Reviews and Meta-Analysis

Care of acute conditions and chronic diseases in Canada and the United States: Rapid systematic review and meta-analysis

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Significance for public health

This study estimated that socioeconomically vulnerable Canadians' chances of receiving better health care were 36% greater than their American counterparts and this estimate was larger than that based on general patient comparisons (9%). One may wonder about the public health significance of such relative risks/protections. Attributions of risk/protection among populations are a function of three factors of which relative risk is only one. The size of the population and the prevalence of exposure to risks are also important. In this instance, the entire USA population is at relatively greater risk of receiving lower quality care, its more prevalent low-income and inadequately insured populations more so. Applying our findings to population parameters and attributable risk formulations we estimated that without reform, over the next generation more than 50 million Americans will be treated less optimally and die earlier than had they enjoyed a single-payer health care system like Canada's.

Abstract

This study tested the hypothesis that socioeconomically vulnerable Canadians with diverse acute conditions or chronic diseases have health care access and survival advantages over their counterparts in the USA. A rapid systematic review retrieved 25 studies (34 independent cohorts) published between 2003 and 2018. They were synthesized with a streamlined meta-analysis. Very low-income Canadian patients were consistently and highly advantaged in terms of health care access and survival compared with their counterparts in the USA who lived in poverty and/or were uninsured or underinsured. In aggregate and controlling for specific conditions or diseases and typically 4 to 9 comorbid factors or biomarkers, Canadians' chances of receiving better health care were estimated to be 36% greater than their American counterparts (RR=1.36, 95% CI 1.35-1.37). This estimate was significantly larger than that based on general patient or non-vulnerable population comparisons (RR=1.09, 95% CI 1.08-1.10). Contrary to prevalent political rhetoric, three studies observed that Americans experience more than twice the risk of long waits for breast or colon cancer care or of dying while they wait for an organ transplant (RR=2.36, 95% CI 2.09-2.66). These findings were replicated across externally valid national studies and more internally valid, metropolitan or provincial/state comparisons. Socioeconomically vulnerable Canadians are consistently and highly advantaged on health care access and outcomes compared to their American counterparts. Less vulnerable comparisons found more modest Canadian advantages. The Affordable Care Act ought to be fully supported including the expansion of Medicaid across all states. Canada's single payer system ought to be maintained and strengthened, but not through privatization.

Introduction

Canadians and Americans rate health care a top concern. They seem naturally to wonder if health care policies are greener on the other side of their unfenced 5,000-kilometer border. Some Americans − particularly concerned with health care inaccessibility among the uninsured − have called for a more Canada-like single payer system. In contrast, some Canadians − concerned with health care shortages − have called for a more American-like system with more private options. Aiming to contribute critical evidence to these debates, our research group has focused on the health care of people living in poverty. We assume that this magnifies human and policy significance.

Canada-USA comparative studies of health care among overall populations can be misleading. For example, the first study to compare Canada and the USA on cancer survival − a 1994 USA General Accounting Office study − observed no practically significant between-country differences.[1] Not accounting for socioeconomic factors, its null findings were not surprising as gross comparisons of diverse national haystacks will necessarily lose important needles of knowledge. Consider the great diversity of people and places in Canada and the USA: women and men, the uninsured to the well-insured, recently emigrated ethnic minority people of color to European white people who landed generations ago, residents of megalopolises to remote places, high poverty to affluent neighborhoods and so on. Any study of diverse national populations that merely reports an average effect will miss knowledge about the unique experiences of important subpopulations. Alternatively, our research group's study of cancer survival among the poor in Toronto, Ontario and Detroit, Michigan during the same era found substantially higher survival rates among Canadians.[2] Though geographically limited, it suggested that this field's scholars and policy makers ought to include socioeconomic factors in their designs and decisions.

Joint Canada/USA surveys have consistently demonstrated greater income-related health, health care and mortality disparities in the USA.[3-5] Similar surveys of the poor in each country found them to be healthier and with greater health care access in Canada.[6,7] With unanimity, these studies advanced universal, single payer health insurance coverage as a key explanation for Canadian advantages. Notwithstanding cross-sectional limitations, they essentially developed a health insurance hypothesis that others have tested with more rigorous, longitudinal methods over a generation. The findings of 64 such Canada-USA longitudinal comparative outcome studies published between 1965 and 2000 were synthesized between 1999 and 2009 in two systematic reviews of diverse health outcomes and a meta-analysis of breast cancer survival.[8-10]

Previous research syntheses

This field's first systematic review of 18 studies of health care among patients with diverse acute conditions or chronic diseases found *few differences between both countries on relevant outcomes such as mortality*.[8] As none of the primary studies accounted for socioeconomic factors, neither could the review. More fundamentally though, many studies of that era could not even account for between-country differences on disease severity. For example, at that time no Canadian cancer registry yet included disease stage at diagnosis. Hence, Canada-USA cancer care comparisons could not account for such basic case-mix differences. However, this early review made an extraordinarily valuable heuristic contribution. It clarified the fact that this field's extant research was not yet rigorous enough to inspire confident judgements about the relative effectiveness of Canadian versus American health care. It also highlighted future research that would be needed to make confident decisions.

Nearly a decade later, a greater number of similarly limited studies of diverse Canadian and American patients were systematically reviewed.[9] Fourteen studies observed Canadian advantages, 5 observed USA advantages and 19 were null. Overall, the risk of mortality was estimated to be 5% lower among Canadians. Such inconsistent and modest between-country differences could as plausibly be due to unaddressed confounding or effect modifications as to true health care differences. This review team also found that the one disease for which results consistently favored Canadians was end-stage renal disease. The high costs and resource utilization associated with this chronic condition are much better managed in Canada's predominantly not-for-profit system. This is another element of patient case-mix − chronic diseases versus acute conditions − to consider in future syntheses.

The third research synthesis, a meta-analysis of 8 breast cancer survival studies, one of which was stage-adjusted, did incorporate socioeconomic factors.[10] Among low-income women, it estimated a Canadian survival advantage of 14% (sample-adjusted rate ratio [RR]=1.14, 95% CI 1.13-1.15) that was even larger among younger women who were not yet Medicare eligible in the USA (RR=1.21, 95% CI 1.17-1.25). No between-country survival difference was observed among its aggregated middle- and high-income groups. However, its ecologically-defined low-income neighborhoods were typically places where only 10% to 15% of the residents were poor. None studied sociologically well-known *high poverty neighborhoods* where 30% to 40% or more of the people were poor.[11,12] This research synthesis recommended future primary studies in such vulnerable places and accounting for other aspects of place such as residence in large urban, small urban or rural places as they represent very different health care endowments in both countries.

This review aims to systematically update this field's knowledge, incorporating as many of the previous reviewers' suggestions as its primary studies allow. We posed three questions:

(1) Compared to Americans, are Canadians advantaged on health care access and outcomes?
(2) Are Canadian advantages larger among socioeconomically vulnerable people?
(3) Are Canadian advantages larger among people with chronic diseases than acute conditions?

Materials and Methods

Traditional interdisciplinary methodological frameworks were used to guide the process and presentation of this systematic review.[13-15] Methodological guidance of teams of researchers and knowledge users on both sides of the Canada-USA border allowed us to gain efficiencies and compress the review time period.[16,17] The rapid systematic review included a classical, but also streamlined meta-analysis to gain specific knowledge about the relative effectiveness of health care in Canada and the USA, particularly among socioeconomically vulnerable subpopulations with specific acute conditions or chronic diseases.[18-20]

Selection of studies

This field's last systematic review searched until December 31, 2002. The following research or gray literature databases were searched between January 1, 2003 and January 1, 2019: PubMed, Medline, CINAHL Complete, ProQuest Nursing and Allied Health Database, EBM Reviews, HealthSTAR, Social Work Abstracts, Social Services Abstracts, ProQuest Sociology Collection, ProQuest Dissertations and Theses, Conference Proceedings Citation Indexes − Science and Social Sciences & Humanities, and Google Scholar. Detailed keyword search schemes are summarized as follows: (Canada or any of 13 provinces or territories) and (United States or USA or any of 50 states) and (health care access or treatment or outcome or survival or for example, asthma or heart attack or MI or coronary heart disease or CHD or cancer or any of the most common acute conditions or chronic diseases). Any observational study of any physical health condition or disease with an indicated treatment or well-defined outcome was included.

In an effort to find studies specifically about socioeconomically vulnerable subpopulations, the searches were then systematically replicated with addition of the following keyword set: (poverty or income or socioeconomic factors or health insurance or uninsured). Study exclusion criteria were: (1) published in 2003, but included in the previous review, (2) opinion surveys of patients or practitioners, (3) randomized controlled trials as they may not reflect typical patients or typical care, (4) national mortality studies that confound disease incidence and survival or (5) studies of mental health. For scholarly and policy reasons we think that mental health care warrants a separate research review; one we are presently scoping.[21,22] Searches were augmented with bibliographic reviews of retrieved studies. Searches of their authors were also performed. Three reviewers, one an experienced academic librarian, independently searched for eligible studies. When two reviewers suggested eligibility based on study titles and abstracts, it was included. If in the review of full study manuscripts any research team member suspected ineligibility, a consensus decision was reached after discussion. Twenty-five studies were so selected.[23-47]

Meta-analysis

The unit of analysis for this meta-analysis was the unique hypothesis test. Between-country comparisons were observed for treatment access or outcomes among overall samples or socioeconomically vulnerable subsamples. These were treated as independent hypotheses. Each study could contribute only once to each hypothesis test. If a primary study provided three outcomes all related to the same hypothesis, for example, 1, 3 and 5-year survival among colon cancer patients living in poverty, the three estimated survival rate ratios would be pooled so that that study would contribute one data point for that meta-analytic hypothesis test. A total of 34 such independent study findings were included in this meta-analysis.

Treatment or survival rate ratios, odds ratios, hazard ratios or similar measures of effect estimated primary study relative risks

(RR). Natural logarithms of study RRs were weighted by their inverse variances, computed from standard errors ($1/SE^2$) so that larger, more precise studies carried more weight. Standard errors were estimated from study statistics, generally from reported 95% CIs. Such precision-weighted effects were then pooled within domains of interest using weighted regression models. Pooled RRs within 95% CIs were calculated from regression statistics, as were tests of heterogeneity (χ^2) and meta-analytic between-groups comparisons (z). All statistical significance decisions were made at the α criterion of 0.05. For ease of interpretation, all RRs greater than 1.00 indicated a Canadian advantage, while those less than 1.00 indicated an American advantage. Study hypotheses were so tested: (1) Compared to Americans, Canadians are advantaged on health care access and outcomes (primarily survival). (2) Canadian advantages are larger among socioeconomically vulnerable people. (3) Canadian advantages are larger among people with chronic diseases than acute conditions. Meta-analytic hypotheses were independently tested and cross-validated by two analysts.

As expected, given the sociodemographic, geographic, clinical and methodological variability, the 34 independent primary study outcomes demonstrated substantial heterogeneity (χ^2 [33] = 26,565.00, P<0.05) around a hypothetically supportive precision-adjusted pooled Canadian advantage of 13% (RR=1.13, 95% CI 1.12-1.14). Our central hypothesized moderators of socioeconomic factors and disease chronicity aim to explain such variability. In fact, we expected and found substantial effect homogeneity within specific groups of interest after accounting for disease and socioeconomic status. For example, focusing on guideline-based treatment access among women living in poverty with breast cancer, the 3 relevant study outcomes demonstrated essentially no heterogeneity (χ^2 [2] = 0.01, P=0.99) around a precision-adjusted pooled Canadian advantage of 75% (RR=1.75, 95% CI 1.64-1.87).[45-47] Therefore, the potential moderating effects of study characteristics were explored with fixed-effects meta-regressions. In addition to hypothetically noted characteristics, this streamlined meta-analysis explored the following patient, contextual and research design characteristics: age, gender, ethnicity, health insurance status, large/small urban/rural places, historical/prospective cohort, cohort timeframe, study sample sizes, geographic sampling frames (national/provincial-state/metropolitan), clinic or population-based, primary/administrative data, number of analytic comorbid factors or biomarkers, and follow-up rates. Study characteristics were abstracted independently from full primary study manuscripts by two reviewers. After discussion and resolution of discrepancies their agreement was 100%.

Results

Sample description

Descriptive details of the 19 overall population and 15 socioeconomic subpopulation study outcomes are respectively presented in Tables 1-3. Socioeconomically vulnerable subpopulations included those who lived in poverty in Canada and the USA and/or were uninsured or inadequately insured in the USA. All unique study hypotheses, based on unique subsamples, treatments or outcomes, are displayed along with their within-study pooled RRs. Descriptive summaries of participant and study characteristics are displayed in Table 4. Half of the study outcomes were of cancer, most prevalently breast or colon cancer. This is perhaps not surprising given the comprehensiveness and validity of contemporary cancer registration in both countries. Representing a distinct advancement over such previously reviewed studies, nearly all of the cancer analyses were minimally case-mix adjusted for age and stage of disease at diagnosis. Otherwise, the diverse acute conditions or chronic diseases displayed in the top of Table 4 seem a fair representation of interesting and important health care indicators studied over the life course from infancy to older adulthood. Twenty-four outcomes combined effects for women and men, treating gender as a covariate. Ten outcomes were of women only, while there were no exclusively male outcomes. Seven studies accounted for race/ethnicity, but again, only as a covariate. No specific racialized/ethnic group outcomes were reported.

A quarter of the study outcomes were nationally representative. Another 60% or so were representative of single or multiple provinces and states. The remainder were single metropolitan area investigations. Research designs were predominantly historical cohorts (82%) initiated in the 1990s (65%). Aggregated study samples ranged from 62 to 120,117, the median being 2,306 participants. About two-thirds of the study outcomes were based on quite powerful samples of 1,000 to 25,000 or more, emphasizing external validity. Another third of the outcomes were based on smaller and better controlled investigations, emphasizing internal validity. Consistent with the prevalent use of well-supported and validated administrative data, most of the analyses lost less than 1% of their original participants to follow-up. Three outcomes of one study reported differential losses (2.5% in Canada *vs* 5.5% in the USA),[34] but such only made these comparisons conservative. As mentioned, all the primary analyses accounted for at least two covariates. Typically, they accounted for 4 to 9 such comorbid factors or biomarkers. Finally, 10 measures of treatment access and 24 treatment outcome measures, typically survival, were represented. In fact, we think that most, if not all, of the *mortality* outcomes were actually measures of survival. As the studies typically followed a well-defined diagnostic group in a similar manner, survival is probably not confounded by condition or disease incidence. The primary studies included in this review seem more rigorous than previously reviewed studies as a larger portion of the studies used well-controlled cohort designs.

Meta-analytic findings

In support of the first hypothesis, 25 study observations indicated Canadian health care advantages, 3 observed USA advantages and 6 were null. The chances of receiving health care in a timely manner and surviving were estimated to be 13% greater among Canadians (RR=1.13, 95% CI 1.12-1.14) than Americans. Meta-analytic findings related to hypotheses two and three are displayed in Table 5. In support of hypothesis two, all 15 observations of socioeconomically vulnerable people indicated Canadian advantages, though 1 only approached statistical significance. Their chances of receiving better health care were estimated to be 36% greater than their American counterparts (RR=1.36, 95% CI 1.35-1.37). This Canadian advantage was significantly and substantially larger than that estimated with 19 overall samples of patients; z=48.47, P<0.05: 10 observed Canadian advantages, 3 USA advantages and 6 were null (RR=1.09, 95% CI 1.08-1.10). Furthermore, statistically and practically larger Canadian advantages were replicated among socioeconomically vulnerable patients with acute conditions (RR=1.14 *vs* RR=1.03) and chronic diseases (RR=1.37 *vs* RR=1.12). Because one of us (KMG) produced 12 of the 15 socioeconomically vulnerable population comparisons we performed a sensitivity analysis. The pooled effect of KMG's research group (RR=1.35, 95% CI 1.34-1.36) did not differ significantly from that of three other research groups (RR=1.38, 95% CI 1.35-1.41), z=0.19, P=0.85. Hypothesis three was also consistently supported. Within overall Canada-USA comparisons

Table 1. Description and outcomes of studies included in the rapid review and meta-analysis: Overall Canada and USA comparisons (acute conditions).

Reference	Clinical population, ages Places Cohort years Other characteristics	Research design Selection Analytic samples Covariate adjustments[a]	Outcome Canada vs USA adjusted rates Risk ratio[b] 95% confidence interval
Acute decompensated heart failure			
Lai *et al*. 2016	ADHF in ED, 18 or older Ottawa, ON & Rochester, MN 2010 1 & 1 ED	Historical cohort Population, health records 156 & 165 Age, gender, 5 comorbidities & 3 biomarkers	30-day mortality 5.1% *vs* 9.7% OR = 1.99 95% CI: 0.83, 4.78
Acute myocardial infarction			
Ko *et al.* 2007	Hospitalized with AMI, 65 or older Ontario & USA 1998 to 2001 All Medicare covered	Historical cohort Random, administrative data 5,634 & 38,886 Age, gender, 7 comorbidities & 7 biomarkers	30-day risk-standardized mortality 16.6% *vs* 17.3% SMR = 1.05 95% CI: 0.99, 1.11[c]
Ko *et al*. 2007	//	//	1-year risk-standardized mortality 27.7% *vs* 31.9% SMR = 1.15 95% CI: 1.06, 1.25
Ko *et al*. 2007	//	//	3-year risk-standardized mortality 40.3% *vs* 45.9% SMR = 1.14 95% CI: 1.05, 1.23 [SMRpooled = 1.08, 95% CI: 1.06, 1.10]
Appendicitis			
Cheong & Emil 2014	Pediatric appendectomy, less than 18 Canada (not Quebec) & USA 2004 to 2010 All insurers	Historical cohort Population, administrative data 41,492 & 78,625 Age & gender	Perforated appendicitis 27.3% *vs* 26.7% RR = 0.98 95% CI: 0.96, 1.00
Asthma			
Rowe *et al*. 2007	Acute asthma in ED, ages 2 to 54 Canada & USA 1996 to 1998 8 & 69 EDs, 4 provinces & 22 states	Prospective cohort Population, primary data 136 & 2,198 Age, gender, race, income & 4 biomarkers	2-week ED relapse nd OR = 0.63 95% CI: 0.30, 1.43
COPD			
Rowe *et al*. 2008	Exacerbated COPD in ED, M 70 Canada & USA 1999 to 2001 5 & 24 EDs, 3 provinces & 15 states	Prospective cohort Population, primary data 58 & 291 Age, gender, race, income, BMI 4 comorbidities & 6 biomarkers	2-week ED relapse nd RR = 0.30 95% CI: 0.01, 6.09
Cataract surgery			
Norregaard *et al*. 2003	Unilateral cataract surgery, 50 or older Manitoba & USA 1993 to 1994 12 & 75 ophthalmology practices	Prospective cohort Consecutive, primary data 111 & 570 Age, gender, general health status 1 comorbidity & 3 biomarkers	4-month visual functioning nd OR = 1.00 95% CI: 0.96, 1.26
Gastroschisis			
Youssef *et al*. 2003	Simple gastroschisis, newborns Canada & USA 2003 to 2013 16 & 345 NICUs	Prospective cohort Population, registry & administrative 584 & 4,502 Age, gender 3 comorbidities & 3 biomarkers	Inpatient mortality 1.4% *vs* 3.4% RR = 2.43 95% CI: 1.27, 4.65
Youssef *et al*. 2003	Complex gastroschisis	111 & 714	10.8% *vs* 9.3% RR = 0.86 95% CI: 0.51, 1.46 [RR_{pooled} = 1.34, 95% CI: 1.12, 1.60]

ADHF, acute decompensated heart failure; AMI, acute myocardial infarction; BMI, body mass index; CT, census tract; CABG, coronary artery bypass graft; COPD, congestive obstructive pulmonary disease; ED, emergency department; ESRD, end-stage renal disease; HR, hazard ratio; IMR, infant mortality ratio; M, mean; Mdn, median; MMR, maternal mortality ratio; nd, no data; NICU, neonatal intensive care unit; OR, odds ratio; PM, person months; PY, person years; RR, rate ratio; SEER, Surveillance, Epidemiology and End Results program; SES, socioeconomic status; SMR, standardized mortality ratio. [a]Potential confounds that were accounted for by sample restriction, matching or mathematical/regression modeling. [b]Risk ratios were adjusted in regressions or directly standardized. Risk ratios greater than 1.00 indicate a Canadian advantage while those less than 1.00 indicate a USA advantage. [c]P = 0.10. [d]Unadjusted rates.

Table 2. Description and outcomes of studies included in the rapid review and meta-analysis: Overall Canada and USA comparisons (chronic disease).

Reference	Clinical population, ages Places Cohort years Other characteristics	Research design Selection Analytic samples Covariate adjustments[a]	Outcome Canada vs USA adjusted rates Risk ratio[b] 95% confidence interval
Cancer			
Bremner *et al.*2015	Advanced lung cancer, 65 or older Ontario & USA (SEER) 2001 to 2005 All Medicare covered	Historical cohort Population, registry-based 8,643 & 16,858 Age, stage & health insurance	Received home health care 57.5% *vs* 20.1% RR = 2.86 95% CI: 2.77, 2.95
Gorey *et al.* 2011	Colon cancer, 25 or older Toronto, ON & San Francisco, CA 1996 to 2006 All income groups	Historical cohort Random, registry-based 930 & 1,014 Age, stage & gender	5-year survival nd OR = 0.94 95% CI: 0.68, 1.29
Gupta *et al.* 2009	Upper aerodigestive tract cancer, M 64 & 62 Ontario & USA (SEER) 1999 to 2006 Most recent of 6 cohorts	Historical cohort Population, registry-based 3,262 & 8,399 Age, gender & mortality causes	5-year relative survival 57.1% *vs* 52.4% RR = 1.09 95% CI: 1.05, 1.13
Warren *et al.* 2011	Non-small cell lung cancer, 65 or older Ontario & USA (SEER) Last 5 months of life	Historical cohort Population, registry-based Age, sex, income & urbanity	Received palliative chemotherapy 20.6 *vs* 10.9 patients per 100 PM 95% CI: 0.36, 0.78 RR = 0.53
Cystic fibrosis			
Stephenson *et al.* 2017	Cystic fibrosis, all ages Canada & USA 2009 to 2013 All insurers	Historical cohort Population, registry-based 4,662 & 32,699 Age, gender, race, BMI, 3 comorbidities & 5 biomarkers	Survival 50.9 & 40.6 median survival age HR = 1.52 95% CI: 1.23, 1.85
Stephenson *et al.* 2017	//	//	Received lung transplant 10.3% & 6.5% RR = 1.58 95% CI: 1.44, 1.74 RR = 0.53
End-stage renal disease			
Hladunewich *et al.* 2014	Hemodialysis, M 27 & 34 Toronto, ON & USA 2000 to 2013 & 1990 to 2011 Pregnant women with ESRD	Prospective & historical cohorts Population, registry-based 19 & 43 Age, ESRD cause National MMR & IMR	Live birth rate 84.4% & 61.4%[d] HR = 1.37 95% CI: 1.04, 1.80
Kim *et al.* 2006	Kidney transplant recipients, 18 or older Canada & USA 1991 to 1998 End-stage renal diseas	Historical cohort Population, registry-based 5,773 & 70,708 Age, gender, race, ESRD cause, Time on dialysis, year of transplant	Post-transplant mortality 29.8 & 40.9 deaths per 1,000 PY[d] HR = 1.35 95% CI: 1.24, 1.47
Quinn *et al.* 2010	Peritoneal dialysis, M 54 & 53 Canada & USA 1990 to 1993 Kidney failure, 10 & 4 centers	Prospective cohort Consecutive, primary data 578 & 102 Age, gender, 2 comorbidities 2 biomarkers & background mortality	Peritoneal dialysis mortality 98.5 & 157.9 deaths per 1,000 PY[d] HR = 1.93 95% CI: 1.13, 3.28
Heart disease			
Eisenberg *et al.* 2005	CABG surgery, 21 or older Canada & USA 1997 to 2000 4 & 5 hospitals	Historical cohort Consecutive, administrative data 7,319 & 4,698 Age, gender, previous CABG, elective or non- & 7 comorbid conditions	In-hospital mortality nd OR = 0.92 95% CI: 0.62, 1.35
Ko *et al.* 2005	Heart failure, hospitalized, 65 or older Ontario & USA 1998 to 2001 All Medicare covered	Historical cohort Population, administrative data 8,180 & 28,521 Age, gender, 5 comorbidities & 5 biomarkers	30-day mortality 10.7% & 8.9% SMR = 0.83 95% CI: 0.77, 0.89
Ko *et al.* 2005	//	//	1-year mortality 32.3% & 32.2% SMR = 1.00 95% CI: 0.96, 1.04 [SMR_{pooled} = 0.96, 95% CI: 0.95, 0.98]
Liver disease			
Stell *et al.* 2004	Liver transplant recipients, Mdn 52 & 50 Canada & USA 2000 First cadaveric transplant	Historical cohort Population, registry-based 308 & 3,364 Age, sex, 4 comorbidities & 4 biomarkers	1-year post-transplant survival 91.3% & 88.0% RR = 1.04 95% CI: 0.99, 1.09[c]
Stell *et al.* 2004	//	//	Wait-list mortality 3.1 *vs* 7.6 deaths per million population RR = 2.43 95% CI: 1.43, 4.14 [RR_{pooled} = 1.05, 95% CI: 1.03, 1.07]

ADHF, acute decompensated heart failure; AMI, acute myocardial infarction; BMI, body mass index; CT, census tract; CABG, coronary artery bypass graft; COPD, congestive obstructive pulmonary disease; ED, emergency department; ESRD, end-stage renal disease; HR, hazard ratio; IMR, infant mortality ratio; M, mean; Mdn, median; MMR, maternal mortality ratio; nd, no data; NICU, neonatal intensive care unit; OR, odds ratio; PM, person months; PY, person years; RR, rate ratio; SEER, Surveillance, Epidemiology and End Results program; SES, socioeconomic status; SMR, standardized mortality ratio. [a]Potential confounds that were accounted for by sample restriction, matching or mathematical/regression modeling. [b]Risk ratios were adjusted in regressions or directly standardized. Risk ratios greater than 1.00 indicate a Canadian advantage while those less than 1.00 indicate a USA advantage. [c]P = 0.10. [d]Unadjusted rates.

Table 3. Description and outcomes of studies included in the rapid review and meta-analysis: Comparisons of socioeconomically vulnerable people in Canada and the USA.

Reference	Clinical population, ages Places Cohort years Other characteristics	Research design Selection Analytic samples Covariate adjustments[a]	Outcome Canada vs USA adjusted rates Risk ratio[b] 95% confidence interval
Acute conditions: Appendicitis			
Cheong & Emil 2014	Pediatric appendectomy, less than 18 Canada (not Quebec) & USA 2004 to 2010 Uninsured in USA	Historical cohort Population, administrative data 41,492 & 12,344 Age & gender	Perforated appendicitis 27.3% *vs* 31.2% RR = 1.14 95% CI: 1.05, 1.23
Chronic diseases: Cancer			
Bremner *et al.* 2015	Advanced lung cancer, 65 or older Ontario & USA (SEER) 2001 to 2005 Lowest Mdn income three-fifths	Historical cohort Population, registry-based 3,071 & 5,215 Age, stage & health insurance	180-day survival 66.0% *vs* 61.5% RR = 1.07 95% CI: 1.04, 1.10
Gorey *et al.* 2017	Breast cancer, 25 or older Ontario & California 1996 to 2014 Very high poverty neighborhoods[c]	Historical cohort Random, registry-based 315 & 2,100 Age, stage, grade, tumor size & hormone receptor status	Received optimum care[d] 38.1% *vs* 23.1% RR = 1.65 95% CI: 1.39, 1.96
Gorey *et al.* 2017	Publicly or uninsured in USA	315 & 974	38.1% *vs* 18.0% RR = 2.12 95% CI: 1.76, 2.56 [RRpooled = 1.87, 95% CI: 1.77, 1.98]
Gorey *et al.* 2015a	HR+ breast cancer, 25 or older Ontario & California 1996 to 2011 Very high poverty neighborhoods[c]	Historical cohort Random, registry-based 216 & 993 Age & hormone receptor status	Received hormone therapy 68.2% *vs* 41.2% RR = 1.65 95% CI: 1.44, 1.89
Gorey *et al.* 2015a	Node negative, low or Intermediate grade breast cancer	85 & 624 Age, stage, grade & tumor size	64.0% *vs* 44.5% Received optimum care[e] RR = 1.44 95% CI: 1.16, 1.79
Gorey *et al.* 2015a	Uninsured in USA	85 & 56	64.0% *vs* 33.8% RR = 1.89 95% CI: 1.31, 2.72 [RRpooled = 1.62, 95% CI: 1.54, 1.70]
Gorey *et al.* 2015b	Non-metastasized colon cancer, 25 or older Ontario & California 1996 to 2011 Very high poverty neighborhoods[c]	Historical cohort Random, registry-based 692 & 1,496 Age, gender & stage	10-year survival 38.2% *vs* 33.3% RR = 1.15 95% CI: 1.02, 1.30
Gorey *et al.* 2015b	All poverty groups Publicly or uninsured in USA	2,060 & 2,509	38.7% *vs* 32.8% RR = 1.18 95% CI: 1.09, 1.28 [RRpooled = 1.17, 95% CI: 1.13, 1.21]
Gorey *et al.* 2013	Colon cancer, women, 25 or older Ontario & California 1996 to 2011 Very high poverty neighborhoods[c]	Historical cohort Random, registry-based 289 & 975 Age, stage & grade	7-year survival 44.6% *vs* 38.4% RR = 1.16 95% CI: 1.00, 1.35
Gorey *et al.* 2013	Un- or Medicaid-insured in CA	289 & 173	44.6% *vs* 30.7% RR = 1.45 95% CI: 1.14, 1.85 [RRpooled = 1.23, 95% CI: 1.17, 1.29]
Gorey *et al.* 2013	Very high poverty neighborhoods[c]	78 & 241	Received adjuvant chemotherapy Stage III: 45.1% *vs* 43.6% RR = 1.03 95% CI: 0.83, 1.28
Gorey *et al.* 2013	Un- or Medicaid-insured in CA	78 & 54	45.1% *vs* 30.2% RR = 1.49 95% CI: 1.00, 2.25
Gorey *et al.* 2013	Very high poverty neighborhoods[c]	55 & 229	Waited 60 days or more for chemotherapy Stage II or III: 20.0% *vs* 37.7% RR = 1.89 95% CI: 1.14, 3.13
Gorey *et al.* 2013	Un- or Medicaid-insured in CA	55 & 57	20% *vs* 59.8% RR = 2.99 95% CI: 1.82, 5.00 [RRpooled = 1.35, 95% CI: 1.25, 1.45]

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(RR=1.12 *vs* RR=1.03) and within socioeconomically vulnerable populations (RR=1.37 *vs* RR=1.14), Canadian advantages were larger among people with chronic diseases. Finally, after accounting for socioeconomic factors and disease chronicity, no other primary study characteristic was significantly associated with Canada/USA RRs.

Discussion

This study found that Canadians with any number of acute health conditions or chronic diseases are significantly more advantaged on health care access and outcomes compared to their counterparts in the USA. It estimated that the chances of Canadians receiving indicated treatments and surviving were 13% greater than Americans. That estimate was more unequivocal and larger than previous review estimates that were based on less internally valid research designs. The most typical primary studies included in this review were historical cohorts that accounted for 4 to 9 covariates in analyzing the experiences of 1,000 to 25,000 patients, more than 99% of whom were available for assessment at follow-up. As with primary research however, such a meta-analytic main or average effect can be misleading. Therefore, we advanced and found much support for a meta-analytic country by socioeconomic status interaction. This clearly demonstrated that Canadian advantages were significantly larger among those living in poverty or those who were otherwise socioeconomically vulnerable such as the uninsured or inadequately insured.

Among patients who lived in high poverty neighborhoods, it was estimated that the chances of Canadians receiving indicated

Table 3. Continued from previous page.

Reference	Clinical population, ages Places Cohort years Other characteristics	Research design Selection Analytic samples Covariate adjustments[a]	Outcome Canada vs USA adjusted rates Risk ratio[b] 95% confidence interval
Gorey *et al.* 2011	Colon cancer, 25 or older Toronto, ON & San Francisco, CA 1996 to 2006 Lowest income (%) third	Historical cohort Random, registry-based 231 & 247 Age, stage & gender	5-year survival nd OR = 2.51 95% CI: 1.52, 4.15
Gorey *et al.* 2011	1996 to 2002 Lowest income (%) two-thirds	291 & 273	Received adjuvant chemotherapy Stage II or III: 57.3% *vs* 34.3% RR = 1.67 95% CI: 1.06, 2.64
Gorey *et al.* 2010a	Node negative breast cancer, 25 or older Ontario & California 1988 to 2006 Lowest income (%) tenth	Historical cohort Random, registry-based 36 & 41 Age, stage & tumor size	15-year survival 50.2% *vs* 30.2% RR = 1.66 95% CI: 1.00, 2.76
Gorey *et al.* 2010a	Lowest income (%) third	105 & 126	Received adjuvant radiation therapy 42.7% *vs* 24.4% RR = 1.75 95% CI: 1.21, 2.53
Gorey *et al.* 2010b	Breast cancer, 25 or older Ontario & California 1998 to 2006 High poverty neighborhoods[f]	Historical cohort Random, registry-based 50 & 50 Age, race & stage	5-year survival 80.3% *vs* 66.3% RR = 1.21 95% CI: 0.98, 1.50g
Gorey *et al.* 2010b	//	49 & 49	Received hormone therapy 55.1% *vs* 31.2% RR = 1.77 95% CI: 1.12, 2.79
Gorey *et al.* 2009	Node positive breast cancer, 25 or older Ontario & California 1998 to 2000 Lowest income (%) third	Historical cohort Random, registry-based 95 & 94 Age & stage	Received adjuvant radiation therapy 60.3% vs 36.0% RR = 1.68 95% CI: 1.12, 2.54
Gorey *et al.* 2009	Non-metastasized breast cancer Windsor, ON & Modesto, CA	110 & 163	Waited 60 days or more for treatment 4.7% vs 9.7% RR = 2.08 95% CI: 0.87, 5.00[g] [RRpooled = 1.75, 95% CI: 1.49, 2.05]
	Cystic Fibrosis		
Stephenson *et al.* 2017	Cystic fibrosis, all ages Canada & USA 2009 to 2013 Uninsured in USA	Historical cohort Population, registry-based 4,662 & 205 Age, gender, race, BMI 3 comorbidities & 5 biomarkers	Survival nd HR = 4.35 95% CI: 2.70, 7.14

BMI, body mass index; HR = hazard ratio; HR+, hormone receptor positive; Mdn, median; nd, no data; OR, odds ratio; RR, rate ratio; SEER, Surveillance, Epidemiology and End Results program; SES, socioeconomic status. All income measures were ecological, census tract (CT)-based. All of the Ontario-California comparisons by Gorey *et al.* also accounted for place by sample stratification (large urban places, small urban places or rural places) and for purchasing power differences (adjustments for Canadian-USA dollar and US Census Bureau poverty and Statistic Canada low-income definition differences). [a]Potential confounds that were accounted for by sample restriction, matching or mathematical/regression modeling. [b]Risk ratios were adjusted in regressions or directly standardized. Risk ratios > 1.00 indicate a Canadian advantage while those < 1.00 indicate a USA advantage. [c]30% or more of the household were poor in the USA compared to similarly low-income neighborhoods in Canada. [d]Diagnosed early with node negative disease and received breast conserving surgery followed by radiation therapy. [e]Received breast conserving surgery within two months of diagnosis and adjuvant radiation therapy with four months of surgery. [f]20% or more of the household were poor in the USA compared to similarly low-income neighborhoods in Canada. g P<0.10.

treatments and surviving were 36% greater than Americans. That estimate was essentially unequivocal across all the reviewed studies and was larger than a previous meta-analytic estimate based on less prevalently poor neighborhoods. Recalling that such a 36% differential is implicated across most common health conditions and diseases over the lives of millions of impoverished Canadians and Americans, its population-level significance is clear. In addition to accounting for socioeconomic factors most of these primary studies also accounted for key personal and contextual case-mix differences between Canada and the USA, notably disease severity and health care service endowments in diverse large to small urban or rural places. We consider the robustness of the observed Canadian advantage to be our review's most provocative scholarly and policy-significant finding. As with primary research, we think that the interpretation of significant interaction effects or important effect modifications ought to take precedence in synthetic research. Therefore, we think four more interpretive adjuncts are in order. First, larger Canadian advantages were replicated among socioeconomically vulnerable patients with acute conditions and chronic diseases, representing a multiplicative Canadian advantage among those living in poverty with chronic diseases. Such patients probably had multiple experiences with their respective health care system over several years. In other words, it seems that the longer patients were in contact with their respective Canadian or American health care systems, the larger were their respective advantages or disadvantages. Second, three studies included four assessments of wait-lists, estimating that the exemplary risks of experiencing relatively long waits for adjuvant cancer care or of dying while waiting for a liver transplant were much greater in the USA (RRs ranged from 1.89 to 2.99, precision-weighted RR=2.36, 95% CI 2.09-2.66) than in Canada.[40,44,47] This evidence stands in stark contrast to prevalent contemporary political rhetoric. Third, all this field's synthetic evidence strongly suggests a dose-response relationship between socioeconomic vulnerability and Canadian advantages. It seems, therefore, that Canada's single payer health care system causally provides much better health care than does the USA's multiple payer system that still leaves millions uninsured or inadequately insured. The Canadian health care system's most pronounced evidence-based advantages are clearly among those who live in poverty who consistently experience much better health care compared to impoverished Americans. In short, the more socioeconomically vulnerable a person is the more protective a single payer health care system is likely to be.

The fourth interpretive adjunct arose serendipitously in our systematic search for eligible studies. We retrieved 8 within-Canada studies of socioeconomic factors and cancer care.[48-55] Though ineligible for this review, these studies were very interesting. One observed a modest indirect low-income-care association. Five others observed similar trends, but were not statistically significant and two others were null. The pooled precision-weighted estimate was minuscule (RR=0.97, 95% CI 0.95-0.99). We identified more than 100 such within-USA studies nearly all of which observed the well-known, large American socioeconomic-care gradient. Six studies that were included in this review, but that also observed typically very low-income or poverty associations with cancer care in both Canada and the USA allowed for a controlled, precision-weighted synthetic comparison.[31,41,43,45-47] A large disadvantage of being poor was observed in the USA (RR=0.73, 95% CI 0.71-0.75) while no such association was observed in Canada (RR=0.99, 95% CI 0.96-1.02), z=14.44, P<0.05. Such within-country observations clarify the between-country comparisons. Given the intimate relationship between low socioeconomic status and health insurance inadequacy in the USA,[56-58] but not in Canada, the pattern resolutely identifies inadequate health insurance coverage in the USA as the primary explanation for this study's findings. It clearly indicts the USA for the largely inadequate health insurance coverage it provides its underclass,[11] including those who live in poverty or near poverty as well as the

Table 4. Participant and study characteristics: 34 study outcomes included in the meta-analysis.

	N.	%
Acute conditions or chronic diseases studied		
Acute heart failure/myocardial infarction	2	5.9
Appendicitis	2	5.9
Asthma	1	2.9
COPD (urgent care)	1	2.9
Cataract surgery	1	2.9
Gastroschisis (NICU care)	1	2.9
Cancer[a]	17	50.0
Kidney failure/ESRD	3	8.8
Cystic fibrosis	3	8.8
Heart failure/heart disease	2	5.9
Liver disease	1	2.9
Participant ages		
Adults 18 to 25 or older	21	61.8
Older adults 50 to 65 or older	6	17.6
All people (children and adults)	4	11.8
Children less than 18 years of age	2	5.9
Infants	1	2.9
Sampling frame: Canada vs USA		
Single province vs single state[b]	10	29.4
Nation vs nation[c]	9	26.5
Single province[d] vs nation[c]	6	17.6
Three or more provinces and states	4	11.8
Single metropolitan areas[e]	4	11.8
Single metropolitan area[e] vs nation	1	2.9
Cohort initiation		
1980s	2	5.9
1990s	22	64.7
2000s	6	17.6
2010s	4	11.8
Research design		
Retrospective cohort[f]	28	82.4
Prospective cohort[g]	6	17.6
Aggregate analytic sample[h]		
< 100	3	8.8
00 to 999	10	29.4
1,000 to 24,999	13	38.2
≥ 25,000	8	23.5
Number of covariates[i]		
2 or 3	12	35.3
4 to 9	13	38.2
10 to 15	9	26.5
Study outcome		
Treatment access[j]	10	29.4
Survival/mortality/failure, < 1 year	9	26.5
Survival/mortality/failure, 1 to 5 years	8	23.5
Survival/mortality/failure, > 5 to 15 years	7	20.6

COPD, congestive obstructive pulmonary disease; ESRD, end-stage renal disease; NICU, neonatal intensive care unit. [a]Cancer of the breast (7), colon (6), lung (3) and upper aerodigestive tract (1). [b]All were Ontario and California; Windsor, ON vs Modesto, CA was embedded within one. [c]Four were based on the Surveillance, Epidemiology and End Results (SEER) program. [d]Five were Ontario and one was Manitoba. [e]Ottawa, ON vs Rochester, MN; four were Toronto, ON vs San Francisco, CA. [f]Used secondary/administrative/registry data and all but one were population-based. [g]More commonly used primary data and were either clinic- or population-based.[h]27 of 34 (79.4%) lost < 1% to follow-up, 5 (14.7%) ≤10%, and 2 did not report. [i]Potential confounds accounted for by sample restriction, matching or regression modeling. [j]3 of the 10 treatment measures included some assessment of wait times.

periodically unemployed or underemployed middle-class. Most regrettably, this indictment holds true in post-Affordable Care Act America. For example, at the time of this writing, 14 states still had not fulfilled the Act's legislative intent to expand Medicaid.

Potential limitations and future research needs

Primary research

Although primary studies in this field were generally not able to directly account for race/ethnicity, mainly due to the lack of such data in Canada, some of them replicated their findings by comparing subsamples of non-Hispanic white patients in the USA with racially and ethnically diverse Canadian samples.[31,41,42,44-46] Large Canadian advantages were still observed in these samples, thereby validating the socioeconomic and health insurance explanations found in this study. But this does not mean that race does not matter for the following reasons. Each nation has had unique histories of oppression leaving certain racialized minority groups relatively more socioeconomically vulnerable: Indigenous First Nations, Inuit and Métis people in Canada and African Americans in the USA. Racialized disparities in health and health care clearly persist in both countries, but they seem relatively muted in Canada.[59-61] In fact, the phenomenon known as the *Hispanic paradox*, that is − the health protective effects of being Hispanic despite living in poverty − may be stronger in Canada.[62] The Indigenous-non-Hispanic white divide, however, seems significantly wider in Canada. Precisely how specific racialized group statuses matter in Canada-USA comparative heath care is not yet known because research questions about the unique experiences of racialized subpopulations have not yet been posed. Their future incorporation would further magnify this field's human and policy significance.

Notwithstanding the noted incremental strengths of this field's research over the past 15 years, it provided predominantly historical cohort-based knowledge about the experiences of Canadian and American patients in the 1990s to 2000s. Prospective cohorts were represented more prevalently than in previous reviews, but remained uncommon. Retrospective studies can be methodologically limited, but we believe that the advancement of confirmed historical insights is critical in planning future research and policies. Also, we were comforted by the fact that the findings of the reviewed retrospective and prospective cohorts did not differ significantly. Still, well-controlled prospective cohorts are clearly needed. A prospective cohort-based research agenda representative of Canada and the USA emphasizing both internal and external validity would undoubtedly be quite expensive. However, such an investment holds the promise of huge knowledge dividends. It could, for example, provide valuable evidence about the relative effects of expanding Medicaid (or not) in the USA and the effects of increasing private options (or not) in Canada. Given the long-standing and often contentious policy debates on health care across North America, such a well-funded research agenda seems long overdue.

Synthetic research

Though its sampling frame included unpublished sources, this meta-analytic sample ultimately included only published studies. One may legitimately wonder if publication bias could be a potent alternative explanation for its findings. However, this seems improbable for the following reasons. First, this review's hypothesis of advantaged Canadian health care specific to socioeconomically vulnerable patients was not the primary hypothetical concern of the majority of its included studies. In addition, the review hypothesis of greater Canadian advantages among those with chronic diseases was not advanced by any of the primary studies. Secondly, 6 of the 34 study outcomes reviewed were null and one of the review's synthetic findings (*i.e.*, 7-study pooled estimate of acute care of all patients, impoverished to affluent) was nearly null. Those are precisely the sort of findings one would not readily expect to retrieve from published studies if publication bias, that is, a preference to publish significant findings, was potent. This field's editorial review boards seem to have been open to publishing null findings. Third, it seems improbable that publication bias could account for such a complex pattern of pooled effects moderated by disease chronicity within patient socioeconomic statuses as is displayed in Table 5. Building upon this modestly funded rapid review, a well-endowed full systematic review might consider expanding its gray literature/unpublished research sampling frame. Future synthetic analysts might start by searching relevant annual meetings or conferences as well as diverse organizations; grassroots, non-profit or governmental, for the findings of researchers and/or knowledge users. A snowball survey of such key informants could bolster the internal and external validity of such a review. In

Table 5. Summary of Canada-USA comparative study outcomes.

No. of study outcomes	Tot. participants	Study risk ratios			Pooled	
		Min.	Max.	Median	Risk ratio	95% CI
Overall population comparisons, tot 19	438,482	0.30	2.86	1.08	1.09[a]	1.08-1.10
Acute conditions 7	173,408	0.30	1.99	1.00	1.03[bd]	1.02-1.04
Chronic diseases 12	265,074	0.53	2.86	1.14	1.12[cd]	1.11-1.13
Socioeconomically vulnerable population comparisons, tot 15	78,589	1.07	4.35	1.66	1.36[a]	1.35-1.37
Acute conditions 1	53,836	1.14	1.14	1.14	1.14[be]	1.05-1.23
Chronic diseases 14	24,753	1.07	4.35	1.67	1.37[ce]	1.36-1.38

Pooled risk ratios with the same superscripts were compared: [a]$z = 48.47$, [b]$z = 4.79$, [c]$z = 41.48$, [d]$z = 22.50$ and [e]$z = 8.94$, all $P<0.05$.

addition to collecting data missing from primary study reports it could facilitate the retrieval of knowledge from unpublished studies that may presently sit in respondent's *file drawers* or those of their colleagues or professional acquaintances. For its admitted rapidity, this systematic review may be limited in other ways. A bit more of its practical context may illuminate them. First, this synthesis was essentially unfunded. Second, we began by scoping all the research on any health status or health care difference between any two high-income countries. The voluminous results of those preliminary searches in addition to funding constraints caused us to focus on a rapid review of the most scholastically interesting, politically important and feasible research: Health care in Canada and the USA. We planned exhaustive searches, but of focused questions within rigorous methodological constraints and a streamlined meta-analysis. We think that these are strengths of this rapid review. However, in doing so we did not adhere to at least two preferred systematic review and meta-analytic methods. As three reviewers independently searched for eligible studies, informally sharing their developing methods throughout the process, we did not produce a unified flow chart, detailing each step of the information gathering process. Also, reviewers were not blinded to primary study findings. Recall though that each step of the review process − study selection, data abstraction and meta-analysis − was initially cross-validated by at least two reviewers. Consensus was ultimately reached on all selected studies. And 9 of 34 of the primary study outcomes we ultimately included were counter hypothetical, that is, they did not support our review's central hypothesis of Canadian advantage. For these reasons we believe that our rapid systematic review approximates the validity of a full systematic review. A better-endowed full systematic review, accomplished by independent reviewers, would be most welcome. Such systematic replications are the hallmark of sound scientific inquiry, primary and synthetic.

Conclusions

This field's research now seems rigorous enough to support confident judgements about the relative effectiveness of Canadian versus American health care, especially among the most socioeconomically vulnerable. Socioeconomically vulnerable Canadians are consistently and highly advantaged on health care access and outcomes compared to their American counterparts. Less vulnerable comparisons found more equivocal and more modest Canadian advantages. The Affordable Care Act ought to be retained, indeed fully supported, including the envisioned expansion of Medicaid across all states. When politically achievable, however, single payer health care would better ensure truly equitable access and outcomes among America's diverse population. Canada's single payer system ought to be maintained and strengthened where needed, but not through the addition of private tiers.

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