7d;
if drug8 = 'N05AD01' then dosage3 =  dose8d;
if drug9 = 'N05AD01' then dosage3 =  dose9d;
if drug10 = 'N05AD01' then dosage3 = dose10d;
if drug11 = 'N05AD01' then dosage3 = dose11d;
if drug12 = 'N05AD01' then dosage3 = dose12d;
if drug13 = 'N05AD01' then dosage3 = dose13d;
if drug14 = 'N05AD01' then dosage3 = dose14d;
if drug1 = 'N05AD01' then frequen3 =  freq1;
if drug2 = 'N05AD01' then frequen3 =  freq2;
if drug3 = 'N05AD01' then frequen3 =  freq3;
if drug4 = 'N05AD01' then frequen3 =  freq4;
if drug5 = 'N05AD01' then frequen3 =  freq5;
if drug6 = 'N05AD01' then frequen3 =  freq6;
if drug7 = 'N05AD01' then frequen3 =  freq7;
if drug8 = 'N05AD01' then frequen3 =  freq8;
if drug9 = 'N05AD01' then frequen3 =  freq9;
if drug10 = 'N05AD01' then frequen3 = freq10;
if drug11 = 'N05AD01' then frequen3 = freq11;
if drug12 = 'N05AD01' then frequen3 = freq12;
if drug13 = 'N05AD01' then frequen3 = freq13;
if drug14 = 'N05AD01' then frequen3 = freq14;

if drug1 = 'N05AC02' then dosage4 =  dose1d;
if drug2 = 'N05AC02' then dosage4 =  dose2d;
if drug3 = 'N05AC02' then dosage4 =  dose3d;
if drug4 = 'N05AC02' then dosage4 =  dose4d;
if drug5 = 'N05AC02' then dosage4 =  dose5d;
if drug6 = 'N05AC02' then dosage4 =  dose6d;
if drug7 = 'N05AC02' then dosage4 =  dose7d;
if drug8 = 'N05AC02' then dosage4 =  dose8d;
if drug9 = 'N05AC02' then dosage4 =  dose9d;
if drug10 = 'N05AC02' then dosage4 = dose10d;
if drug11 = 'N05AC02' then dosage4 = dose11d;
if drug12 = 'N05AC02' then dosage4 = dose12d;
if drug13 = 'N05AC02' then dosage4 = dose13d;
if drug14 = 'N05AC02' then dosage4 = dose14d;
if drug1 = 'N05AC02' then frequen4 =  freq1;
if drug2 = 'N05AC02' then frequen4 =  freq2;
if drug3 = 'N05AC02' then frequen4 =  freq3;
if drug4 = 'N05AC02' then frequen4 =  freq4;
```

```
if drug5 = 'N05AC02' then frequen4 =  freq5;
if drug6 = 'N05AC02' then frequen4 =  freq6;
if drug7 = 'N05AC02' then frequen4 =  freq7;
if drug8 = 'N05AC02' then frequen4 =  freq8;
if drug9 = 'N05AC02' then frequen4 =  freq9;
if drug10 = 'N05AC02' then frequen4 = freq10;
if drug11 = 'N05AC02' then frequen4 = freq11;
if drug12 = 'N05AC02' then frequen4 = freq12;
if drug13 = 'N05AC02' then frequen4 = freq13;
if drug14 = 'N05AC02' then frequen4 = freq14;

if drug1 = 'C03AA02' then dosage5 =  dose1d;
if drug2 = 'C03AA02' then dosage5 =  dose2d;
if drug3 = 'C03AA02' then dosage5 =  dose3d;
if drug4 = 'C03AA02' then dosage5 =  dose4d;
if drug5 = 'C03AA02' then dosage5 =  dose5d;
if drug6 = 'C03AA02' then dosage5 =  dose6d;
if drug7 = 'C03AA02' then dosage5 =  dose7d;
if drug8 = 'C03AA02' then dosage5 =  dose8d;
if drug9 = 'C03AA02' then dosage5 =  dose9d;
if drug10 = 'C03AA02' then dosage5 = dose10d;
if drug11 = 'C03AA02' then dosage5 = dose11d;
if drug12 = 'C03AA02' then dosage5 = dose12d;
if drug13 = 'C03AA02' then dosage5 = dose13d;
if drug14 = 'C03AA02' then dosage5 = dose14d;
if drug1 = 'C03AA02' then frequen5 =  freq1;
if drug2 = 'C03AA02' then frequen5 =  freq2;
if drug3 = 'C03AA02' then frequen5 =  freq3;
if drug4 = 'C03AA02' then frequen5 =  freq4;
if drug5 = 'C03AA02' then frequen5 =  freq5;
if drug6 = 'C03AA02' then frequen5 =  freq6;
if drug7 = 'C03AA02' then frequen5 =  freq7;
if drug8 = 'C03AA02' then frequen5 =  freq8;
if drug9 = 'C03AA02' then frequen5 =  freq9;
if drug10 = 'C03AA02' then frequen5 = freq10;
if drug11 = 'C03AA02' then frequen5 = freq11;
if drug12 = 'C03AA02' then frequen5 = freq12;
if drug13 = 'C03AA02' then frequen5 = freq13;
if drug14 = 'C03AA02' then frequen5 = freq14;

if drug1 = 'A02BA01' then dosage6 =  dose1d;
if drug2 = 'A02BA01' then dosage6 =  dose2d;
if drug3 = 'A02BA01' then dosage6 =  dose3d;
```

```
if drug4 = 'A02BA01' then dosage6 =  dose4d;
if drug5 = 'A02BA01' then dosage6 =  dose5d;
if drug6 = 'A02BA01' then dosage6 =  dose6d;
if drug7 = 'A02BA01' then dosage6 =  dose7d;
if drug8 = 'A02BA01' then dosage6 =  dose8d;
if drug9 = 'A02BA01' then dosage6 =  dose9d;
if drug10 = 'A02BA01' then dosage6 = dose10d;
if drug11 = 'A02BA01' then dosage6 = dose11d;
if drug12 = 'A02BA01' then dosage6 = dose12d;
if drug13 = 'A02BA01' then dosage6 = dose13d;
if drug14 = 'A02BA01' then dosage6 = dose14d;
if drug1 = 'A02BA01' then frequen6 =  freq1;
if drug2 = 'A02BA01' then frequen6 =  freq2;
if drug3 = 'A02BA01' then frequen6 =  freq3;
if drug4 = 'A02BA01' then frequen6 =  freq4;
if drug5 = 'A02BA01' then frequen6 =  freq5;
if drug6 = 'A02BA01' then frequen6 =  freq6;
if drug7 = 'A02BA01' then frequen6 =  freq7;
if drug8 = 'A02BA01' then frequen6 =  freq8;
if drug9 = 'A02BA01' then frequen6 =  freq9;
if drug10 = 'A02BA01' then frequen6 = freq10;
if drug11 = 'A02BA01' then frequen6 = freq11;
if drug12 = 'A02BA01' then frequen6 = freq12;
if drug13 = 'A02BA01' then frequen6 = freq13;
if drug14 = 'A02BA01' then frequen6 = freq14;

if drug1 = 'A02BA02' then dosage7 =  dose1d;
if drug2 = 'A02BA02' then dosage7 =  dose2d;
if drug3 = 'A02BA02' then dosage7 =  dose3d;
if drug4 = 'A02BA02' then dosage7 =  dose4d;
if drug5 = 'A02BA02' then dosage7 =  dose5d;
if drug6 = 'A02BA02' then dosage7 =  dose6d;
if drug7 = 'A02BA02' then dosage7 =  dose7d;
if drug8 = 'A02BA02' then dosage7 =  dose8d;
if drug9 = 'A02BA02' then dosage7 =  dose9d;
if drug10 = 'A02BA02' then dosage7 = dose10d;
if drug11 = 'A02BA02' then dosage7 = dose11d;
if drug12 = 'A02BA02' then dosage7 = dose12d;
if drug13 = 'A02BA02' then dosage7 = dose13d;
if drug14 = 'A02BA02' then dosage7 = dose14d;
if drug1 = 'A02BA02' then frequen7 =  freq1;
if drug2 = 'A02BA02' then frequen7 =  freq2;
if drug3 = 'A02BA02' then frequen7 =  freq3;
```

```
if drug4 = 'A02BA02' then frequen7 =  freq4;
if drug5 = 'A02BA02' then frequen7 =  freq5;
if drug6 = 'A02BA02' then frequen7 =  freq6;
if drug7 = 'A02BA02' then frequen7 =  freq7;
if drug8 = 'A02BA02' then frequen7 =  freq8;
if drug9 = 'A02BA02' then frequen7 =  freq9;
if drug10 = 'A02BA02' then frequen7 = freq10;
if drug11 = 'A02BA02' then frequen7 = freq11;
if drug12 = 'A02BA02' then frequen7 = freq12;
if drug13 = 'A02BA02' then frequen7 = freq13;
if drug14 = 'A02BA02' then frequen7 = freq14;


*DEFINE DURATION*;
if drug1 = 'N05BA03' then durat1 =  dur1;
if drug2 = 'N05BA03' then durat1 =  dur2;
if drug3 = 'N05BA03' then durat1 =  dur3;
if drug4 = 'N05BA03' then durat1 =  dur4;
if drug5 = 'N05BA03' then durat1 =  dur5;
if drug6 = 'N05BA03' then durat1 =  dur6;
if drug7 = 'N05BA03' then durat1 =  dur7;
if drug8 = 'N05BA03' then durat1 =  dur8;
if drug9 = 'N05BA03' then durat1 =  dur9;
if drug10 = 'N05BA03' then durat1 = dur10;
if drug11 = 'N05BA03' then durat1 = dur11;
if drug12 = 'N05BA03' then durat1 = dur12;
if drug13 = 'N05BA03' then durat1 = dur13;
if drug14 = 'N05BA03' then durat1 = dur14;

if drug1 = 'N05CD03' then durat2 =  dur1;
if drug2 = 'N05CD03' then durat2 =  dur2;
if drug3 = 'N05CD03' then durat2 =  dur3;
if drug4 = 'N05CD03' then durat2 =  dur4;
if drug5 = 'N05CD03' then durat2 =  dur5;
if drug6 = 'N05CD03' then durat2 =  dur6;
if drug7 = 'N05CD03' then durat2 =  dur7;
if drug8 = 'N05CD03' then durat2 =  dur8;
if drug9 = 'N05CD03' then durat2 =  dur9;
if drug10 = 'N05CD03' then durat2 = dur10;
if drug11 = 'N05CD03' then durat2 = dur11;
if drug12 = 'N05CD03' then durat2 = dur12;
if drug13 = 'N05CD03' then durat2 = dur13;
if drug14 = 'N05CD03' then durat2 = dur14;
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if drug1 = 'N05AD01' then durat3 =  dur1;
if drug2 = 'N05AD01' then durat3 =  dur2;
if drug3 = 'N05AD01' then durat3 =  dur3;
if drug4 = 'N05AD01' then durat3 =  dur4;
if drug5 = 'N05AD01' then durat3 =  dur5;
if drug6 = 'N05AD01' then durat3 =  dur6;
if drug7 = 'N05AD01' then durat3 =  dur7;
if drug8 = 'N05AD01' then durat3 =  dur8;
if drug9 = 'N05AD01' then durat3 =  dur9;
if drug10 = 'N05AD01' then durat3 = dur10;
if drug11 = 'N05AD01' then durat3 = dur11;
if drug12 = 'N05AD01' then durat3 = dur12;
if drug13 = 'N05AD01' then durat3 = dur13;
if drug14 = 'N05AD01' then durat3 = dur14;

if drug1 = 'N05AC02' then durat4 =  dur1;
if drug2 = 'N05AC02' then durat4 =  dur2;
if drug3 = 'N05AC02' then durat4 =  dur3;
if drug4 = 'N05AC02' then durat4 =  dur4;
if drug5 = 'N05AC02' then durat4 =  dur5;
if drug6 = 'N05AC02' then durat4 =  dur6;
if drug7 = 'N05AC02' then durat4 =  dur7;
if drug8 = 'N05AC02' then durat4 =  dur8;
if drug9 = 'N05AC02' then durat4 =  dur9;
if drug10 = 'N05AC02' then durat4 = dur10;
if drug11 = 'N05AC02' then durat4 = dur11;
if drug12 = 'N05AC02' then durat4 = dur12;
if drug13 = 'N05AC02' then durat4 = dur13;
if drug14 = 'N05AC02' then durat4 = dur14;

if drug1 = 'C03AA02' then durat5 =  dur1;
if drug2 = 'C03AA02' then durat5 =  dur2;
if drug3 = 'C03AA02' then durat5 =  dur3;
if drug4 = 'C03AA02' then durat5 =  dur4;
if drug5 = 'C03AA02' then durat5 =  dur5;
if drug6 = 'C03AA02' then durat5 =  dur6;
if drug7 = 'C03AA02' then durat5 =  dur7;
if drug8 = 'C03AA02' then durat5 =  dur8;
if drug9 = 'C03AA02' then durat5 =  dur9;
if drug10 = 'C03AA02' then durat5 = dur10;
if drug11 = 'C03AA02' then durat5 = dur11;
if drug12 = 'C03AA02' then durat5 = dur12;
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```
if drug13 = 'C03AA02' then durat5 = dur13;
if drug14 = 'C03AA02' then durat5 = dur14;


if drug1 = 'A02BA01' then durat6 =  dur1;
if drug2 = 'A02BA01' then durat6 =  dur2;
if drug3 = 'A02BA01' then durat6 =  dur3;
if drug4 = 'A02BA01' then durat6 =  dur4;
if drug5 = 'A02BA01' then durat6 =  dur5;
if drug6 = 'A02BA01' then durat6 =  dur6;
if drug7 = 'A02BA01' then durat6 =  dur7;
if drug8 = 'A02BA01' then durat6 =  dur8;
if drug9 = 'A02BA01' then durat6 =  dur9;
if drug10 = 'A02BA01' then durat6 = dur10;
if drug11 = 'A02BA01' then durat6 = dur11;
if drug12 = 'A02BA01' then durat6 = dur12;
if drug13 = 'A02BA01' then durat6 = dur13;
if drug14 = 'A02BA01' then durat6 = dur14;

if drug1 = 'A02BA02' then durat7 =  dur1;
if drug2 = 'A02BA02' then durat7 =  dur2;
if drug3 = 'A02BA02' then durat7 =  dur3;
if drug4 = 'A02BA02' then durat7 =  dur4;
if drug5 = 'A02BA02' then durat7 =  dur5;
if drug6 = 'A02BA02' then durat7 =  dur6;
if drug7 = 'A02BA02' then durat7 =  dur7;
if drug8 = 'A02BA02' then durat7 =  dur8;
if drug9 = 'A02BA02' then durat7 =  dur9;
if drug10 = 'A02BA02' then durat7 = dur10;
if drug11 = 'A02BA02' then durat7 = dur11;
if drug12 = 'A02BA02' then durat7 = dur12;
if drug13 = 'A02BA02' then durat7 = dur13;
if drug14 = 'A02BA02' then durat7 = dur14;

if drug1 = 'A02BA01' then durat8 =  dur1;
if drug2 = 'A02BA01' then durat8 =  dur2;
if drug3 = 'A02BA01' then durat8 =  dur3;
if drug4 = 'A02BA01' then durat8 =  dur4;
if drug5 = 'A02BA01' then durat8 =  dur5;
if drug6 = 'A02BA01' then durat8 =  dur6;
if drug7 = 'A02BA01' then durat8 =  dur7;
if drug8 = 'A02BA01' then durat8 =  dur8;
if drug9 = 'A02BA01' then durat8 =  dur9;
```

```
if drug10 = 'A02BA01' then durat8 = dur10;
if drug11 = 'A02BA01' then durat8 = dur11;
if drug12 = 'A02BA01' then durat8 = dur12;
if drug13 = 'A02BA01' then durat8 = dur13;
if drug14 = 'A02BA01' then durat8 = dur14;

if drug1 = 'A02BA02' then durat9 =  dur1;
if drug2 = 'A02BA02' then durat9 =  dur2;
if drug3 = 'A02BA02' then durat9 =  dur3;
if drug4 = 'A02BA02' then durat9 =  dur4;
if drug5 = 'A02BA02' then durat9 =  dur5;
if drug6 = 'A02BA02' then durat9 =  dur6;
if drug7 = 'A02BA02' then durat9 =  dur7;
if drug8 = 'A02BA02' then durat9 =  dur8;
if drug9 = 'A02BA02' then durat9 =  dur9;
if drug10 = 'A02BA02' then durat9 = dur10;
if drug11 = 'A02BA02' then durat9 = dur11;
if drug12 = 'A02BA02' then durat9 = dur12;
if drug13 = 'A02BA02' then durat9 = dur13;
if drug14 = 'A02BA02' then durat9 = dur14;

if durat1 >= 2 then inappro = inappro + 1;
if durat2 >= 2 then inappro = inappro + 1;
if durat3 >= 2 then inappro = inappro + 1;
if durat4 >= 3 then inappro = inappro + 1;
if durat5 >= 3 then inappro = inappro + 1;
if durat6 >= 2 then inappro = inappro + 1;
if durat7 >= 2 then inappro = inappro + 1;
if durat8 >= 2 then inappro = inappro + 1;
if durat9 >= 2 then inappro = inappro + 1;

*DEFINE COMBINATIONS*;

LABEL combo1 = 'c1 two beta-blockers';
COMBO1 = 0;
ARRAY C1[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9
DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF 'C07AA00' < C1[I] < 'C07AG02'
THEN COMBO1=COMBO1+1;
END;
DROP I;
```

```
LABEL combo2 = 'c2 two Ca-channel blockers';
COMBO2 = 0;
ARRAY C2[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9
DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF 'C08CA00' < C2[I] < 'C08DB02' AND 'C08CA00' < C2[I] < 'C08DB02'
THEN COMBO2=COMBO2+1;
END;
DROP I;

LABEL combo3 = 'c3 two ACE inhibitors';
COMBO3 = 0;
ARRAY C3[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9
DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF 'C02EA00' < C3[I] < 'C02EA64' AND 'C02EA00' < C3[I] < 'C02EA64'
THEN COMBO3=COMBO3+1;
END;
DROP I;

LABEL combo4 = 'c4 thiazide + thiazide';
COMBO4 = 0;
ARRAY C4[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9
DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF 'C03AA00' < C4[I] < 'C03AA63'
THEN COMBO4=COMBO4+1;
END;
DROP I;

LABEL combo5 = 'c5 furosemide + furosemide';
COMBO5 = 0;
ARRAY C5[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9
DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF C5[I] EQ 'C03CA01'
THEN COMBO5=COMBO5+1;
END;
```

```
DROP I;

LABEL combo6 = 'c6 two K-sparing diuretics';
COMBO6 = 0;
ARRAY C6[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9
DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF 'C03DA00' < C6[I] < 'C03DB63'
THEN COMBO6=COMBO6+1;
END;
DROP I;

LABEL combo7 = 'theophylline';
COMBO7 = 0;
ARRAY C7[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9
DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF C7[I] EQ 'R03DA03'
THEN COMBO7=COMBO7+1;
IF C7[I] EQ 'R03DA63'
THEN COMBO7=COMBO7+1;
END;
DROP I;

LABEL combo8 = 'c8 verapamil';
COMBO8 = 0;
ARRAY C8[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9
DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF C8[I] EQ 'C08DA01'
THEN COMBO8=COMBO8+1;
END;
DROP I;

LABEL combo9 = 'c9 ethacrynic acid';
COMBO9 = 0;
ARRAY C9[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9
DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
```

```
IF C9[I] EQ 'C03CC01'
THEN COMBO9=COMBO9+1;
END;
DROP I;

LABEL combo10 = 'c10 K-supplement';
COMBO10 = 0;
ARRAY C10[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9 DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF 'A12BA02' < C10[I] < 'A12BA64'
THEN COMBO10=COMBO10+1;
END;
DROP I;

LABEL combo11 = 'c11 indapamide';
COMBO11 = 0;
ARRAY C11[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9 DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF C11[I] EQ 'C03BA03'
THEN COMBO11=COMBO11+1;
END;
DROP I;

LABEL combo12 = 'c12 clonazepam + other benzodiazepine';
COMBO12 = 0;
ARRAY C12[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9 DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF C12[I] EQ 'N03AE02' AND 'N05AA00' < C12[I] < 'N05BX02'
THEN COMBO12=COMBO12+1;
IF C12[I] EQ 'N03AE02' AND 'N05CD00' < C12[I] < 'N05CD07'
THEN COMBO12=COMBO12+1;
END;
DROP I;

LABEL combo13 = 'c13 benzodiazepine';
COMBO13 = 0;
ARRAY C13[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9 DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF 'N05BA00' < C13[I] < 'N05BA63'
```

```
THEN COMBO13=COMBO13+1;
IF 'N05CD00'< C13[I] <'N05CD07'
THEN COMBO13=COMBO13+1;
END;
DROP I;

LABEL combo14 = 'c14 clonazepam';
COMBO14 = 0;
ARRAY C14[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9 DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF C14[I] EQ 'N03AE02'
THEN COMBO14=COMBO14+1;
END;
DROP I;

LABEL combo15 = 'c15 two sedatives';
COMBO15 = 0;
ARRAY C15[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9 DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF 'N05CA00' < C15[I] < 'N05CC04'
THEN COMBO15=COMBO15+1;
IF 'N05CF00'< C15[I] <= 'N05ZZ99'
THEN COMBO15=COMBO15+1;
END;
DROP I;

LABEL combo16 = 'c16 two tranqullizers';
COMBO16 = 0;
ARRAY C16[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9 DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF 'N05AA00' < C16[I] < 'N05AZ99' AND 'N05AA00' < C16[I] <
'N05AZ99'
THEN COMBO16=COMBO16+1;
IF 'N05AA00' < C16[I] < 'N05AZ99' AND 'N05BB00' < C16[I] <
'N05BX02'
THEN COMBO16=COMBO16+1;
IF 'N05BB00' < C16[I] < 'N05BX02' AND 'N05BB00' < C16[I] <
'N05BX02'
THEN COMBO16=COMBO16+1;
END;
```

```
DROP I;

LABEL combo17 = 'c17 two barbiturates';
COMBO17 = 0;
ARRAY C17[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9 DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF 'N05CA00' < C17[I] < 'N05CA66'
THEN COMBO17=COMBO17+1;
END;
DROP I;

LABEL combo18 = 'c18 two MAO inhibitors';
COMBO18 = 0;
ARRAY C18[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9 DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF 'N06AF01' < C18[I] < 'N06AG02'
THEN COMBO18=COMBO18+1;
END;
DROP I;

LABEL combo19 = 'c19 two tricyclic antidepressants';
COMBO19 = 0;
ARRAY C19[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9 DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF 'N06AA00' < C19[I] < 'N06AA10' AND 'N06AA00' < C19[I] <
'N06AA10'
THEN COMBO19=COMBO19+1;
END;
DROP I;

LABEL combo20 = 'c20 benzodiazepine + sedative';
COMBO20 = 0;
ARRAY C20[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9 DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF 'N05BA00' < C20[I] < 'N05BA62' AND 'N05CC00' < C20[I] <
'N05CC04'
THEN COMBO20=COMBO20+1;
IF 'N05BA00' < C20[I] < 'N05BA62' AND 'N05CF01' < C20[I] <=
'N05ZZ99'
```

```
THEN COMBO20=COMBO20+1;
IF 'N05CA01' < C20[I] < 'N05CA65' AND 'N05CC00' < C20[I] <
'N05CC04'
THEN COMBO20=COMBO20+1;
IF 'N05CA01' < C20[I] < 'N05CA65' AND 'N05CF01' < C20[I] <=
'N05ZZ99'
THEN COMBO20=COMBO20+1;
END;
DROP I;


LABEL combo21 = 'c21 sedative + barbiturate';
COMBO21 = 0;
ARRAY C21[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9 DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF 'N05CC00' < C21[I] < 'N05CC04' AND 'N05CA00' < C21[I] <
'N05CA66'
THEN COMBO21=COMBO21+1;
IF 'N05CF00' < C21[I] <= 'N05ZZ99' AND 'N05CA00' < C21[I] <
'N05CA66'
THEN COMBO21=COMBO21+1;
END;
DROP I;


LABEL combo22 = 'c22 opiate';
COMBO22 = 0;
ARRAY C22[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9 DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF 'N02AA00' < C22[I] <= 'N02AH99'
THEN COMBO22=COMBO22+1;
END;
DROP I;

LABEL combo23 = 'c23 antidepressant';
COMBO23 = 0;
ARRAY C23[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9 DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF 'N06AA09' < C23[I] < 'N06AB05'
THEN COMBO23=COMBO23+1;
```

```
IF 'N06AX00' < C23[I] <= 'N06AZ99'
THEN COMBO23=COMBO23+1;
END;
DROP I;

LABEL combo24 = 'c24 levodopa';
COMBO24 = 0;
ARRAY C24[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9 DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF C24[I] EQ 'N04BA01'
THEN COMBO24=COMBO24+1;
IF C24[I] EQ 'N04BA50'
THEN COMBO24=COMBO24+1;
END;
DROP I;

LABEL combo25 = 'c25 meperidine';
COMBO25 = 0;
ARRAY C25[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9 DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF C25[I] EQ 'N02AH01'
THEN COMBO25=COMBO25+1;
END;
DROP I;

LABEL combo26 = 'c26 MAO inhibitor + antidepressant';
COMBO26 = 0;
ARRAY C26[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9 DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF 'N06AF01' < C26[I] < 'N06AG02' AND 'N06AA09' < C26[I] <
'N06AB05'
THEN COMBO26=COMBO26+1;
IF 'N06AF01' < C26[I] < 'N06AG02' AND 'N06AX00' < C26[I] <=
'N06AZ99'
THEN COMBO26=COMBO26+1;
END;
DROP I;

LABEL combo27 = 'c27 two NSAIDs';
COMBO27 = 0;
```

```
ARRAY C27[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9 DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF 'M01AA00' < C27[I] < 'M01AX04' AND 'M01AA00' < C27[I] <
'M01AX04'
THEN COMBO27=COMBO27+1;
END;
DROP I;


LABEL combo28 = 'c28 ASA';
COMBO28 = 0;
ARRAY C28[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9 DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF C28[I] EQ 'N02BA01'
THEN COMBO28=COMBO28+1;
IF C28[I] EQ 'N02BA61'
THEN COMBO28=COMBO28+1;
END;
DROP I;

LABEL combo29 = 'c29 warfarin';
COMBO29 = 0;
ARRAY C29[*] $ DRUG1 DRUG2 DRUG3 DRUG4 DRUG5 DRUG6 DRUG7 DRUG8
DRUG9 DRUG10 DRUG11 DRUG12 DRUG13 DRUG14;
DO I = 1 TO 14;
IF C29[I] EQ 'B01AA01'
THEN COMBO29=COMBO29+1;
END;
DROP I;

PAIR1 = 0;
PAIR2 = 0;
PAIR3 = 0;
PAIR4 = 0;
PAIR5 = 0;
PAIR6 = 0;
PAIR7 = 0;
PAIR8 = 0;
PAIR9 = 0;
PAIR10 = 0;
PAIR11 = 0;
```

```
PAIR12 = 0;
PAIR13 = 0;
PAIR14 = 0;

IF COMBO1 = 1 AND COMBO7 = 1 THEN PAIR1 = PAIR1 + 1;
IF COMBO1 = 2 AND COMBO7 = 2 THEN PAIR1 = PAIR1 + 1;
IF COMBO1 = 1 AND COMBO8 = 1 THEN PAIR2 = PAIR2 + 1;
IF COMBO1 = 2 AND COMBO8 = 2 THEN PAIR2 = PAIR2 + 1;
IF COMBO5 = 1 AND COMBO9 = 1 THEN PAIR3 = PAIR3 + 1;
IF COMBO5 = 2 AND COMBO9 = 2 THEN PAIR3 = PAIR3 + 1;
IF COMBO6 = 1 AND COMBO10 = 1 THEN PAIR4 = PAIR4 + 1;
IF COMBO6 = 2 AND COMBO10 = 2 THEN PAIR4 = PAIR4 + 1;
IF COMBO4 = 1 AND COMBO11 = 1 THEN PAIR5 = PAIR5 + 1;
IF COMBO4 = 2 AND COMBO11 = 2 THEN PAIR5 = PAIR5 + 1;
IF COMBO13 = 1 AND COMBO14 = 1 THEN PAIR6 = PAIR6 + 1;
IF COMBO13 = 2 AND COMBO14 = 2 THEN PAIR6 = PAIR6 + 1;
IF COMBO13 = 1 AND COMBO15 = 1 THEN PAIR7 = PAIR7 + 1;
IF COMBO13 = 2 AND COMBO15 = 2 THEN PAIR7 = PAIR7 + 1;
IF COMBO15 = 1 AND COMBO17 = 1 THEN PAIR8 = PAIR8 + 1;
IF COMBO15 = 2 AND COMBO17 = 2 THEN PAIR8 = PAIR8 + 1;
IF COMBO17 = 1 AND COMBO22 = 1 THEN PAIR9 = PAIR9 + 1;
IF COMBO17 = 2 AND COMBO22 = 2 THEN PAIR9 = PAIR9 + 1;
IF COMBO17 = 1 AND COMBO23 = 1 THEN PAIR10 = PAIR10 + 1;
IF COMBO17 = 2 AND COMBO23 = 2 THEN PAIR10 = PAIR10 + 1;
IF COMBO18 = 1 AND COMBO24 = 1 THEN PAIR11 = PAIR11 + 1;
IF COMBO18 = 2 AND COMBO24 = 2 THEN PAIR11 = PAIR11 + 1;
IF COMBO18 = 1 AND COMBO25 = 1 THEN PAIR12 = PAIR12 + 1;
IF COMBO18 = 2 AND COMBO25 = 2 THEN PAIR12 = PAIR12 + 1;
IF COMBO18 = 1 AND COMBO23 = 1 THEN PAIR13 = PAIR13 + 1;
IF COMBO18 = 2 AND COMBO23 = 2 THEN PAIR13 = PAIR13 + 1;
IF COMBO28 = 1 AND COMBO29 = 1 THEN PAIR14 = PAIR14 + 1;
IF COMBO28 = 2 AND COMBO29 = 2 THEN PAIR14 = PAIR14 + 1;

DOUB1 = 0;
DOUB2 = 0;
DOUB3 = 0;
DOUB4 = 0;
DOUB5 = 0;
DOUB6 = 0;
DOUB13 = 0;
DOUB14 = 0;
DOUB15 = 0;
DOUB16 = 0;
```

```
DOUB17 = 0;
DOUB18 = 0;
DOUB23 = 0;
DOUB27 = 0;
DOUB28 = 0;

IF COMBO1 > 1 THEN DOUB1 = 1;
IF COMBO2 > 1 THEN DOUB2 = 1;
IF COMBO3 > 1 THEN DOUB3 = 1;
IF COMBO4 > 1 THEN DOUB4 = 1;
IF COMBO5 > 1 THEN DOUB5 = 1;
IF COMBO6 > 1 THEN DOUB6 = 1;
IF COMBO13 > 1 THEN DOUB13 = 1;
IF COMBO14 > 1 THEN DOUB14 = 1;
IF COMBO15 > 1 THEN DOUB15 = 1;
IF COMBO16 > 1 THEN DOUB16 = 1;
IF COMBO17 > 1 THEN DOUB17 = 1;
IF COMBO18 > 1 THEN DOUB18 = 1;
IF COMBO23 > 1 THEN DOUB23 = 1;
IF COMBO27 > 1 THEN DOUB27 = 1;
IF COMBO28 > 1 THEN DOUB28 = 1;

inappro = 0;

if dosage1 > 30 then inappro = inappro + 1;
if dosage2 > 0.25 then inappro = inappro + 1;
if dosage3 * frequen3 > 3 then inappro = inappro + 1;
if dosage4 * frequen4 > 30 then inappro = inappro + 1;
if dosage5 * frequen5 > 50 then inappro = inappro + 1;
if dosage6 * frequen6 > 900 then inappro = inappro + 1;
if dosage7 * frequen7 > 300 then inappro = inappro + 1;


INAPPRO = INAPPRO + SING1;
INAPPRO = INAPPRO + SING2;
INAPPRO = INAPPRO + SING3;
INAPPRO = INAPPRO + SING4;
INAPPRO = INAPPRO + SING5;
INAPPRO = INAPPRO + SING6;
INAPPRO = INAPPRO + SING7;
INAPPRO = INAPPRO + SING10;
INAPPRO = INAPPRO + SING11;
INAPPRO = INAPPRO + SING12;
```

```
INAPPRO = INAPPRO + SING13;
INAPPRO = INAPPRO + SING14;
INAPPRO = INAPPRO + SING15;
INAPPRO = INAPPRO + SING16;
INAPPRO = INAPPRO + SING18;
INAPPRO = INAPPRO + SING19;
INAPPRO = INAPPRO + SING20;
INAPPRO = INAPPRO + SING21;
INAPPRO = INAPPRO + SING22;
IF PAIR1 >= 1 THEN INAPPRO = INAPPRO + 1;
IF PAIR2 >= 1 THEN INAPPRO = INAPPRO + 1;
IF PAIR3 >= 1 THEN INAPPRO = INAPPRO + 1;
IF PAIR4 >= 1 THEN INAPPRO = INAPPRO + 1;
IF PAIR5 >= 1 THEN INAPPRO = INAPPRO + 1;
IF PAIR6 >= 1 THEN INAPPRO = INAPPRO + 1;
IF PAIR7 >= 1 THEN INAPPRO = INAPPRO + 1;
IF PAIR8 >= 1 THEN INAPPRO = INAPPRO + 1;
IF PAIR9 >= 1 THEN INAPPRO = INAPPRO + 1;
IF PAIR10 >= 1 THEN INAPPRO = INAPPRO + 1;
IF PAIR11 >= 1 THEN INAPPRO = INAPPRO + 1;
IF PAIR12 >= 1 THEN INAPPRO = INAPPRO + 1;
IF PAIR13 >= 1 THEN INAPPRO = INAPPRO + 1;
IF PAIR14 >= 1 THEN INAPPRO = INAPPRO + 1;
IF DOUB1 >= 1 THEN INAPPRO = INAPPRO + 1;
IF DOUB2 >= 1 THEN INAPPRO = INAPPRO + 1;
IF DOUB3 >= 1 THEN INAPPRO = INAPPRO + 1;
IF DOUB4 >= 1 THEN INAPPRO = INAPPRO + 1;
IF DOUB5 >= 1 THEN INAPPRO = INAPPRO + 1;
IF DOUB6 >= 1 THEN INAPPRO = INAPPRO + 1;
IF DOUB13 >= 1 THEN INAPPRO = INAPPRO + 1;
IF DOUB14 >= 1 THEN INAPPRO = INAPPRO + 1;
IF DOUB15 >= 1 THEN INAPPRO = INAPPRO + 1;
IF DOUB16 >= 1 THEN INAPPRO = INAPPRO + 1;
IF DOUB17 >= 1 THEN INAPPRO = INAPPRO + 1;
IF DOUB18 >= 1 THEN INAPPRO = INAPPRO + 1;
IF DOUB23 >= 1 THEN INAPPRO = INAPPRO + 1;
IF DOUB27 >= 1 THEN INAPPRO = INAPPRO + 1;
IF DOUB28 >= 1 THEN INAPPRO = INAPPRO + 1;
```

APPENDIX G

EBDH counts for potentially inappropriate medication use

Table G.1: Number of day-hospital patients taking at least one potentially inappropriate drug, Beers criteria.

	Sample
Long Acting Benzodiazepines	
Diazepam	1
Chlordiazepoxide	0
Flurazepam	2
Meprobamate	0
Short Duration Barbiturates	
Pentobarbital	0
Secobarbital	0
Antidepressants	
Amitriptyline	2
Antihypertensive Agents	
Reserpine	0
NSAIDs	
Indomethacin	1
Phenylbutazone	0
Oral Hypoglycemic Agents	
Chlorpropramide	0
Analgesic Agents	
Propoxyphene	0
Pentazocine	0
Dementia Treatments	
Cyclandelate	0
Isoxsuprine	-
Platelet Inhibitors	
Dipyridamole	0
Muscle Relaxants or Antispasmodic Agents	
Cyclobenzaprine	0
Orphenadrine	1
Methocarbamol	0
Carisoprodol	0
Antiemetic Agents	
Trimethobenzamide	-
Total	7

Table G.2: Number of day-hospital patients taking at least one potentially inappropriate drug dose, Beers criteria.

	Sample
Dosage	
Oxazepam > 30 mg	0
Triazolam > 0.25 mg	0
Haloperidol > 3 mg/day	0
Thioridazine > 30 mg/day	0
Hydrochlolothiazide > 50 mg/day	0
Cimetidine > 900 mg/day	1
Ranitidine > 300 mg/day	0
Iron > 325 mg/day	0
Total	1

Table G.3: Number of day-hospital patients taking at least one potentially inappropriate drug duration, Beers criteria.

	Sample
Duration	
Oxazepam > 4 weeks	3
Triazolam > 4 weeks	0
Alprazolam > 4 weeks	0
Cimetidine > 12 weeks	0
Ranitidine > 12 weeks	1
Oral antibiotics > 4 weeks	0
Oxymetazoline > 2 weeks	3
Phenylephrine > 2 weeks	0
Pseudoephedrine > 2 weeks	3
Total	10

Table G.4: Number of day-hospital patients taking at least one potentially inappropriate drug combination, Tamblyn Criteria.

	Sample
Cardiovascular	
2 beta-blockers	0
2 Ca-channel blockers	0
2 ACE inhibitors	0
thiazide + thiazide	0
beta blocker + theophylline	0
beta-blocker + verapamil	0
ethacrynic acid + furosemide	0
furosemide + furosemide	1
2 K-sparing diuretics	0
K-sparing diuretic + K-supplement	0
inapamide + thiazide	0
Psychotropic	
clonazepam + benzodiazepine	0
2 benzodiazepines	4
clonazepam + clonazepam	0
benzodiazepine + sedative	0
sedative + barbiturate	0
2 sedatives	0
2 tranquillizers	0
2 barbiturates	0
barbiturate + opiate	0
barbiturate + antidepressant	0
MAO inhibitor + levodopa	0
MAO inhibitor + meperidine	0
MAO inhibitor + antidepressant	0
2 MAO inhibitors	0
2 tricyclic antidepressants	0
NSAID	
ASA + warfarin	1
2 NSAIDs	0
ASA + ASA	0
Total	6

APPENDIX H

EBDH correlation matrix

Table H.1: Correlation Matrix EBDH.

Variables	Age	Sex	Marital	Family	Lang	Educ	BMI	Smoke	Alchol	Diet	Health	Funct.	Cogni.	Depress	Source	Hosp	Admin	Drug
Age Group	1.00	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Sex	0.02	1.00	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Marital Status	0.25**	0.23*	1.00	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Family Group	-0.13	-0.28**	-0.49***	1.00	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Language	-0.04	-0.19	-0.04	0.10	1.00	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Education	-0.08	-0.07	-0.04*	0.06	-0.08	1.00	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BMI	-0.27*	-0.07	0.09	-0.00	0.10	0.05	1.00	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Smoking Status	0.03	-0.33***	-0.27**	0.15	0.03	0.19	0.17	1.00	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Alcohol Consump.	-0.04	-0.05	0.05	0.16	0.12	-0.22	0.09	0.05	1.00	-----	-----	-----	-----	-----	-----	-----	-----	-----
Diet	-0.03	-0.17	-0.06	-0.19	-0.17	-0.15	0.00	-0.02	-0.13	1.00	-----	-----	-----	-----	-----	-----	-----	-----
Main Health Prob.	0.01	0.15	-0.06	0.15	0.06	-0.19	-0.05	-0.08	0.22	-0.06	1.00	-----	-----	-----	-----	-----	-----	-----
Functional Status	-0.07	-0.18	0.00	0.33***	0.03	-0.30*	-0.20	0.08	0.04	0.07	0.02	1.00	-----	-----	-----	-----	-----	-----
Cognitive Status	-0.10	0.10	-0.01	0.11	-0.02	0.08	0.18	0.05	0.02	-0.12	0.30**	-0.29**	1.00	-----	-----	-----	-----	-----
Depression -	0.10	0.12	0.06	-0.28**	0.00	0.08	0.04	0.03	-0.06	0.09	0.00	-0.28**	0.03	1.00	-----	-----	-----	-----
Source of Ref.	-0.46***	-0.12	-0.35***	0.03**	0.10	0.24	0.07	0.09	-0.09	-0.11	0.13	0.00	0.30**	-0.08	1.00	-----	-----	-----
Hospitalization	0.38***	0.17	0.14	-0.09	-0.06	0.04	-0.15	-0.05	-0.09	-0.08	-0.00	-0.16	-0.23*	0.00	-0.43***	1.00	-----	-----
Drug Admin	-0.17	-0.32**	-0.13	0.32**	0.08	0.07	-0.02	-0.07	0.23	0.09	-0.17	0.49***	-0.23*	-0.06	-0.01	-0.18	1.00	-----
Drug Use -0.01	-0.24*	0.09	0.03	-0.03	0.08	-0.04	0.10	-0.06	0.05	0.02	0.20*	0.06	0.00	0.04	-0.16	0.13	1.00	1.00

* = p<0.05, ** = p<0.01, *** = p<0.001

APPENDIX I

EBDH analysis using Beers et al. criteria

EBDH analysis using Beers et al. criteria

Univariate LR was repeated on each of the EBDH variables in order to identify predictors of potentially inappropriate medication for the Beers criteria alone. Odds ratios and confidence intervals from this analysis are presented in Table H.1. Statistically significant characteristics were current smokers and depression.

For the Beers criteria alone, the final multivariate LR model included five predictor variables in the model: Age Group, Sex, Smoking Status, Cognitive Status, and Depression. From Table H.2, potentially inappropriate medication is more likely to occur in those: currently smoking; with low Cognitive Status, and with Depression.

Table I.1: Univariate logistic regressions modelling potentially inappropriate medication use among elderly day-hospital patients taking at least one medication, Beers criteria.

Variables	Odds Ratio	95% Confidence Intervals
Age Group		
65-69	1.0	
70-79	1.1	0.2 - 6.2
80+	0.6	0.1 - 3.2
Sex		
male	1.0	
female	4.2	0.9 - 20.0
Marital Status		
married	2.1	0.6 - 8.2
other	1.0	
Family Group		
alone	1.6	0.4 - 3.5
not alone	1.0	
Education		
high school	2.5	0.7 - 9.2
college/university	1.0	
Body-Mass Index		
underweight	1.8	0.5 - 7.1
acceptable	1.0	
possibly overweight	1.7	0.2 - 18.4
overweight	1.8	0.4 - 7.9
Smoking Status		
never	1.0	
former	0.6	0.1 - 3.1
current	5.1	1.4 - 18.2
Alcohol Consumption		
never	1.0	
former	0.6	0.1 - 5.6
current	0.4	0.1 - 1.6
Diet		
regular	1.0	
other	1.7	0.6 - 5.4
Main Health Problem		
nervous system	0.6	0.1 - 2.8
heart & respiration	0.7	0.1 - 4.0
musculo-skeletal	4.3	0.9 - 20.4
other	1.0	

continued

Table I.1: Univariate logistic regressions modelling potentially inappropriate medication use among elderly day-hospital patients taking at least one medication, Beers criteria, continued.

Variables	Odds Ratio	95% Confidence Intervals
Functional Status		
poor	1.0	
moderate	0.9	0.2 - 3.4
good	0.8	0.2 - 3.2
Cognitive Status		
poor	2.9	0.8 - 10.2
moderate	1.0	0.2 - 4.5
good	1.0	
Depression		
not depressed	1.0	
depressed	4.4	1.3 - 15.0
Source of Referral		
GAOT	6.8	0.8 - 54.0
other	1.0	
Recent Hospitalization		
yes	1.0	
no	2.2	0.6 - 7.4
Drug Administration		
self	1.0	
assistant & dosette	2.5	0.8 - 7.6
Drug Use		
1-5	1.0	
6+	2.2	0.7 - 7.0

Table I.2: Multivariate logistic regression modelling the Beers criteria for potentially inappropriate medication use among elderly day-hospital patients taking at least one medication.

Variables	Odds Ratio	95% Confidence Intervals
Age Group		
65-69	1.0	
70-79	1.0	0.1 - 7.5
80 +	0.6	0.1 - 4.7
Sex		
male	1.0	
female	5.8	0.8 - 40.2
Smoking Status		
never	1.0	
former	1.2	0.1 - 9.1
current	10.1	1.8 - 55.5
Cognitive Status		
poor	7.7	1.4 - 43.5
moderate	1.0	0.2 - 6.7
good	1.0	
Depression		
not depressed	1.0	
depressed	5.8	1.3 - 25.1

APPENDIX J

EBDH analysis using Tamblyn et al. criteria

EBDH analysis using Tamblyn et al. criteria

Univariate LR was also repeated on each of the EBDH variables in order to identify predictors of potentially inappropriate medication for the Tamblyn criteria. Odds ratios and confidence intervals from this analysis are presented in Table I.1. Current Smoking status produced a statistically significant odds ratios

For the Tamblyn criteria, the final multivariate LR model only included two predictor variables: age group and sex. As shown in Table I.2 neither of these variables was significant in determining potentially inappropriate medication use in day-hospital patients.

Table J.1: Univariate logistic regressions modelling potentially inappropriate medication use among elderly day-hospital patients taking at least one medication, Tamblyn criteria.

Variables	Odds Ratio	95% Confidence Intervals
Age Group		
65-69	1.0	
70-79	0.3	0.0 - 2.1
80+	0.6	0.1 - 3.2
Sex		
male	1.0	
female	1.3	0.3 - 5.5
Marital Status		
married	0.4	0.1 - 1.6
other	1.0	
Family Group		
alone	2.1	0.6 - 7.9
not alone	1.0	
Education		
high school	1.5	0.3 - 7.9
college/university	1.0	
Body-Mass Index		
underweight	1.6	0.3 - 7.5
acceptable	1.0	
possibly overweight	5.8	0.7 - 46.1
overweight	0.5	0.0 - 5.4
Smoking Status		
never	1.0	
former	2.0	0.4 - 10.4
current	4.8	1.0 - 24.3
Alcohol Consumption		
never & former	1.0	
current	0.8	0.2 - 3.4
Diet		
regular	1.0	
other	1.7	0.4 - 6.4
Main Health Problem		
nervous system	1.0	0.2 - 6.6
heart & respiration	1.4	0.2 - 11.2
musculo-skeletal	4.3	0.6 - 30.2
other	1.0	

continued

Table J.1: Univariate logistic regressions modelling potentially inappropriate medication use among elderly day-hospital patients taking at least one medication, Tamblyn criteria, continued.

Variables	Odds Ratio	95% Confidence Intervals
Functional Status		
poor	1.0	
moderate	0.6	0.1 - 2.7
good	0.7	0.1 - 3.5
Cognitive Status Score		
poor	3.1	0.8 - 11.8
moderate & good	1.0	
Depression		
not depressed	1.0	
depressed	3.4	0.8 - 14.0
Referred By		
GAOT	4.0	0.5 - 33.1
other	1.0	
Recent Hospitalization		
yes	1.0	
no	1.1	0.3 - 4.1
Drug Administration		
self	1.0	
assistant & dosette	1.3	0.3 - 4.9
Drug Use		
1-5	1.0	
6+	2.5	0.6 - 10.2

Table J.2: Multivariate logistic regression modelling the Tamblyn criteria for potentially inappropriate combination medication use among elderly day-hospital patients taking at least one medication.

Variables	Odds Ratio	95% Confidence Intervals
Age Group		
65-69	1.0	
70-79	0.3	0.0 - 2.1
80+	0.6	0.1 - 3.2
Sex		
male	1.0	
female	1.3	0.3 - 5.6

APPENDIX K

NPHS drug use interview questions

NPHS drug use interview questions

DRUG-INT Now I'd like to ask a few questions about ...(r/'s) use of medications, both prescription and over-the-counter as well as other health products.

DRUG-Q1 In the past month, did ... take any of the following medications?
(Read list. Mark all that apply.)

___ Pain relievers such as aspirin or tylenol (includes arthritis medicine and anti-inflammatories)
___ Tranquilizers such as valium
___ Diet pills
___ Anti-depressants
___ Codeine, Demerol or Morphine
___ Allergy medicine such as "Sinutab"
___ Asthma medications
___ Cough or cold remedies
___ Penicillin or other antibiotic
___ Medicine for the heart
___ Medicine for blood pressure
___ Diuretics or water pills
___ Steroids
___ Insulin
___ Pills to control diabetes
___ Sleeping pills
___ Stomach remedies
___ Laxatives
___ Hormones for menopause or aging symptoms (check item: sex=female, age>=30)
___ Birth control pills (check item: sex=female, age >=12 & age <=49)
___ Any other medication (Specify_____)
___ None of the above

DRUG-C1 If any drug(s) specified in DRUG-Q1 go to DRUG-Q2. Otherwise go to DRUG-4.

DRUG-Q2 Now, I am referring to yerterday and the day before yesterday. During those two days, how many different medications did you/he/she take?

___ Number of different medications
DK,R (Go to DRUG-Q4)

If number=0 then go to DRUG-Q4

For each number >0 ask DRUG-Q3...up to a maximum of 12.

DRUG-Q3 What is the exact name of the medication that...took? (Ask the person to look at the bottle, tube or box.)

_____

DK, R to any medication (Go to next section)

DRUG-Q4 There are many other health products such as ointments, vitamins, herbs, minerals, teas or protein drinks which people use to prevent illness or to improve or maintain their health. Do/Does ... use any of these or other health products?

___ Yes
___ No (Go to next section)
DK, R (Go to next section)

DRUG-Q5 What is the exact name of the health product that ... use(s)? (Ask the person to look at the bottle, tube or box.) (up to 12 products)

_____

APPENDIX L

NPHS sample size calculations

Population Survey or Descriptive Study Using Random (Not Cluster) Sampling

Population Size	2,712,538
Expected Frequency	5.50 %
Worst Acceptable	2.50 %

Confidence Level	Sample Size
80 %	95
90 %	156
95 %	222
99 %	383
99.9 %	625
99.99 %	874

Formula: Sample Size = n/(1- (n/population))

$n = Z^*Z\ (P(1-P)) / (D^*D)$

Reference: Kish L. Survey Sampling. John Wiley & Sons, NY, 1965.

APPENDIX M

NPHS Expanded Sample by Weights

Table M.1: Sample size and community residing Canadian population distribution based on expansion weight estimates, by age group and by sex, NPHS 1994.

Age Group (years)	Males sample	Males estimate (X100)	Females sample	Females estimate (X100)	Total sample (X100) (%)	Total estimate (%)
12 - 14	333	7063	296	6218	629 (3.7)	13281 (5.6)
15 - 19	584	10608	608	9953	1192 (7.0)	20561 (8.6)
20 - 24	631	8334	730	8945	1361 (8.0)	17278 (7.2)
25 - 29	701	10838	847	10728	1548 (9.1)	21566 (9.0)
30 - 34	836	12593	1055	13717	1891 (11.1)	26310 (11.0)
35 - 39	801	13196	907	12653	1708 (10.0)	25850 (10.8)
40 - 44	699	11491	735	10982	1434 (8.4)	22473 (9.4)
45 - 49	634	10131	690	9325	1324 (7.8)	19456 (8.1)
50 - 54	522	7947	536	7491	1058 (6.2)	15438 (6.4)
55 - 59	442	6170	530	6870	972 (5.7)	13040 (5.4)
60 - 64	399	5447	499	6278	898 (5.3)	11725 (4.9)
65 - 69	403	5139	500	5766	903 (5.3)	10905 (4.6)
70 - 74	350	4031	523	5573	873 (5.1)	9605 (4.0)
75 - 79	233	2653	387	3727	620 (3.6)	6380 (2.7)
80 - 84	130	1217	253	2188	383 (2.2)	3405 (1.4)
85+	70	946	147	1269	217 (1.3)	2215 (0.9)
Total	7768	117803	9243	121683	17011	239486
%	(45.7)	(49.2)	54.3)	(50.8)	(100.0)	(100.0)

APPENDIX N

NPHS counts for potentially inappropriate medication use

Table N.1: Number of community residing elderly taking at least one potentially inappropriate drug, Beers criteria (NPHS 1994).

	Sample	Weighted Estimate (X100)
Long Acting Benzodiazepines		
Diazepam	11	94
Chlordiazepoxide	10	74
Flurazepam	15	174
Meprobamate	1	10
Short Duration Barbiturates		
Pentobarbital	10	129
Secobarbital	0	0
Antidepressants		
Amitriptyline	31	265
Antihypertensive Agents		
Reserpine	2	7
NSAIDs		
Indomethacin	27	225
Phenylbutazone	1	25
Oral Hypoglycemic Agents		
Chlorpropramide	10	54
Analgesic Agents		
Propoxyphene	3	30
Pentazocine	2	12
Dementia Treatments		
Cyclandelate	0	0
Isoxsuprine	-	-
Platelet Inhibitors		
Dipyridamole	15	116
Muscle Relaxants or Antispasmodic Agents		
Cyclobenzaprine	2	9
Orphenadrine	3	30
Methocarbamol	5	46
Carisoprodol	0	0
Antiemetic Agents		
Trimethobenzamide	-	-
Total	148	1301

Table N.2: Number of community residing elderly taking at least one potentially inappropriate drug combination, Tamblyn criteria (NPHS 1994).

	Sample	Weighted Estimate (X100)
Cardiovascular		
2 beta-blockers	3	22
2 Ca-channel blockers	4	79
2 ACE inhibitors	2	12
thiazide + thiazide	0	0
beta blocker + theophylline	1	6
beta-blocker + verapamil	3	18
ethacrynic acid + furosemide	1	1
furosemide + furosemide	1	0
2 K-sparing diuretics	2	8
K-sparing diuretic + K-supplement	15	107
inapamide + thiazide	0	0
Psychotropic		
clonazepam + benzodiazepine	2	15
2 benzodiazepines	13	236
clonazepam + clonazepam	0	0
benzodiazepine + sedative	2	23
sedative + barbiturate	10	129
2 sedatives	1	29
2 tranquillizers	1	14
2 barbiturates	1	29
barbiturate + opiate	0	0
barbiturate + antidepressant	0	0
MAO inhibitor + levodopa	0	0
MAO inhibitor + meperidine	0	0
MAO inhibitor + antidepressant	0	0
2 MAO inhibitors	0	0
2 tricyclic antidepressants	0	0
NSAID		
ASA + warfarin	4	40
2 NSAIDs	5	113
ASA + ASA	11	88
Total	82	1020

APPENDIX O

NPHS correlation matrix

Table O.1: NPHS correlation matrix.

Variables	Age	Sex	Marital	Family	Educ	Inc	Hhinc	Urban	Prov	Smoke	Alcohol	BMI	Health	Problem
Age Group	1.00	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Sex	0.08	1.00	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Marital Status	0.24	0.24	1.00	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Family Group	-0.28	-0.18	**-0.65**	1.00	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Education-0.16	-0.00	-0.04	0.01	1.00	-----	-----	-----	-----	-----	-----	-----	-----	-----	
Income Adequacy	-0.25	-0.14	-0.41	0.38	0.31	1.00	-----	-----	-----	-----	-----	-----	-----	-----
Household Inc	-0.27	-0.15	-0.42	0.44	0.30	**0.91**	1.00	-----	-----	-----	-----	-----	-----	-----
Urban/Rural	-0.00	0.08	0.09	-0.06	0.16	0.10	0.09	1.00	-----	-----	-----	-----	-----	-----
Province	0.02	0.01	0.02	-0.07	0.06	0.07	0.04	0.11	1.00	-----	-----	-----	-----	-----
Smoking Status	-0.18	-0.26	-0.01	0.02	-0.02	-0.01	-0.00	0.00	-0.00	1.00	-----	-----	-----	-----
Alcohol Consump.	-0.22	-0.19	-0.12	0.08	0.16	0.22	0.21	0.06	0.08	0.22	1.00	-----	-----	-----
BMI	-0.16	-0.10	-0.09	0.08	-0.07	0.02	0.01	-0.04	0.02	-0.02	0.02	1.00	----	----
Self-Rated Health	-0.12	-0.00	0.04	0.02	0.20	0.21	0.20	0.05	0.02	-0.07	0.16	-0.04	1.00	----
Main Health Prob.	0.12	-0.00	-0.05	0.06	0.05	0.13	0.13	0.02	-0.03	-0.04	0.08	-0.04	0.44	1.00
Regular MD	-0.05	-0.06	0.05	-0.04	-0.02	-0.05	-0.04	-0.04	0.00	0.07	0.02	-0.04	0.06	0.08
Visits to MD	0.13	0.06	0.03	0.03	-0.04	-0.07	-0.07	0.02	-0.01	-0.03	-0.09	0.05	-0.33	-0.30
Visits to HP	-0.08	-0.06	0.02	0.02	-0.04	-0.05	-0.04	-0.05	-0.01	0.10	0.01	-0.04	0.10	0.12
Visits to AP	0.05	-0.05	0.01	-0.02	-0.04	-0.02	-0.02	-0.03	-0.06	0.01	-0.01	0.00	0.02	0.04
Hospitalization	-0.11	-0.01	-0.05	0.06	0.06	0.10	0.10	0.03	0.01	-0.02	0.06	-0.01	0.22	0.21

Continued

Table O.1: NPHS correlation matrix continued.

Variables	Age	Sex	Marital	Family	Educ	Inc. A.	Hh Inc.	U/R	Prov	Smoke	Alcohol	BMI	Health	Problem
Dexterity	0.07	0.00	0.02	-0.01	-0.02	-0.04	-0.04	0.01	0.00	-0.02	-0.07	-0.02	-0.09	-0.10
Restriction	-0.12	-0.01	-0.06	0.06	0.05	0.14	0.14	0.02	-0.04	-0.05	0.08	-0.05	0.45	**0.96**
Self-esteem	-0.02	0.01	-0.02	0.00	0.10	0.08	0.07	0.10	-0.04	-0.02	0.06	-0.01	0.20	0.08
Depression	-0.04	0.05	0.06	-0.02	-0.00	-0.05	-0.05	-0.01	0.00	0.05	0.01	-0.00	-0.12	-0.10
Social Support	-0.01	0.09	-0.10	0.09	0.04	0.09	0.09	-0.01	-0.01	-0.07	-0.01	-0.01	0.08	0.04
Health Services	0.11	0.07	0.01	-0.03	-0.01	-0.03	-0.04	0.02	0.02	-0.05	-0.05	0.04	-0.22	-0.22
Drug Use	0.17	0.19	0.08	-0.10	0.01	-0.06	-0.08	0.03	0.04	-0.08	-0.10	0.03	-0.33	-0.34

Continued

Table O.1:NPHS correlation matrix continued.

Variables	MD	Visits	HP	AP	Hosp	Dexter	Restr	Self-est	Dep	S. Sup.	Hlth S.	Use
Age Group	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Sex	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Marital Status	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Family Group	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Education-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	
Income Adequacy	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Houshold Inc	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Urban/Rural	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Province	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Smoking Status	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Alcohol Consump.	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BMI	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Self-Rated Health	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Main Health Prob.	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Regular MD	1.00	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Visits to MD	-0.26	1.00	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Visits to HP	0.26	-0.44	1.00	-----	-----	-----	-----	-----	-----	-----	-----	-----
Visits to AP	0.02	-0.05	0.03	1.00	-----	-----	-----	-----	-----	-----	-----	-----

Continued

Table O.1:NPHS correlation matrix continued.

Variables	MD	Visits	HP	AP	Hosp	Dexter	Restr	Self-est	Dep	S. Sup.	Hlth S.	Use
Hospitalization	0.07	-0.29	0.09	0.03	1.00	-----	-----	-----	-----	-----	-----	-----
Dexterity	-0.03	0.05	-0.01	0.00	-0.04	1.00	-----	-----	-----	-----	-----	-----
Restriction	0.07	-0.32	0.12	0.05	0.23	-0.10	1.00	-----	-----	-----	-----	-----
Self-esteem	0.02	-0.06	0.00	-0.02	0.04	-0.03	0.09	1.00	-----	-----	-----	-----
Depression	-0.00	0.07	-0.03	-0.04	-0.07	-0.00	-0.10	-0.08	1.00	-----	-----	-----
Social Support	-0.04	0.01	-0.04	-0.00	0.02	-0.03	0.04	0.05	-0.06	1.00	-----	-----
Health Services	-0.49	0.47	-0.51	-0.33	**-0.75**	0.04	-0.24	-0.04	0.07	0.02	1.00	-----
Drug Use	-0.18	0.38	-0.22	-0.08	-0.18	0.05	-0.34	-0.02	0.08	-0.01	0.30	1.00.

APPENDIX P

NPHS analysis without weights

NPHS analysis without weights

A separate univariate logistic regression (LR) was performed on each of the NPHS variables without the use of relative weights (Table O.1). The variables with statistically significant odds ratios were:

1. middle Income Adequacy or less;
2. Household Income of $39,999 or less;
3. Alcohol Consumption of never and of former;
4. BMI rating of over weight or unknown;
5. Self-Rated Health of poor and fair;
6. nervous system, heart and circulatory, arthritis, musculo-skeletal, and other Main Health Problems;
7. one to five and six or more Visits to MD within the past year;
8. Hospitalization
9. Dexterity problems with no help
10. Restriction of Activity;
11. Depression;
12. low Social Support
13. two to five, and six more drugs used concomitantly.

Multivariate LR reduced this model to four predictor variables (Table O.2). Potentially inappropriate medication is more likely to occur in those with middle Income Adequacy or below, with a dexterity problem - no help, with any possibility of depression, and with 2 or more concomitant medications.

Table P.1: Univariate logistic regressions modelling potentially inappropriate medication use among Canadians aged 65 and over taking at least one medication, without the use of reduction weights (NPHS 1994).

Variables	Odds Ratio	95% Confidence Intervals
Age Group		
65-69	1.0	
70-77	1.2	0.9 - 1.7
80+	0.9	0.6 - 1.4
Sex		
male	1.0	
female	1.0	0.7 - 1.3
Marital Status		
married	0.9	0.5 - 1.6
single	1.0	
widowed	1.0	0.6 - 1.9
divorced	0.9	0.4 - 2.0
Education		
< high school	1.2	0.8 - 1.8
high school grad	0.9	0.5 - 1.6
> high school	0.8	0.4 - 1.3
college/university	1.0	
Body-Mass Index		
underweight	1.1	0.7 - 2.0
acceptable	1.0	
possible over	0.9	0.5 - 1.7
overweight	1.6	1.1 - 2.2
unknown	1.6	1.0 - 2.3
Smoking Status		
never	1.0	0.8 - 1.4
former	1.2	0.8 - 1.8
current	1.0	
Alcohol Consumption		
never	1.7	1.2 - 2.4
former	1.5	1.1 - 2.1
current	1.0	
Income Adequacy		
low	2.2	1.0 - 4.7
lower-middle	2.2	1.1 - 4.3
middle	2.1	1.0 - 4.0
upper-middle	1.0	0.5 - 2.2
high	1.0	

continued

Table O.1: Univariate logistic regressions modelling potentially inappropriate medication use among Canadians aged 65 and over taking at least one medication, without the use of reduction weights (NPHS 1994), continued.

Variables	Odds Ratio	95% Confidence Intervals
Household Income		
0 - 14,999	2.0	1.2 - 3.3
15,000 - 39,999	1.8	1.1 - 2.9
40,000 +	1.0	
Urban / Rural		
urban	1.0	
rural	1.2	0.9 - 1.6
Province		
Atlantic	1.4	0.9 - 2.0
Quebec	1.0	0.6 - 1.7
Ontario	1.0	
Prairies	1.0	0.7 - 1.5
British Columbia	0.7	0.4 - 1.3
Social Support		
none	1.2	0.4 - 4.2
low	1.4	1.0 - 2.0
high	1.0	
Self-Rated Health		
poor	4.1	2.0 - 8.2
fair	2.0	1.1 - 3.8
good	1.7	0.9 - 3.3
very good	1.0	0.5 - 2.0
excellent	1.0	
Main Health Problem		
nervous system	2.5	1.4 - 4.4
heart and circulatory	2.6	1.7 - 4.0
respiratory	1.4	0.6 - 3.4
arthritis	1.9	1.2 - 3.1
musculo-skeletal	1.9	1.2 - 3.1
other	2.4	1.5 - 3.9
none	1.0	
Dexterity		
no problem	1.0	
problem, no help	2.5	1.2 - 5.4
problem, help	2.1	0.8 - 5.6

continued

Table O.1: Univariate logistic regressions modelling potentially inappropriate medication use among Canadians aged 65 and over taking at least one medication, without the use of reduction weights (NPHS 1994), continued.

Variables	Odds Ratio	95% Confidence Intervals
Restricted Activity		
no	1.0	
yes	2.1	1.5 - 2.8
Self-esteem		
low	1.3	0.9 - 1.9
medium	1.0	
high	1.1	0.8 - 1.7
Depression		
not depressed	1.0	
depressed	2.7	1.7 - 4.3
Regular MD		
no	1.0	
yes	2.7	0.8 - 8.7
Visits to MD		
0	1.0	
1-5	4.9	1.5 - 15.6
5+	7.8	2.4 - 24.7
Visits to Health Professionals		
no	1.0	
yes	2.2	0.7 - 7.0
Visits to Alternative HPs		
no	1.6	0.6 - 4.5
yes	1.0	
Recent Hospitalization		
no	1.0	
yes	1.4	1.0 - 2.0
Drug Use		
1	1.0	
2-5	4.1	2.3 – 7.5
6+	11.0	5.9 – 20.8

Table P.2: Step-wise logistic regression modelling potentially inappropriate medication use among Canadians aged 65 years and older taking at least one medication, without the use of reduction weights (NPHS 1994).

Variables	Odds Ratio	Confidence Intervals
Age Group		
65-69	1.0	
70-79	1.1	0.8 - 1.5
80 +	0.7	0.4 - 1.1
Sex		
male	1.0	
female	0.8	0.6 - 1.1
Income Adequacy		
low	2.5	1.1 - 5.6
lower-middle	2.2	1.1 - 4.4
middle	2.1	1.0 - 4.2
upper-middle	1.0	0.5 - 2.3
high	1.0	
Dexterity		
no problem	1.0	
problem, no help	2.8	1.3 - 6.4
problem, help	1.8	0.7 - 5.0
Depression		
not depressed	1.0	
depressed	2.2	1.3 - 3.6
Drug Use		
1	1.0	
2-5	4.0	2.2 - 7.3
6 +	11.0	5.8 -20.8

A `comparison of the NPHS data set analyzed with and without the use of relative weights indicates the influence of this procedure on the results. The appropriate use of weights is required in order to avoid distorting conclusions when analyzing sample survey data with the intention of making inferences on the total population.[109] The configuration of the general population in terms of age and sex distribution is applied to the sample prior to analysis by using relative weights. This way, the sample size is preserved in order to maintain the power of the results, but the results can be generalized to the target population.

APPENDIX Q

NPHS analysis using Beers et al. criteria

NPHS analysis using Beers et al. Criteria

Univariate LR was repeated on each of the NPHS variables in order to identify predictors of potentially inappropriate medication for the Beers (modified) criteria alone (Table P.1). Variables with statistically significant odds ratios were:

1. High school graduates
2. BMI rating of overweight or unknown
3. Alcohol Consumption of never or former;
4. lower-middle Income Adequacy;
5. Household Income from 0 to $14,999;
6. Social Support score of zero to three (none and low);
7. Poor Self-Rated Health;
8. nervous system, heart and circulatory, arthritis, musculo-skeletal, and other Main Health Problems;
9. Dexterity problems with no help;
10. Restricted Activity;
11. low Self-esteem;
12. Depression;
13. six or more Visits to MD within the past year;
14. two to five or six or more medications taken concomitantly.

Table Q.1: Univariate logistic regressions modelling potentially inappropriate medication use among elderly Canadians taking at least one medication, Beers (restricted) criteria (NPHS 1994).

Variables	Odds Ratio	95% Confidence Intervals
Age Group		
65-69	1.0	
70-79	0.9	0.6 - 1.3
80+	0.7	0.4 - 1.2
Sex		
male	1.0	
female	0.8	0.6 - 1.2
Marital Status		
married	1.3	0.5 - 3.2
single	1.0	
widowed	1.1	0.4 - 3.0
divorced	0.8	0.2 - 2.9
Education		
< high school	1.6	0.9 - 2.9
high school grad	1.9	1.0 - 3.8
> high school	1.1	0.5 - 2.2
college/university	1.0	
Body-Mass Index		
underweight	0.8	0.4 - 1.8
acceptable	1.0	
possibly overweight	0.7	0.3 - 1.8
overweight	1.6	1.0 - 2.5
unknown	1.6	1.0 - 2.7
Smoking Status		
never	1.0	
former	1.2	0.8 - 1.9
current	1.0	0.5 - 1.9
Alcohol Consumption		
never	2.0	1.2 - 3.2
former	1.6	1.0 - 2.5
current	1.0	
Income Adequacy		
low	1.8	0.6 - 5.5
lower-middle	2.7	1.2 - 6.3
middle	2.1	0.9 - 4.7
upper-middle	1.5	0.6 - 3.5
high	1.0	

continued

Table Q.1: Univariate logistic regressions modelling potentially inappropriate medication use among elderly Canadians taking at least one medication, Beers (restricted) criteria (NPHS 1994), continued.

Variables	Odds Ratio	95% Confidence Intervals
Household Income		
0 - 14,999	2.0	1.1 - 3.5
15,000 - 39,999	1.5	0.9 - 2.6
40,000 +	1.0	
Urban/Rural		
urban	1.0	
rural	1.2	0.7 - 1.9
Province		
Atlantic	1.4	0.7 - 2.5
Quebec	0.4	0.2 - 0.8
Ontario	1.0	
Prairies	0.8	0.5 - 1.4
British Columbia	0.8	0.4 - 1.5
Social Support		
none & low	1.8	1.2 - 2.6
high	1.0	
Self-Rated Health		
poor	5.0	2.1 - 12.4
fair	1.7	0.7 - 4.1
good	1.8	0.8 - 4.1
very good	1.3	0.5 - 3.2
excellent	1.0	
Main Health Problem		
nervous system	3.0	1.5 - 5.9
heart and circulatory	3.5	2.0 - 6.0
respiratory	0.4	0.0 - 3.1
arthritis	2.4	1.3 - 4.4
musculo-skeletal	2.0	1.0 - 4.0
other	2.7	1.5 - 5.0
none	1.0	
Dexterity		
no problem	1.0	
problem, no help	4.0	1.7 - 9.3
problem, help	2.4	0.7 - 7.6
Restricted Activity		
no	1.0	
yes	2.4	1.6 - 3.6

continued

Table Q.1: Univariate logistic regressions modelling potentially inappropriate medication use among elderly Canadians taking at least one medication, Beers (restricted) criteria (NPHS 1994), continued.

Variables	Odds Ratio	95% Confidence Intervals
Self-esteem		
low	1.7	1.1 - 2.8
medium	1.0	
high	1.3	0.8 - 2.2
Depression		
not depressed	1.0	
depressed	3.1	1.7 - 5.6
Regular MD		
no	1.0	
yes	14.8	0.5 - 435.1
Visits to MD		
0	1.0	
1-5	2.5	0.8 - 8.2
5+	3.7	1.1 - 11.8
Visits to Health Professionals		
no	1.0	
yes	1.0	0.3 - 3.3
Visits to Alternative HPs		
no	1.4	0.4 - 4.6
yes	1.0	
Recent Hospitalization		
no	1.0	
yes	1.2	0.7 - 1.8
Drug Use		
1	1.0	
2-5	1.8	1.0 - 3.3
6+	5.2	2.7 - 9.8

For the Beers (modified) criteria alone, the final model included six predictor variables in the model: Age Group, Sex, Dexterity, Restricted Activity, Depression and concomitant Drug Use. Potentially inappropriate medication is more likely to occur in those: with a Dexterity problem with no help; with Restricted Activity; with Depression; and with six or more concomitant medications (Table P.2).

Table Q.2: Multivariate logistic regression modelling the Beers (restricted) criteria for potentially inappropriate medication use among elderly Canadians taking at least one medication (NPHS 1994).

Variables	Odds Ratio	95% Confidence Intervals
Age Group		
65-69	1.0	
70-79	0.8	0.5 - 1.2
80 +	0.6	0.3 - 1.1
Sex		
male	1.0	
female	0.8	0.5 - 1.1
Dexterity		
no problem	1.0	
problem, no help	4.1	1.6 - 10.4
problem, help	1.7	0.5 - 5.8
Restricted Activity		
no	1.0	
yes	1.8	1.2 - 2.7
Depression		
not depressed	1.0	
depressed	2.6	1.4 - 4.8
Drug Use		
1	1.0	
2-5	1.6	0.9 - 3.0
6 +	4.2	2.2 - 8.3

APPENDIX R

NPHS analysis using Tamblyn et al. criteria

NPHS analysis using Tamblyn et al. criteria

Univariate LR was also repeated on each of the NPHS variables in order to identify predictors of potentially inappropriate medication for the Tamblyn criteria (Table Q.1) Variable levels with statistically significant odds ratios were:

1. less than high school education and high school graduates;
2. BMI rating of underweight;
3. living in Quebec;
4. no or low Social Support;
5. poor Self-Rated Health;
6. respiratory or other Main Health Problems;
7. Dexterity problems with no help;
8. high Self-esteem;
9. Depression;
10. two to five, and six or more medications taken concomitantly.

Table R.1: Univariate logistic regressions modelling potentially inappropriate medication use among elderly Canadians taking at least one medication, Tamblyn criteria (NPHS 1994).

Variables	Odds Ratio	95% Confidence Intervals
Age Group		
65-69	1.0	
70-79	0.8	0.5 - 1.2
80+	0.5	0.3 - 1.0
Sex		
male	1.0	
female	1.1	0.8 - 1.7
Marital Status		
married	1.7	0.6 - 4.9
single	1.0	
widowed	1.3	0.4 - 3.9
divorced	0.9	0.2 - 3.9
Education		
< high school	2.1	1.1 - 3.8
high school grad	1.8	0.9 - 3.9
> high school	0.6	0.2 - 1.5
college/university	1.0	
Body-Mass Index		
underweight	1.9	1.0 - 3.6
acceptable	1.0	
possibly overweight	1.7	0.8 - 3.3
overweight	1.2	0.7 - 2.0
unknown	1.4	0.8 - 2.4
Smoking Status		
never	1.0	
former	1.3	0.8 - 2.0
current	1.4	0.8 - 2.6
Alcohol Consumption		
never	0.7	0.4 - 1.3
former	1.1	0.7 - 1.8
current	1.0	
Income Adequacy		
low	0.3	0.1 - 1.3
lower-middle	1.1	0.5 - 2.2
middle	1.2	0.6 - 2.2
upper-middle	0.5	0.2 - 1.0
high	1.0	

continued

Table R.1: Univariate logistic regressions modelling potentially inappropriate medication use among elderly Canadians taking at least one medication, Tamblyn criteria (NPHS 1994), continued.

Variables	Odds Ratio	95% Confidence Intervals
Household Income		
0 - 14,999	1.3	0.7 - 2.3
15,000 - 39,999	1.4	0.8 - 2.2
40,000 +	1.0	
Urban/Rural		
urban	1.0	
rural	0.7	0.4 - 1.2
Province		
Atlantic	1.5	0.7 - 3.2
Quebec	2.9	1.8 - 4.7
Ontario	1.0	
Prairies	1.0	0.5 - 2.0
British Columbia	0.8	0.4 - 1.7
Social Support		
none	3.9	1.0 - 15.8
low	2.1	1.4 - 3.2
high	1.0	
Self-Rated Health		
poor	6.3	2.4 - 16.4
fair	2.1	0.8 - 5.2
good	2.1	0.8 - 5.1
very good	1.4	0.5 - 3.6
excellent	1.0	
Main Health Problem		
nervous system	0.8	0.3 - 2.2
heart and circulatory	1.5	0.8 - 2.8
respiratory	2.4	1.0 - 5.3
arthritis	1.0	0.5 - 2.1
musculo-skeletal	0.9	0.4 - 2.0
other	1.9	1.0 - 3.3
none	1.0	
Dexterity		
no problem	1.0	
problem, no help	3.0	1.2 - 7.8
problem, help	2.0	0.6 - 7.1

continued

Table R.1: Univariate logistic regressions modelling potentially inappropriate medication use among elderly Canadians taking at least one medication, Tamblyn criteria (NPHS 1994), continued

Variables	Odds Ratio	95% Confidence Intervals
Restricted Activity		
no	1.0	
yes	1.3	0.9 - 1.9
Self-esteem		
low	1.2	0.8 - 2.1
medium	1.0	
high	1.9	1.2 - 3.1
Depression		
not depressed	1.0	
depressed	3.2	1.7 - 5.8
Regular MD		
no	1.0	
yes	5.1	0.6 - 39.9
Visits to MD		
0	1.0	
1-5	2.0	0.7 - 5.7
5+	2.3	0.8 - 6.4
Visits to Health Professionals		
no	1.0	
yes	0.7	0.2 - 2.0
Visits to Alternative HPs		
no	3.3	0.5 - 20.9
yes	1.0	
Recent Hospitalization		
no	1.0	
yes	1.2	0.8 - 1.9
Drug Use		
1	1.0	
2-5	4.7	2.0 – 11.1
6+	13.1	5.3 – 32.2

For the Tamblyn criteria, the final model included seven predictor variables in the model: Age Group, Sex, Province, Social Support, Dexterity, Self-esteem and Drug Use (Table Q.2). Potentially inappropriate medication use is more likely to occur among those:

1. living in Quebec;
2. with a Social Support score of zero to three(none & low);
3. with poor Self-Rated Health;
4. with a Dexterity problem with no help;
5. with high Self-esteem;
6. taking two to five, or six or more concomitant medications.

Table R.2: Multivariate logistic regression modelling the Tamblyn criteria for potentially inappropriate combination medication use among elderly Canadians at least one medication (NPHS 1994).

Variables	Odds Ratio	95% Confidence Intervals
Age Group		
65-69	1.0	
70-79	0.7	0.5 - 1.1
80 +	0.6	0.3 - 1.1
Sex		
male	1.0	
female	1.1	0.7 - 1.6
Province		
Atlantic	1.6	0.7 - 3.4
Quebec	2.4	1.5 - 3.9
Ontario	1.0	
Prairies	1.0	0.5 - 2.0
British Columbia	0.7	0.3 - 1.6
Social Support		
none	6.5	1.4 - 29.3
low	1.7	1.1 - 2.6
high	1.0	
Dexterity		
no problem	1.0	
problem, no help	3.6	1.3 - 10.0
problem, help	2.2	0.6 - 8.0
Self-esteem		
low	1.2	0.7 - 2.0
medium	1.0	
high	1.8	1.1 - 3.0
Drug Use		
1	1.0	
2-5	5.5	2.3 - 13.4
6+	16.3	6.5 - 41.0

IMAGE EVALUATION TEST TARGET (QA-3)

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6″

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