

# Turning 65 in Ontario: The Impact of Public Drug Benefit Coverage on Hospitalizations for Acute and Chronic Disease

Atteindre l'âge de 65 ans en Ontario :  
Répercussions d'un régime public d'assurance-  
médicaments sur les hospitalisations pour  
maladies aiguës et chroniques



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## Abstract

Ongoing access to medication is required for the management of many chronic diseases. We sought to examine the health impact of entering the provincial drug benefit plan at age 65 years. We constructed cohorts of same-aged individuals with incident heart failure, with diabetes and from the whole population using administrative data. The hazard of hospitalization at a given age compared to one year younger for ages 63 to 67 years was determined. On turning age 65, persons were more rather than less likely to be hospitalized for diabetes and acute infection when compared to the prior year. Among residents of low-income neighbourhoods these effects were no longer significant, but the risk of hospitalization for heart failure was increased. A similar effect was not observed for the paired cohorts at the transition from age 63 to 64 years. A health benefit of obtaining drug insurance was not observed in this study; however, the relationship may have been confounded by the effects of retirement and other changes occurring at age 65. Moreover, a benefit experienced by only a small proportion of the population may not be apparent in this analysis, which included many individuals unaffected by the policy.

## Résumé

L'accès continu à des médicaments est nécessaire pour contrôler de nombreuses maladies chroniques. Nous avons cherché à examiner les répercussions qu'aura, sur la santé, l'adhésion à un régime provincial d'assurance-médicaments à partir de l'âge de 65 ans. En utilisant des données administratives, nous avons établi des cohortes d'individus de même âge ayant déjà présenté un épisode d'insuffisance cardiaque, souffrant de diabète et provenant de l'ensemble de la population. Nous avons comparé les dangers liés à l'hospitalisation à un âge donné et à un an de moins pour les sujets âgés de 63 à 67 ans. À l'atteinte de l'âge de 65 ans, les sujets étaient davantage susceptibles d'être hospitalisés pour cause de diabète et d'infection aiguë qu'ils ne l'étaient un an plus tôt. Parmi les résidents de quartiers défavorisés, ces effets n'étaient plus significatifs, mais il y avait un risque accru d'hospitalisation pour insuffisance cardiaque. On n'a pas observé d'effet semblable pour les cohortes jumelées représentant la transition entre 63 et 64 ans. Cette étude n'a révélé aucun avantage découlant de l'adhésion à un régime d'assurance-médicaments; cependant, la relation peut avoir été diluée dans les effets de la retraite et autres changements survenant à l'âge de 65 ans. En outre, un avantage dont bénéficie seulement un faible pourcentage de la population peut ne pas être apparent dans cette étude puisque celle-ci englobait de nombreux sujets non touchés par la politique.

**P**HARMACOTHERAPY HAS BECOME THE MAINSTAY IN THE MANAGEMENT OF many chronic diseases, and access to appropriate drugs can have an impact on disease-related morbidity and mortality. For example, patients who do not receive optimal drug therapy for congestive heart failure have higher rates of mortality and morbidity, including elevated rates of hospitalizations (Garg and Yusuf 1995; Luzier et al. 1998; Digitalis Investigation Group 1997; Pitt et al. 1999). Cost barriers in acquiring necessary medications may be one important factor limiting patients' ability to adhere to therapy (Heisler et al. 2004; Jackson et al. 2004).

The relationship between drug benefit coverage and the utilization of essential medications has been the subject of much study (Adams et al. 2001; Blustein 2000; Federman et al. 2001; Fortess et al. 2001; Gianfrancesco et al. 1994; Goldman et al. 2004; Grootendorst et al. 1997; Harten and Ballentyne 2004; Kozyrskyj et al. 2001; Lilliard et al. 1999; Shulman et al. 1986; Soumerai et al. 1987; Soumerai and Ross-Degnan 1990; Soumerai et al. 1994; Martin and McMillan 1996). Most work has been limited to natural experiments in the setting of policy changes where the effects of restricting drug coverage on medication use were studied. Strategies that have been employed include deductibles where benefits apply only after the patient has paid an initial fixed portion of the annual costs, co-payments where patients bear a proportion of the cost of each prescription and capping of the total number of prescriptions reimbursed in a period. These approaches have the effect of reducing the payer's expenditures through cost sharing but also through creating an effective incentive for reduced utilization. Reductions in drug use have been reported to occur in essential therapy such as insulin for diabetes mellitus and antipsychotics for mental illness (Soumerai et al. 1987), as well as for more discretionary medications such as analgesics and cough remedies (Harris and Custer 1991; Soumerai et al. 1987; Reeder and Nelson 1985).

A limited number of studies have reported the effect of introducing or extending drug coverage on medication use (Blustein 2000; Adams et al. 2001; Grootendorst et al. 1997). Elderly Americans newly enrolled in the prescription drug coverage program offered by the United Mine Workers of America Health and Retirement Funds increased their prescription drug use by 18% (Gianfrancesco et al. 1994). Similarly, the introduction of the RAND Elderly Health Supplement, a prescription drug coverage expansion to the Medicare program, increased the probability of use among those to whom drugs were prescribed (Lilliard et al. 1999). None of these studies, however, explored the impact of drug utilization on health outcomes.

For those Ontarians without comprehensive private drug insurance, turning 65 and thereby qualifying for coverage under the provincial drug benefit plan may represent an opportunity for improved health. That is, increased access to medication at age 65 by removal of financial barriers should be associated with a decrease in hospitalizations for certain chronic conditions. The effect should be most pronounced in those with low incomes and most easily detected in cases where hospitalizations can

be averted by chronic drug therapy or prompt acute drug therapy. This study examines the impact of insured access to drugs on outcomes by comparing hospitalizations among cohorts of individuals who are either 64 or 65 years old (the latter qualifying for Ontario Drug Benefits [ODB] coverage) and who are vulnerable to financial barriers because of low socioeconomic status.

## Methods

### Study design

We conducted a population-based retrospective cohort study by linking administrative healthcare databases covering nearly one million individuals 60 to 70 years of age in Ontario, Canada, from April 1, 1997 through September 30, 2000. Ontario residents age 65 years and older have prescription drug coverage through a comprehensive provincial drug formulary. This study was approved by the Research Ethics Board of Sunnybrook and Women's College Health Sciences Centre.

### Data sources

The administrative healthcare databases in Ontario allowed for cohort identification, co-morbidity assessment and endpoint ascertainment. These databases contain unique patient identifiers that permit deterministic linkage of patient level records between databases and over time. Hospital discharge abstracts were obtained from the Canadian Institute for Health Information. Each abstract contains up to 16 diagnostic codes classified as most responsible, preexisting co-morbidity or complications arising in hospital (Lee et al. 2005). Claims to the Ontario Health Insurance Plan (OHIP) describe service delivery by physicians working in a fee-for-service environment (Wilchensky et al. 2004). Claims to the ODB describe drugs dispensed and charges to the program; the database includes eligibility information for the various program subtypes (Levy et al. 2003). Population-wide coverage is available only to persons over 65 years of age, while a range of program subtypes apply to persons under age 65 in vulnerable circumstances, such as being on social assistance or long-term disability. The program reimburses all drugs from a broadly inclusive formulary. Of relevance to the current study, covered medications include routine treatments for heart failure (ACE inhibitors, diuretics and beta blockers) for hyperglycaemia (insulins, sulfonylureas and metformin with thiazolidinediones on restricted access) and oral antibiotics. Seniors with an income over \$16,018 for singles or \$24,175 for couples have an annual deductible of \$100 and a co-payment of \$6.11 on each prescription, while lower-income individuals have no deductible and a co-payment of \$2. For persons with

supplementary private insurance, the ODB is still the first payer, restricting private coverage to reimbursement for non-formulary drugs and co-payments. The Ontario Diabetes Database (ODD) is a validated administrative data-derived registry of persons in Ontario with diagnosed diabetes (Hux et al. 2002). The Registered Persons Database (RPDB) provides demographic data on all persons eligible for health insurance coverage in the province. All these databases are available at the Institute for Clinical Evaluative Sciences and can be linked through a reproducibly scrambled numeric identifier.

### Cohort definitions

Individuals were eligible for study if they turned 60–70 years of age between April 1, 1997 and September 30, 2000. The index date was set as the patient's first birthday within that window. For each individual, disease status was defined in the six years prior to the index date. Three study groups were defined on the basis of clinical diagnoses, namely, congestive heart failure (CHF), diabetes mellitus (DM) and acute infection. These three groups were analyzed separately, and patient pools in each diagnostic group were not mutually exclusive. These conditions were selected on the assumption that effective outpatient pharmacotherapy may avert the need for acute hospitalizations.

For patients in the CHF group, individuals having any hospitalization with a primary or most responsible diagnosis of CHF (ICD-9 428) in the three-year diagnostic window prior to the index date were identified from records of the Canadian Institute for Health Information (CIHI 2005). They were verified to be incident cases of CHF by excluding any who had hospitalizations or physician claims with a diagnosis of CHF in the three years prior to that three-year diagnostic window. The diabetes cohort was defined from the Ontario Diabetes Database by selecting incident cases in the three years prior to the index date. Within the ODD, incident cases are defined as those who met the case definition in that year but had not met criteria for entry to the ODD for at least three consecutive previous years. By selecting cases matched for disease duration, confounding related to disease progression is reduced. For the acute infection analysis, all persons who met the age criteria described above were eligible.

For each analysis, paired cohorts of patients were selected by one-year age differences (60–61 years, 61–62 years, 62–63 years, etc.) within each diagnostic category. Patients were then followed up for one year to examine disease-specific endpoints.

### Study endpoints

For the CHF cohort, the outcome was an emergency department (ED) visit or hospitalization for CHF. ED visits were identified using a previously defined algorithm and

were considered to have been for CHF when the diagnosis on the OHIP claim was CHF (ICD-9 428). Admissions to hospital for CHF were defined when CHF was listed as the primary or most responsible diagnosis.

For the DM cohort, the primary endpoint was an ED visit or hospitalization for DM. Admissions to hospital for DM were defined when one of the diagnostic codes shown in Table 1 was listed as the primary or most responsible diagnosis.

TABLE 1. Diagnostic codes used to define outcomes

OUTCOME	CONDITION (ICD-9 CODE)
Congestive heart failure (Hospitalization or ED visit)	Congestive heart failure (428)
Diabetes mellitus (Hospitalization or ED visit)	Diabetes mellitus (250.0) Diabetic ketoacidosis (250.1) Diabetic hyperosmolar coma (250.2) Diabetes coma NEC (250.3) Hypoglycemic coma (251.0)
Acute infection (Hospitalization)	Pneumococcal pneumonia (481) Various bacterial pneumonias (482.x) Acute cystitis (595) Acute pyelonephritis (590.1) Septicemia (038.x)

For the acute infection cohort, the outcome was hospitalizations for respiratory and urinary tract infections or sepsis defined when one of the codes listed in Table 1 was reported as the primary or most responsible diagnosis. ED visits were not included, as they may represent the initial presentation of the acute infection rather than a treatment failure.

### Socioeconomic status

A secondary analysis stratified by socioeconomic status was conducted, since it is expected that patients of low socioeconomic status would be at greatest risk of being affected by the availability of drug coverage. Such persons may work part-time or in settings without insurance and, at the same time, have inadequate financial resources to cover drug costs out of pocket. While some high-income individuals may also be

without private insurance, they may not face the same barriers to purchasing necessary medications. Income level for individuals in the study was estimated from neighbourhood-level data collected in the 1996 census, using a validated algorithm (Roos and Mustard 1997; Demissie 2000). The neighbourhoods in Ontario, each representing a census enumeration area (median population  $\approx 700$ ), were divided into five categories based on median household income quintile within each census metropolitan area (CMA) or census agglomeration (CA). Income quintiles are then assigned to individual patients by linking on the patient's postal code from the RPDB as a common identifier. Individuals living in enumeration areas (1.4% of individuals in the sample) that lack income data were excluded.

For this subgroup analysis, patients in the lowest two quintiles were defined as "low socioeconomic status" and the patients in the highest three quintiles were defined as "high socioeconomic status." Individuals age 65 years and younger who received drug coverage through provincial social assistance programs in the one year prior to the index date (8.8% of individuals in the sample) were excluded from the analysis.

## Statistical analysis

For each group of patients in each diagnostic category, time-to-event analysis using Cox proportional hazards models was conducted to estimate the relative risk of an event in the one-year follow-up period for a total of 10 comparisons in each diagnostic group. Patients were censored at reaching one of the pre-specified endpoints or death, or at one year following their index date. In each of these models, age was the primary independent variable and event status was the dependent variable. The 10 relative hazard estimates in each diagnostic group were then compared to determine which age groupings resulted in statistically significant changes in health outcomes. Theoretically, the 64–65 year group or 65–66 year group would reveal statistically significant associations with health outcomes as a function of drug coverage. These analyses were repeated for low and high socioeconomic status groups.

## Results

Table 2 shows the hazard ratio for hospitalization for the three target conditions when compared in cohorts separated in age by one year and matched for disease duration (for chronic diseases). For residents of low-income neighbourhoods, the risk of hospitalization for congestive heart failure was increased on turning 65. In the case of diabetes, a trend in the same direction was observed; however, the effect was not statistically significant. For the full cohort, the risk of hospitalization was increased at age 65 years for diabetes and acute infection. In no case did we observe the hypothesized effect of access to provincial drug benefits on turning 65 leading to a decrease in

hospitalizations for target conditions. The effects seen in the low socioeconomic status subgroup were not statistically different from those seen in the population as a whole. In the other cohort years, for many comparisons the point estimates of the risk of hospitalization approached or exceeded unity, as would be expected given the effects of aging. However, the effects were much more modest than in the case of turning 65.

TABLE 2. Hazard of adverse outcome in paired cohorts differing one year in age

CONDITION	COMPARISON AGES IN YEARS	LOW-INCOME HAZARD RATIO, 95% CI	FULL COHORT HAZARD RATIO, 95% CI
Congestive heart failure	64 vs. 63	0.78 (0.53, 1.13)	0.92 (0.73, 1.16)
	65 vs. 64	1.48 (1.04, 2.10)	1.14 (0.91, 1.42)
	66 vs. 65	1.26 (0.95, 1.66)	1.36 (1.13, 1.64)
	67 vs. 66	0.97 (0.77, 1.23)	0.94 (0.80, 1.10)
Diabetes mellitus	64 vs. 63	0.94 (0.58, 1.53)	0.90 (0.67, 1.21)
	65 vs. 64	1.52 (0.97, 2.38)	1.43 (1.08, 1.89)
	66 vs. 65	1.07 (0.73, 1.56)	1.01 (0.79, 1.30)
	67 vs. 66	1.21 (0.86, 1.70)	1.09 (0.87, 1.38)
Acute infection	64 vs. 63	1.01 (0.76, 1.34)	0.97 (0.81, 1.16)
	65 vs. 64	1.14 (0.87, 1.50)	1.45 (1.23, 1.72)
	66 vs. 65	1.39 (1.09, 1.77)	1.28 (1.10, 1.47)
	67 vs. 66	1.20 (0.97, 1.48)	1.03 (0.90, 1.18)

## Discussion

We examined rates of hospitalization for conditions in which secure access to necessary medications would be expected to lead to reduced rates of admission to hospital, in order to examine the impact of initiating coverage in the ODB Program. We hypothesized that turning 65 years of age and thereby qualifying for access under the ODB Program should lead to reduced hospitalizations for these conditions and that the effects would be most apparent in individuals living in low-income neighbourhoods who, prior to turning 65, might have lacked both private drug insurance and resources to pay for medications out of pocket. This hypothesized effect was not observed; in fact, there was a trend toward increased rates of hospitalization for the

target conditions in persons reaching retirement age. Our failure to observe health benefits when secure drug access was provided to persons with chronic disease may be due to the complex interplay of health, social, psychological and economic factors that attend retirement from the workforce, or they may be due to insensitivity of the source data to subtle clinical effects.

The fact that poor health outcomes were observed in the entire study population gaining provincial drug benefit coverage, and were not restricted to those whose low-income status might impair access prior to coverage, suggests that these adverse outcomes are unlikely to result from increased drug access. Other studies have examined the health effects of retirement, which for many individuals coincides with turning 65. While retirement from paid employment has anecdotally been associated with deterioration in health status, evidence from studies designed to address this question does not consistently support the notion (Kremer 1985; Ekerdt and Bosse 1982; Ekerdt et al. 1983; Midanik et al. 1995; Mein et al. 2003). A recent report using prospectively collected longitudinal data from the Whitehall study of civil servants suggests that retirement is associated with an improvement in mental health, particularly for those in the highest job class, and no change in physical health functioning (Mein et al. 2003). Similarly, a study of members of the Kaiser health maintenance organization suggested that retirement was associated with decreased stress levels, reduced reporting of alcohol problems among women and more participation in regular exercise (Midanik et al. 1995). None of these studies examined the impact of retirement on cohorts of persons with chronic diseases, nor did they examine the effects of socioeconomic status and drug benefit coverage changes at retirement.

Limitations of our source data may have biased the observed findings. In particular, we used age 65 years as a surrogate for retirement and used residents of neighbourhoods in the two lowest-income quintiles yet not on social assistance as a surrogate for persons lacking adequate private insurance prior to retirement. Both assumptions may have led to substantial misclassification. Persons with chronic diseases at an advanced stage, where missed medication may precipitate hospitalization, may have retired early and qualified for benefits prior to age 65 years. Even in cases where persons have retired at age 65 years, they may not seek out drug benefits under the ODB Program immediately on qualifying, and this may lead to discontinuity in drug coverage. As with other observational studies using healthcare administrative data, there are difficulties in measuring co-morbidities that might confound outcome assessments. However, since the comparison cohorts in this study were defined on the basis of age rather than disease status or treatment, systematic differences in co-morbidity are less likely.

More importantly, we lacked a sensitive indicator for persons without private drug insurance at age 64 years. While such individuals may be more likely to live in lower-income neighbourhoods, they may still be a minority of the population and the health benefits to them, if any, may not be detected when they are analyzed as part of a larger

population. This dilution of benefit is problematic in the research context; however, it also represents the reality of policy initiatives applied at the population level. If the group likely to benefit from an initiative is small but the program is applied to the entire population, then the health gains in those at risk must be substantial in order to be detected as a measured benefit in the whole population.

The present findings suggest that access to drug benefit coverage at age 65 years for persons with selected chronic diseases is not associated with a reduction in hospitalizations for those conditions. These observations should not be interpreted as showing that public drug benefit coverage provides no benefit to patients. Further study is required to elucidate the impact of retirement on health status among retirees from a broad range of socioeconomic backgrounds and the influence of insurance coverage on those changes. The current study also serves as a cautionary note regarding the challenges of using administrative data to evaluate the health impact of policy interventions. The use of linked data sources and thoughtful study design can mitigate a number of confounding influences in such studies but can never eliminate them.

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#### REFERENCES

- Adams, A.S., S.B. Soumerai and D. Ross-Degnan. 2001. "Use of Antihypertensive Drugs by Medicare Enrollees: Does Type of Drug Coverage Matter?" *Health Affairs (Millwood)* 20(1): 276–286.
- Blustein, J. 2000. "Drug Coverages and Drug Purchases by Medicare Beneficiaries with Hypertension." *Health Affairs (Millwood)* 19(2): 219–230.
- Canadian Institute for Health Information. 2004 (March 31). "ICD-9/CCP and ICD-9-CM." Retrieved December 8, 2005. <[http://secure.cihi.ca/cihiweb/dispPage.jsp?cw\\_page=codingclass\\_icd9cm\\_e](http://secure.cihi.ca/cihiweb/dispPage.jsp?cw_page=codingclass_icd9cm_e)>.
- Demissie, K., J.A. Hanley, D. Menzies, L. Joseph and P. Ernst. 2000. "Agreement in Measuring Socio-Economic Status: Area-Based versus Individual Measures." *Chronic Diseases in Canada* 21: 1–7.
- Digitalis Investigation Group. 1997. "The Effect of Digoxin on Mortality and Morbidity in Patients with Heart Failure." *New England Journal of Medicine* 336(8): 525–533.
- Ekerdt, D.J., L. Baden, R. Bosse and E. Dibbs. 1983. "The Effect of Retirement on Physical Health." *American Journal of Public Health* 73(7): 779–783.

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- Ekerdt, D.J. and R. Bosse. 1982. "Change in Self-Reported Health with Retirement." *International Journal of Aging and Human Development* 15(3): 313–223.
- Federman, A.D., A.S. Adams, D. Ross-Degnan, S.B. Soumerai and J.Z. Ayanian. 2001. "Supplemental Insurance and Use of Effective Cardiovascular Drugs among Elderly Medicare Beneficiaries with Coronary Heart Disease." *Journal of the American Medical Association* 286(14): 1732–1739.
- Fortess, E.E., S.B. Soumerai, T.J. McLaughlin and D. Ross-Degnan. 2001. "Utilization of Essential Medications by Vulnerable Older People after a Drug Benefit Cap: Importance of Mental Disorders, Chronic Pain, and Practice Setting." *Journal of the American Geriatric Society* 49(6): 793–797.
- Garg, R. and S. Yusuf. 1995. "Overview of Randomized Trials of Angiotensin-Converting Enzyme Inhibitors on Mortality and Morbidity in Patients with Heart Failure." *Journal of the American Medical Association* 273(18): 1450–1456.
- Gianfrancesco, F.D., A.P. Baines and D. Richards. 1994. "Utilization Effects of Prescription Drug Benefits in an Aging Population." *Health Care Financing Review* 15(3): 113.
- Goldman, D.P., G.F. Joyce, J.J. Escarce, J.E. Pace, M.D. Solomon, M. Laouri, P.B. Landsman and S.M. Teutsch. 2004. "Pharmacy Benefits and Use of Drugs by the Chronically Ill." *Journal of the American Medical Association* 291(19): 2344–2350.
- Grootendorst, P.V., B.J. O'Brien and G.M. Anderson. 1997. "On Becoming 65 in Ontario. Effects of Drug Plan Eligibility on Use of Prescription Medicines." *Medical Care* 35(4): 387–398.
- Harris, J.S. and W.S. Custer. 1991. "Health Care Economic Factors and the Effects of Benefits Plan Design Changes." *Journal of Occupational Medicine* 33(3): 279–286.
- Harten, C., and P. Ballantyne. 2004. "The Impact of Cost-Sharing within Canadian Provincial Drug Benefit Programs: A Review." *Journal of Pharmaceutical Finance, Economics and Policy* 13(1): 35–53.
- Heisler, M., K.M. Langa, E.L. Eby, A.M. Fendrick, M.U. Kabeto and J.D. Piette. 2004. "The Health Effects of Restricting Prescription Medication Use Because of Cost." *Medical Care* 42(7): 626–634.
- Hux, J.E., F. Ivis, V. Flintoft and A. Bica. 2002. "Diabetes in Ontario: Determination of Prevalence and Incidence Using a Validated Administrative Data Algorithm." *Diabetes Care* 25(3): 512–516.
- Jackson, J.E., M.P. Doescher, B.G. Saver and P. Fishman. 2004. "Prescription Drug Coverage, Health, and Medication Acquisition among Seniors with One or More Chronic Conditions." *Medical Care* 42(11): 1056–1065.
- Kozyrskyj, A., C. Mustard and F. Simons. 2001. "Socioeconomic Status, Drug Insurance Benefits, and New Prescriptions for Inhaled Corticosteroids in Schoolchildren with Asthma." *Archives of Pediatrics and Adolescent Medicine* 155(11): 1219–1224.
- Kremer, Y. 1985. "The Association between Health and Retirement: Self-Health Assessment of Israeli Retirees." *Social Science and Medicine* 20(1): 61–66.
- Lee, D.S., L. Donovan, P.C. Austin, Y. Gong, P.P. Liu, J.L. Rouleau and J.V. Tu. 2005. "Comparison of Coding of Heart Failure and Comorbidities in Administrative and Clinical Data for Use in Outcomes Research." *Medical Care* 43(2): 182–188.

- Levy, A.R., B.J. O'Brien, C. Sellors, P. Grootendorst and D. Willison. 2003. "Coding Accuracy of Administrative Drug Claims in the Ontario Drug Benefit Database." *Canadian Journal of Clinical Pharmacology* 10(2): 67–71.
- Lilliard, L., J. Rogowski and R. Kington. 1999. "Insurance Coverage for Prescription Drugs: Effects on Use and Expenditures in the Medicare Population." *Medical Care* 37(9): 926–936.
- Luzier, A.B., A. Forrest, M. Adelman, F.I. Hawari, J.J. Schentag and J.L. Izzo, Jr. 1998. "Impact of Angiotensin-Converting Enzyme Inhibitor Underdosing on Rehospitalization Rates in Congestive Heart Failure." *American Journal of Cardiology* 82(4): 465–469.
- Martin, B. and J. McMillan. 1996. "The Impact of Implementing a More Restrictive Prescription Limit on Medicaid Recipients: Effects on Cost, Therapy, and Out-of-Pocket Expenditures." *Medical Care* 34(7): 686–701.
- Mein, G., P. Martikainen, H. Hemingway, S. Stansfeld and M. Marmot. 2003. "Is Retirement Good or Bad for Mental and Physical Health Functioning? Whitehall II Longitudinal Study of Civil Servants." *Journal of Epidemiology and Community Health* 57(1): 46–49.
- Midanik, L.T., K. Soghikian, L.J. Ransom and I.S. Tekawa. 1995. "The Effect of Retirement on Mental Health and Health Behaviors: The Kaiser Permanente Retirement Study." *Journals of Gerontology, Series B: Psychological Sciences and Social Sciences* 50(1): S59–S61.
- Pitt, B., F. Zannad, W.J. Remme, R. Cody, A. Castaigne, A. Perez, J. Palensky and J. Wittes. 1999. "The Effect of Spironolactone on Morbidity and Mortality in Patients with Severe Heart Failure." *New England Journal of Medicine* 341(10): 709–717.
- Reeder, C.E. and A.A. Nelson. 1985. "The Differential Impact of Copayment on Drug Use in a Medicaid Population." *Inquiry* 22(4): 396–403.
- Roos, N.P. and C.A. Mustard. 1997. "Variation in Health and Health Care Use by Socioeconomic Status in Winnipeg, Canada: Does the System Work Well? Yes and No." *Milbank Quarterly* 75(1): 89–111.
- Shulman, N., B. Martinez, D. Brogan, A. Carr and C. Miles. 1986. "Financial Cost As an Obstacle to Hypertension Therapy." *American Journal of Public Health* 76(9): 1105–1108.
- Soumerai, S.B., J. Avorn, D. Ross-Degnan and S. Gortmaker. 1987. "Payment Restrictions for Prescription Drugs under Medicaid. Effects on Therapy, Cost, and Equity." *New England Journal of Medicine* 317(9): 550–556.
- Soumerai, S.B., T.J. McLaughlin, D. Ross-Degnan, C.S. Casteris and P. Bollini. 1995. "Effects of Limiting Medicaid Drug-Reimbursement Benefits on the Use of Psychotropic Agents and Acute Mental Health Services by Patients with Schizophrenia." *New England Journal of Medicine* 331(10): 650–655.
- Soumerai, S.B. and D. Ross-Degnan. 1990. "Experience of State Drug Benefit Programs." *Health Affairs (Millwood)* 9(3): 36–54.
- Wilchesky, M., R.M. Tambllyn and A. Huang. 2004. "A Validation of Diagnostic Codes within Medical Services Claims." *Journal of Clinical Epidemiology* 57(2): 131–141.