A tale of two healthcare systems: Cost-utility analysis of open carpal tunnel release in Canada and United States

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PURPOSE: Canadian healthcare is often criticized for extended wait-times, while the United States (US) suffers from increased costs. The purpose of this pilot study was to determine the cost-utility of open carpal tunnel release in Canada versus the USA.

METHODS: A prospective cohort study evaluated patients undergoing open carpal tunnel release at an institution in Canada and the US. All costs from a societal perspective were captured. Utility was measured using validated health-related quality of life (HRQOL) scales: the EuroQol-5D and the Michigan Hand Outcome Questionnaire.

RESULTS: Twenty-one patients at the Canadian site and 8 patients at the US site participated. Mean total costs were $1581 ± 1965 and $2179 (range: $1421-2741) at the Canadian and US site, respectively. HRQOL demonstrated significant improvements following surgery ($p<0.05$). Patient utilities pre-operatively and at 6 weeks and 3 months post-operatively were 0.72 ± 0.20, 0.86 ± 0.11, and 0.83 ± 0.16 at the Canadian site and 0.81 ± 0.09, 0.86 ± 0.10, and 0.86 ± 0.12 at the US site. Improvements in HRQOL directly related to surgery were not significantly different between patients in Canada and the US. American patients, however, attained improved HRQOL sooner due to shorter wait times (27 ± 10 vs. 214 ± 119 days, $p<0.001$). The incremental cost-utility of the US system was $7758/QALY gained compared to the Canadian system. Sensitivity analyses confirmed that these results were robust.

CONCLUSIONS: This pilot study suggests that carpal tunnel surgery is more cost-effective in the US due to prolonged wait times in Canada.

Key Words: *Carpal tunnel syndrome; Carpal tunnel surgery; Cost-effectiveness; Cost-utility, Quality of life, Decision analysis*

Contexte de deux systèmes de soins de santé: analyse coût-utilité de la libération de tunnel ouvert au Canada et aux États-Unis

BUT: Les soins de santé canadiens sont souvent critiqués pour les temps d'attente prolongés, tandis que les États-Unis (US) souffrent d'une augmentation des coûts. Le but de cette étude pilote était de déterminer la rentabilité de la libération du tunnel carpien ouvert au Canada par rapport aux États-Unis.

MÉTHODES: Une étude de cohorte prospective a évalué les patients qui subissaient la libération du canal carpien ouvert dans un établissement au Canada et aux États-Unis. Tous les coûts, d'un point de vue sociétal, ont été pris en compte. L'utilité a été mesurée à l'aide d'échelles validées de la qualité de vie liée à la santé (HRQOL): l'EuroQol-5D et le Michigan Hand Outcome Questionnaire.

RÉSULTATS: Vingt et un patients sur le site canadien et 8 patients sur le site américain ont participé. Les coûts totaux moyens ont été respectivement de 1581 $ ± 1965 $ et de $ 2179 ($ 1421-2741) sur le site canadien et américain. La QVRS a démontré des améliorations significatives après la chirurgie ($p <0,05$). Les services aux patients préopératoires et à 6 semaines et 3 mois après l'intervention étaient 0,72 ± 0,20, 0,86 ± 0,11 et 0,83 ± 0,16 au site canadien et 0,81 ± 0,09, 0,86 ± 0,10 et 0,86 ± 0,12 sur le site américain. Les améliorations de la QVRS directement liées à la chirurgie n'étaient pas significativement différentes entre les patients au Canada et aux États-Unis. Cependant, les patients américains ont obtenu une meilleure CVRS plus rapidement en raison des temps d'attente plus courts (27 ± 10 vs 214 ± 119 jours, $p <0,001$). Le coût différentiel-utilité du système américain était de 7758 $ / QALY gagné par rapport au système canadien. Les analyses de sensibilité ont confirmé que ces résultats étaient robustes.

CONCLUSIONS: Cette étude pilote suggère que la chirurgie du canal carpien est plus rentable aux États-Unis en raison des temps d'attente prolongés au Canada.

In the present political and economic climate, there is increasing scrutiny of healthcare expenditures and increasing pressure to attain value-for-money with respect to healthcare practice. Canada, with its publicly funded, single-payer, universal health insurance, is often criticized for extended wait-times. The United States, conversely, boasts reduced wait-times but suffers from increased costs as the result of its multi-payer public and private healthcare system (1). These increased healthcare costs are difficult to justify with evidence that life expectancy and outcomes for some diseases are the same or better in Canada when compared to the USA (2-6).

Appropriate comparison between healthcare practices in Canada and the US may be achieved through meticulous calculation of the costs and effectiveness. While previous studies have examined either the costs or the effectiveness of surgical procedures (e.g. total hip and knee replacements, cardiac surgery) between Canada and the United States, none provide a direct comparison of cost-effectiveness in the same population (1,2,6-10). This information is important to ensure the efficient delivery of surgical healthcare services. Carpal tunnel surgery may facilitate this investigation given the high disease prevalence, availability of validated outcome scales, and relatively short follow-up times.

The goal of this pilot study was to determine the cost-utility of open carpal tunnel release in Canada versus the United States and to determine the feasibility of performing a large sample size Cost-Utility Analysis study comparing the two health care systems. This may ultimately identify factors that promote or limit the efficient delivery of services in hand/plastic surgery.

METHODS

We performed a pilot prospective study to measure the costs and effectiveness of carpal tunnel surgery performed in Canada and the United States. Consecutive patients from two academic hospitals, Canada (St. Joseph's Healthcare, Hamilton, ON) and one in the United States (Southern Illinois Hand Center, Effingham, Illinois), were screened at the time of their initial consultation. Patients with a clinical and EMG/NCS confirmed diagnosis of carpal tunnel syndrome undergoing unilateral open carpal tunnel release were considered for study participation. Patients were excluded for the following criteria: younger than 18 years of age, Worker's compensation, diabetes, generalized peripheral neuropathy, Raynaud's, pregnancy, previous hand surgery including carpal tunnel release, medically unfit for surgery, and inability to complete surveys in English. All patients underwent open carpal tunnel release according to the investigators' routine practice. Research ethics board approval was obtained at each institution.

Costs

All direct and indirect costs from a societal perspective were calculated as

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recommended by the Panel on Cost-Effectiveness in Health and Medicine (11). Direct costs included surgeon, hospital, anesthesia, and physiotherapy fees. Costs for Canadian patients were obtained from the Ontario Ministry of Health and Long Term Care (MOHLTC) Physician Fee Schedule and the hospital's finance department. Costs for US patients were based on the Medicare Physician Fee Schedule and reimbursement rates as reported by the hospital's finance departments. Mean patient charges were also reported upon request. Indirect costs were collected through a modified case report form (CRF) designed to collect information on resource utilization specific to carpal tunnel syndrome (12). Patients recorded all out-of pocket expenses such as post-operative medications, travel, general practitioner, physiotherapy and emergency room visits, and caregiver expenses. They also recorded time of work for themselves and their caregivers. Productivity losses were calculated using the Human Capital method (13). Duration of work loss for the patient or caregiver was multiplied by the average daily wage rate. All costs were converted to US dollars using purchasing power parities (14). Costs were not discounted due to the short time frame of the study (less than 1 year).

Effectiveness

Effectiveness was measured from the patients' perspective using Quality Adjusted Life Years (QALYs). QALYs account for both patient quality of life and the time spent in the different health states. Quality of life was measured using two validated measures: (1) the Michigan Hand Outcomes Questionnaire (MHQ), a condition-specific scale, and (2) the EuroQOL-5D (EQ-5D), a utility measure from which QALYs can be calculated. QALYs are important components of cost-utility analyses.

Questionnaires were self-administered by all patients at three time points: preoperatively, and at six weeks and three months post-operatively. A minimal clinically important difference in patient utility was assumed to be 0.03 (15). The duration of time spent in each health states was measured by wait times, defined for both the time from initial referral to initial consultation (WAIT 1) and the time from decision to operate to the date of operation (WAIT 2). Wait times were collected through the modified case-report form.

The MHQ is a 37-item questionnaire that measures 6 domains of interest. It is a specific and validated measure for assessing hand outcomes and quality of life in patients with carpal tunnel syndrome (16). The MHQ combines both functional and symptom scales of the right and left hand independently.

Utility values were obtained from the EQ-5D, a validated measure of health status used in the clinical and economic evaluation of health care. Using population values, each EQ-5D score can be translated via a regression equation to an equivalent utility score, derived from a general population using time trade-off techniques (17). Utilities measure relative patient preferences for a particular health state on a scale from zero (representing death) to one (representing perfect health). Utility values were then multiplied by the time spent in each health state to determine the QALYs gained.

Sample size calculation

As this was a pilot study, a power analysis was not performed. We aimed to collect preliminary data on the outcomes of interest to adequately power a full-scale study.

Data analysis

A descriptive analysis was performed. Categorical data was compared using chi-squared or Fisher's exact test. Continuous data was compared using a student t-test or Wilcoxon rank test (when not normally distributed). Mean changes in MHQ and EQ-5D scores were calculated from baseline to each follow-up time point. Multiple regression analysis was used to control for differences in baseline utility between Canadian and US patients (18). An incremental cost-utility ratio (ICUR) was calculated as the difference in total costs between the Canadian and US system divided by the difference in QALYs. A threshold of $50,000/QALY or less was used to indicate cost-effectiveness (19). Analyses were performed using SPSS, version 18.0 (SPSS, Chicago, IL).

RESULTS

Twenty-nine patients participated in this study, 21 from Canada and 8 from the US. No patients were lost to follow-up. Patient demographics are summarized in Table 1. There were no significant differences between Canadian and US study participants. Patients' insurance at the US site was Medicare (25%), private insurance (63%), and self-pay (12%).

TABLE 1
Patient demographics

	Canada (n=21)	US (n=8)	p-value
Age (years), mean (SD)	59 (14)	57 (15)	NS
Female, n (%)	13 (62%)	4 (57%)	NS
Duration of symptoms (months)	59 (64)	45 (67)	NS
Married, n (%)	16 (80%)	7 (88%)	NS
Insurance type, n (%)			
Provincial insurance	21 (100%)		
Medicare		2 (25%)	
Private insurance		5 (63%)	
Self-pay		1 (12%)	
Employment			NS
Full-time	7 (35%)	3 (37%)	
Part-time	2 (10%)	1 (12%)	
Homemaker	2 (10%)	3 (37%)	
Retired	9 (45%)	1 (12%)	
Repetitive tasks	9 (45%)	2 (40%)	NS
Gross household income			NS
<$25,000	5 (25%)	3 (37%)	
$25-49,999	3 (15%)	4 (50%)	
$50-74,999	2 (10%)	0	
>=$75,000	9 (45%)	1 (12%)	
College or University degree	6 (30%)	2 (25%)	NS
Smoker	4 (20%)	0	NS

Comparison of the routine practices for open carpal tunnel release between the two primary surgeons (AT, NN) identified some distinct differences. While both surgeons performed a variation of a short scar or classic open carpal tunnel release, CTR in Canada was performed under local anesthesia in a minor procedure room setting with only one registered nurse or registered practical nurse and no anesthesiologist present. A medical trainee (resident or medical student) was present to assist. Mean operative time was 15+/-5 minutes, and total time in the procedure room was 23+/-8 minutes (measured by total nursing time).

CTR at the US site was performed in a main operating room under regional anesthesia (Bier block) with an anesthesiologist and 3 registered nurses or licensed practical nurses present. Mean operative time was 8+/-3 minutes. Each case was booked for 30 minutes. One patient sustained an adverse event unrelated to the surgery (fall from standing) 4 weeks post-operatively. No other complications were identified.

Mean total costs were less in Canada compared to the US ($1581+/-1965 vs. $2179+/-1499) resulting in a cost difference of $598. Direct costs of CTR in Canada and the US were $541+/-102 and $1126 (range: 426-1738), respectively. Breakdown of costs are summarized in Table 2. Direct costs from the US institution were provided as a mean and range. Patient charges were $2185 for patients with private insurance and $1638.75 for self-pay.

Total mean indirect costs were similar in Canada compared to the US ($1040+/-1963 vs. $1003+/-1499). All 8 patients in the US attended physiotherapy compared to only 1 of 21 in Canada. Personal expenditures (parking, gas, medications) only comprised a small proportion of the indirect costs. Employed patients and caregivers required similar time off work (US: 5.8+/-10.2 days and 0.4+/-0.8 days, respectively; Canada: 7.6+/-12.2 days and 0.8+/-1.7 days, respectively). Costs due to productivity loss between US and Canadian patients averaged $675+/-1483 and $816+/-1932 when considering all patients in the study sample, respectively.

Quality of life improved significantly at both 6 week and 3 month time points following carpal tunnel release. There were no significant differences in quality of life scores at each time point between patients in Canada and the US (Figure 1). At 3 months post-op, overall MHQ scores for Canadian and US patients improved from baseline scores of 64+/-17 and 70+/-14 to 81+/-15 and 79+/-11, respectively ($p<0.001$). EQ-5D utility values also improved significantly from baseline. At 3 months post-op, EQ-5D utility scores for Canadian and US patients improved from baseline scores of 0.72+/-0.20 and 0.81+/-0.09 to 0.83+/-0.12 and 0.86+/-0.12, respectively ($p=0.008$).

Wait times for carpal tunnel surgery in Canada were significantly longer than in the US. Wait times from referral to initial consultation with a hand

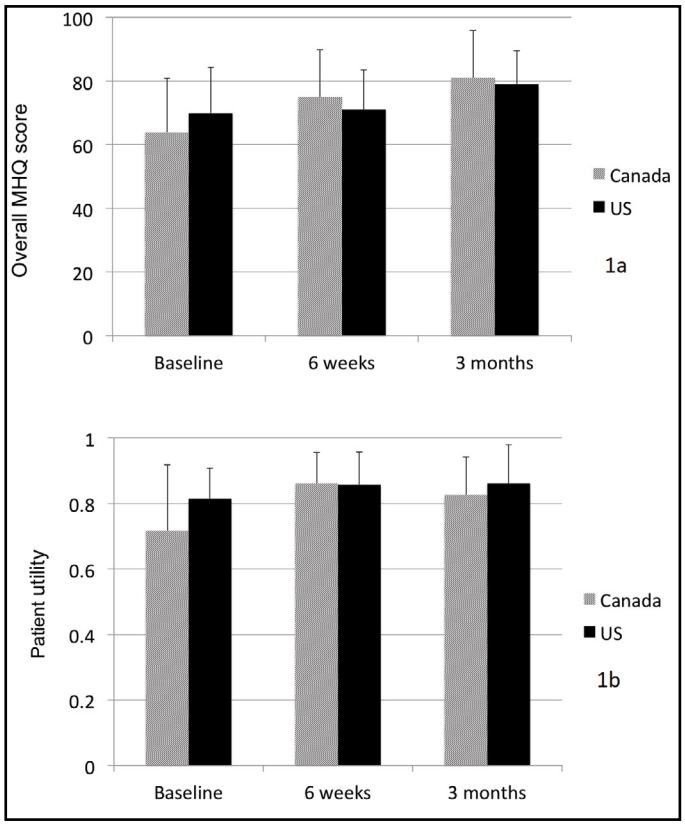

Figure 1) *Health-related quality of life outcomes pre-operatively, and 6 weeks and 3 months post-operatively (A) Michigan Hand Questionnaire (B) EuroQOL 5D. *p<0.05 compared to baseline*

TABLE 2
Direct and indirect costs of open carpal tunnel surgery in Canada and the United States

	Canada (USD)	US ($)
Direct costs, mean (SD)	541 (102)	1176 (426-1738)*
Consultation	100	
Facility, mean $ (SD)	186 (77)	
Supplies	46	51
Nursing	32	
Anesthesia	n/a	
Surgeon	189	
Follow up	65	
Indirect costs, mean (SD)	1039 (1963)	1002 (1499)
Physiotherapy, mean $ (SD)	17 (74)	210 (165)
Mileage, mean $ (SD)	7 (19)	36 (40)
Parking, mean $ (SD)	15 (8)	n/a
Other (splints, bandages, medications)	10 (9)	6 (5)
Productivity loss (societal)		
Personal, $ (SD	816 (1932)	675 (1483)
Caregiver, $ (SD	170 (337)	75 (139)
Total Direct + Indirect	1581 (1965)	2179 (1830)

surgeon (Wait 1) were 66+/-103 days and 15+/-9 days in Canada and the US, respectively (p=0.180). Wait times from decision to operate to surgery (Wait 2) were 147+/-60.5 days and 12+/-4 days (p<0.001), respectively. Total wait times from initial referral to surgery in Canada and the US were 214+/-119 days and 27+/-10 days, respectively (p<0.001) (Figure 2).

While carpal tunnel release resulted in similar improvements in quality of life, significantly shorter wait times for US patients resulted in a gain of 0.077 QALYs compared to their Canadian counterparts. An incremental cost-utility ratio was then calculated to be $7758/QALY.

One-way sensitivity analyses demonstrated that the results were robust. Variations in the costs of carpal tunnel surgery had little impact on the

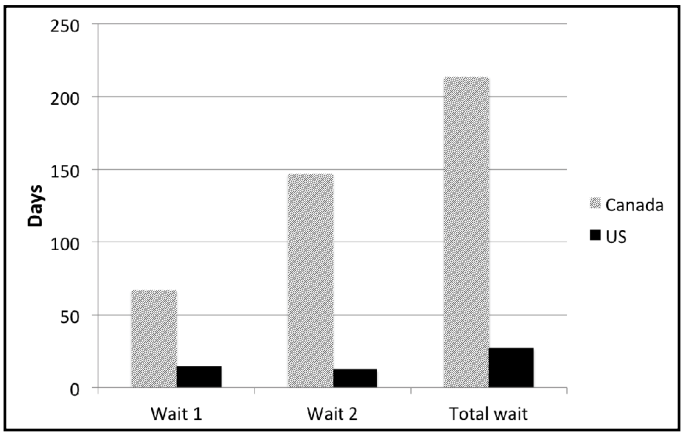

Figure 2) *Wait times for carpal tunnel surgery. WAIT 1: time from initial referral to initial consultation; WAIT 2: time from decision to operate to surgery; TOTAL WAIT: WAIT1 + WAIT 2. *p<0.05 compared to baseline*

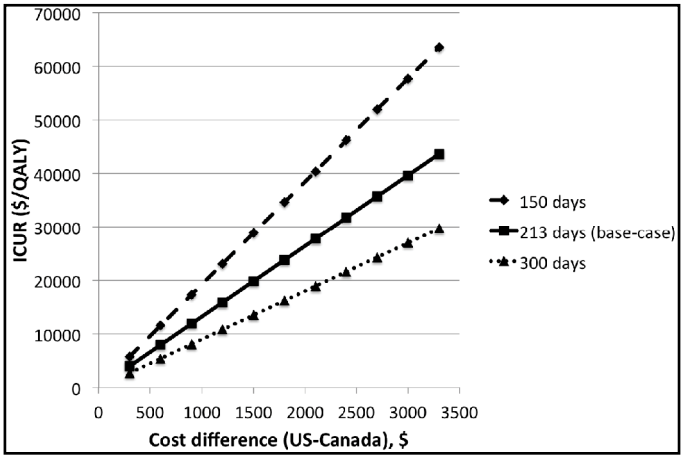

Figure 3) *Sensitivity analysis of the Incremental Cost-Utility Ratio (ICUR) varying the difference in total costs and wait times for carpal tunnel surgery in the US vs. Canada. Dashed vertical line indicates base-case scenario*

overall ICUR. As illustrated in Figure 3, carpal tunnel surgery in the US would remain cost-effective (ICUR<$50000/QALY) unless total costs exceed $5500 per surgery (cost difference >$4000). Since patients in the US may be charged more than the actual cost of services, sensitivity analyses were performed to consider patient charges instead of cost; the US system remains favored (ICUR $20,828/QALY). Similarly, wait times for surgery in Canada would have to be reduced to less than 60 days before the US system would become less favorable.

DISCUSSION

Patients with carpal tunnel syndrome experienced significant improvements in quality of life following carpal tunnel surgery. This improvement was similar between patients treated in Canada and the US. Significant differences in cost and wait times for surgery between these patients, however, demonstrates inefficiencies in both healthcare systems. From this prospective pilot study, an ICUR of $7758/QALY was calculated; this is below the conventional willingness-to-pay threshold of $50000/QALY thus favoring the US system (19).

While no prior study has compared both the costs and effectiveness of healthcare in Canada and the US, previous studies have independently demonstrated lower costs in Canada, similar outcomes, but longer wait times. Antoniou et al demonstrated lower in-hospital costs for Canadian patients undergoing total hip arthroplasty, while wait times for knee replacement surgery were longer in Canada compared to American counterparts (1,3). A systematic review suggested similar, possibly superior, health outcomes across multiple health conditions including cancer, coronary artery disease, chronic medical illnesses, and surgical procedures for patients treated in Canada vs. the US (8). Our study supports these findings: costs were less, wait times were longer, and improvements in HRQOL directly associated with surgery were similar for carpal tunnel surgery in Canada compared to the US.

Previous cost-effectiveness studies of carpal tunnel surgery offer the opportunity for comparison; however, most are limited by a lack of prospective data or failure to account for indirect costs. Multiple authors have independently performed cost-effectiveness analyses comparing endoscopic to open carpal tunnel release (20-22). Reported costs of open carpal tunnel surgery were similar to our results. Chung et al. performed a decision analytic model based on a hypothetical group of patients in the United States (20). Only direct costs were considered based on Medicare relative value units with sensitivity analyses performed for costs associated with private practice in Southeastern Michigan. For open carpal tunnel release, costs (in 1997 USD) were $842 and $2202 for Medicare and private practice, respectively.

Vasen et al. found similar costs: the reimbursement of open carpal tunnel surgery by the Massachusetts Department of Industrial Accidents was $1672 (21). The total cost, however, was $6315 after accounting for lost wages due to absence from work. Time to return to work was estimated to be 54 days, but this was estimated from previous randomized controlled trials that included a mix of patients with and without Worker's compensation. In contrast, employed patients in our study missed 7.6+/-12.2 and 5.8+/-10.2) days of work in Canada and the US, respectively. Five patients in Canada and 2 patients in the US required caregiver assistance post-operatively resulting in caregiver time off work of a mean of 0.8+/-1.7 and 0.4+/-0.8 days, respectively.

Time off work varied in the literature. Saw et al. performed a prospective randomized controlled trial comparing endoscopic to open carpal tunnel release in the UK (22). Time off work for employed patients undergoing open carpal tunnel surgery was 26 (+/-14) days. No patients in their study required additional support from a community support or caregiver. Korthals-de Bos et al. performed an economic evaluation alongside a randomized controlled trial comparing splinting to open carpal tunnel release in the Netherlands (23). Mean cost for patients undergoing surgery was 2126 euros including both direct and indirect costs. Indirect costs included lost wages for a mean of 9.2 days off work after excluding outliers.

Effectiveness of carpal tunnel surgery was similar to previously reported studies. Chung et al. surveyed nurses, hand therapists, and surgical residents using the rating method to determine the utility for several of hypothetical situations (20). Baseline utility for patients with carpal tunnel syndrome was 6.98 (out of 10) compared to 0.72 (out of 1) and 0.81 for our patients in Canada and the US, respectively. Chung et al. assumed that patients returned to perfect health following successful surgery (utility=10). In our study, patient utility at 3 months post-op reached 0.83 and 0.86 in Canada and the US, respectively. Korthals-de Bos et al. similarly used the EQ-5D and found patient utility to be 0.85 (0.12) following carpal tunnel release (23). Imperfect health related quality of life following successful surgery was similar to the self-reported health status of the age-matched general adult US population (24).

Limitations of this study include the small sample size and consideration of only one institution in each healthcare system. Even with modest recruitment goals, we were only able to recruit 8 patients at the US centre. At interim review, we identified that a large number of patients presenting with bilateral carpal tunnel syndrome were excluded because of desire for contralateral surgery before the study endpoint at 3-month follow-up.

Due to the single payer public healthcare system, cost data from the single Canadian centre is likely generalizable to non-Worker's compensation patients across Ontario. Variations exist across Canada, as healthcare is administered at a provincial level. It is more difficult, however, to generalize cost data across the US based on a single center due to the multi-payer public/private healthcare system. Sensitivity analyses, however, offer the opportunity to account for these unpredictable variations. Even with cost differences between the US and Canada approaching $4000 (base-case: $598), the US system remained cost-effective.

Mean total wait times of 213 days likely underestimate the wait times for open carpal tunnel surgery in Canada. Because of knowledge of study enrolment, office administrators would prioritize patients with carpal tunnel surgery to be seen sooner in initial consultation. Instead of the 67-day wait time from referral to initial consultation in the current study; the typical wait time is approximately 8-9 months (240-270 days). Total wait times in Canada would thus be closer to 390 days, further favoring the US system.

While cost-effectiveness analysis favored the US system due to significantly shorter wait times, detailed prospective analysis offers the opportunity to identify areas to improve efficiency in both healthcare systems. Good evidence demonstrates that open carpal tunnel release can be performed under local anesthetic in a minor procedure room without anesthesia presence at lower cost and similar outcomes including patient satisfaction (25-27). Similarly, there is a paucity of evidence supporting routine prescription of physiotherapy following carpal tunnel release (28).

Reducing wait times in Canada remains a challenge. Simply increasing the physician workforce may not be the solution (29). Barriers exist not only to timely access to hand/plastic surgeons for carpal tunnel syndrome, as evident from wait times from referral to initial consultation, but also to availability of operating room resources, illustrated by wait times from decision to operate to time of surgery.

CONCLUSION

Our pilot study demonstrates the feasibility of prospectively measuring the costs and effectiveness of open carpal tunnel release at institutions in Canada and the US in a larger trial. Preliminary results suggest that, despite higher costs, carpal tunnel surgery in the US is more cost-effective due to HRQOL implications of extended wait times in Canada. Further investigation may improve generalizability of results and elucidate specific areas for improved efficiency.

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