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Toronto Health Economics and Technology Assessment Collaborative

Community-Based Care for the Specialized Management of Heart Failure

A Cost-Effectiveness and Budget Impact Analysis

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Executive Summary

Background

Despite advances in pharmacologic and device therapy, the prognosis for patients with heart failure (HF) remains poor. Alternative models of care delivery, such as multi-disciplinary HF clinics have been shown to reduce mortality.

Objective

To determine the cost-effectiveness of HF clinics compared to standard care for HF patients in Ontario, Canada.

Methods

We performed a cost-effectiveness analysis, with a 12 year time horizon, from the perspective of the Ontario Ministry of Health and Long-term Care. We compared a standard care cohort, consisting of all patients admitted to hospital with HF in 2005, to a hypothetical cohort treated in HF clinics. Survival curves describing the natural history of HF were constructed using mortality estimates from the Enhanced Feedback for Effective Cardiac Treatment (EFFECT) study. Survival benefits and resource uptake associated with HF clinics were estimated from a meta-analysis of published trials. HF clinics costs were obtained by costing of a representative clinic in Ontario. Health-related costs associated with physician visits, hospitalizations, emergency department visits, same day surgeries and medication use, were determined through linkage to administrative databases. Outcome measures included life expectancy (years), costs (in 2008 Canadian dollars) and the incremental cost-effectiveness ratio (ICER). A budget impact analyses was performed over a time horizon of 5 years, incorporating projected incident cases of HF and the implementation costs of specialized HF clinics in Ontario.

Results:

The systematic review determined that HF clinics were associated with a 29% reduction in all-cause mortality (risk ratio [RR] 0.71; 95% Confidence Interval [CI] 0.56-0.91) but a 12% increase in hospitalizations (RR 1.12; 95% CI 0.92-1.135). The cost of care in HF clinics was $52 per 30 patient-days. Projected life-expectancy of HF clinic patients was 3.91 years, compared to 3.21 years for standard care. The 12 year cumulative cost per patient in the HF clinic group was $66,532 versus $53,638 in the standard care group. The ICER was $18,259/life year gained. The average annual cost for HF clinic implementation was $17 million in Ontario.

Conclusions

Multi-disciplinary HF clinics reduce mortality and increase life expectancy. Despite increasing overall costs due to increased late hospitalizations, HF clinics appear to be a cost effective way of delivering ambulatory care to HF patients.

Background

Heart failure (HF) is a complex, progressive syndrome characterized by abnormal heart function resulting in poor exercise tolerance, recurrent hospitalizations, and reductions in both quality of life, and survival.[1] Although tremendous progress has been made in pharmacologic and device therapy, HF patients continue to have a poor prognosis, with an annual mortality ranging from 5% to 50%.[1] The incidence of HF is projected to increase, with estimates suggesting a three-fold increase in HF hospitalizations over the next decade.[2] Alternative targeted health care delivery models have therefore been of particular interest in HF, as a means of improving both quality of life and survival.[3]

Disease management through specialized multi-disciplinary clinics has been shown to improve patient outcomes in several health conditions, including asthma, diabetes mellitus, chronic kidney disease, and cancer.[4;5] An important potential benefit of multi-disciplinary care in HF includes improved utilization and compliance with evidence-based medications shown to prolong survival. Moreover, this model of care may better address the complex interplay between medical, psychosocial, and behavioural factors facing HF patients and their caregivers.[3] Several previous randomized studies and meta-analyses have evaluated the efficacy of such clinics with selected results suggesting a marked reduction in mortality.[1;3;6] However, interpreting this literature is challenging because the composition of HF clinics and the interventions they offer have varied as has the population studied.[3]

From a health policy standpoint, it remains unclear if the benefit of HF clinics is balanced against the costs of the intervention itself and the subsequent future health care costs associated with more closely managed care. Previous economic evaluations of HF clinics have been restricted to relatively small clinical trials, most with short time horizons.[3;7-11] Accordingly, our objective was to determine the cost-effectiveness of specialized multidisciplinary HF clinics compared to standard care for the long term management of HF patients in Ontario, Canada.

Methods

Research Ethics Board Approval

This study was approved by the Institutional Research Ethics Board at Sunnybrook Health Sciences Centre, Toronto, Ontario.

Study Design

We performed a cost effectiveness analysis to model the costs and outcomes in a cohort of patients discharged after an index hospitalization for HF, comparing two treatment strategies: 1.) treatment in a specialized multi-disciplinary HF clinic (defined as care involving at least one physician and nurse, one of whom has specialized training in HF) versus 2.) standard care (defined as care provided by a single practitioner). Outcomes of interest were life expectancy, measured in years, costs (adjusted for inflation to 2008 Canadian dollars using the Bank of Canada Consumer Price Index (www.bankofcanada.ca/en/cpi.html), and the incremental cost-effectiveness ratio (ICER), calculated as the incremental cost per life year gained.

Economic Assumptions

The perspective of this analysis was that of the Ontario Ministry of Health and Long-term care (MOHLTC), the single third-party payer for health services in the province. The time horizon for the analysis was 12 years, the period for which accurate estimates of HF natural history in Ontario was available. All health outcomes and costs were discounted at 5% per year (http://www.cadth.ca).

Patient Cohort

The target population were patients with a recent hospitalization for HF. For the purpose of estimating survival gain and cost, we identified an actual cohort of all patients in the fiscal year 2005 that were discharged from hospital with a diagnosis of HF in Ontario, Canada. Patients were identified based on International Classification of Disease (ICD) Version 10 code I50 in the Canadian Health Institute for Health Information (CIHI) discharge abstract database. We restricted the cohort to patients above the age of 25 years who were residents of Ontario with valid Ontario Health Insurance Plan (OHIP) identification numbers. If an individual had more than one HF hospitalization for 2005, the first admission was defined as the index event. Based on this definition, we identified 16,443 hospitalized HF patients who represented our cohort of interest.

Estimating Life Expectancy Gains from HF Clinics

We used age-gender specific mortality rates from the Enhanced Feedback for Effective Cardiac Treatment (EFFECT) study to estimate the natural history of HF. The EFFECT study was a chart abstraction of 9,943 HF patients, across 44 hospitals in Ontario followed for up to 12 years.[12] Patients in the EFFECT study were from a wide spectrum of clinical settings, including both large tertiary care centers and smaller rural community hospitals, and thus were representative of HF in Ontario. Survival curves were constructed for patients receiving standard care using the age-gender specific life-tables from the EFFECT study.[12]

Estimates for life expectancy of patients treated in HF clinics were obtained from a systematic review and meta-analysis of the literature, which is published separately.[13] To ensure that these efficacy estimates were representative of the treatment strategies in our model, the systematic review was restricted to randomized controlled trials of HF clinics consisting, at a minimum, of a nurse and physician, one of whom was a specialist in HF management.[13] These trials compared HF clinics to standard care by a single practitioner, and the population was restricted to HF patients after discharge from hospital.[13] Summary risk ratio (RR) estimates for mortality and hospitalization were calculated using the random effects model of DerSimonian and Laird (Table 1). The systematic review included 8 randomized controlled trials.[14-21] The meta-analysis concluded that HF clinics are associated

with a statistically significant 29% decrease in all-cause mortality (summary RR 0.71; 95% confidence interval (CI) 0.56-0.91) but a non-significant 12% increase in overall hospitalizations (summary RR 1.12; 95% CI 0.92-1.35).[13]

Survival curves for the HF clinic cohort were then constructed by applying the summary estimate from the meta-analysis to the natural history survival curves constructed from the EFFECT study. Based on expert opinion, we incorporated a 10% annual attrition rate of patients dropping out from the HF clinics into the model. We assumed that the survival benefit afforded by HF clinics only applied to patients who continued to receive care in these clinics. Patients who dropped out of HF clinic care were assumed to have the same mortality rate as those patients receiving standard care. We also assumed that non-compliant patients would not return to HF clinic care.

Heart Failure Clinic Costs

Costs associated with treatment provided at HF clinics were identified from an existing HF clinic at the University Health Network (UHN) in Toronto, Ontario which we considered to be representative of specialized multi-disciplinary HF clinics in the province. Where selected costs could not be valued, clinical experts were consulted. Briefly, care at the UHN HF clinic is primarily provided by a physician with specific training in HF management and an advanced care nurse practitioner. Care is also provided by allied health care professions as needed. On average, patients had two clinic visits per year; new patients or patients with unstable symptoms were evaluated more frequently.

The types of costs that were considered for the HF clinic are summarized in Table 2. These included costs associated with: 1) health practitioner visits and clinic staffing (including physician, nurse practitioner, pharmacist, dietician, social worker, kinesiologist, and clerical staff), 2) laboratory and imaging tests, and 3) operating and overhead (plant operations, cleaning, waste disposal and pest removal, fire safety, security, building repairs and maintenance, equipment depreciation, administrative fees, utilities). Staffing costs were based on annual staff incomes including benefits, adjusted by the proportion of time spent in the clinic. We assumed that patients would have an EKG every visit, an echocardiogram once a year, and annual screening blood-work assessing renal function, electrolytes and hematologic profile. Categories of costs were inputted as the average cost per 30-patient days for treatment at a HF clinic, which we assumed was constant over the model's time horizon.

Long-Term Health Related Costs

Long-term health-related costs for the standard care cohort were determined by linkage to population-based administrative databases at the Institute for Clinical Evaluative Sciences (ICES), using encrypted unique patient identifiers.[22] Administrative records were available up to March 31st, 2008, allowing cost-estimates for a maximum follow-up period of 36 months. We identified all health-related resources utilized by patients within the study period and paid for by the Ontario MOHLTC. The categories of costs included were physician visits, acute care and chronic care hospitalizations, emergency department visits, same day surgeries, and medication use.

Costs associated with physician visits and laboratory tests were determined using data from the claims history in OHIP database, which includes fee-for-service claims submitted by physicians and other licensed health professionals.[22] It also includes shadow billings from providers of organizations covered by alternate payment arrangements. Because there are regional variations in reimbursements, the median 2008 cost for each physician and laboratory service fee code was used to estimate cost.

The CIHI discharge abstract database has records on the frequency and type of all acute and chronic care hospitalizations in the patients included in our cohort. The CIHI discharge

record includes a 'most responsible' diagnosis and up to 15 additional diagnosis codes that can be used to estimate co-morbidity, as well as procedure codes, length of stay and in-hospital mortality data.[22] The cost of hospitalization was estimated using the Resource Intensity Weight (RIW) methodology.[22] We multiplied the RIW associated with the case-mix group for each hospitalization by the average provincial cost per weighted case for all Ontario acute and chronic hospitals.[22] This method yields a mean cost per hospitalization for cases assigned to a particular case-mix group category.

A similar RIW methodology was employed to determine the costs for emergency department visits and same day surgeries, both using the National Ambulatory Care Reporting Service (NACRS) database.[22] NACRS contains administrative, clinical, financial, and demographic data for hospital-based ambulatory care, including emergency department visits, outpatient surgical procedures, medical day/night care, and high-cost ambulatory clinics such as dialysis, cardiac catheterization, and oncology.[22]

Finally, data on medication costs were obtained from the Ontario Drug Database (ODB), which has comprehensive drug utilization information on patients over 65 years, for whom full drug coverage is provided for by the MOHLTC.[22] We did not include medication costs associated with patients under the age of 65 years as these would not be covered by the provincial government.

Long-term costs associated with HF treatment required modelling, because our follow-up period for observed linked costs was limited to 36 months and therefore, did not span the 12-year time horizon of the analysis. Based on results of previous studies in cancer care, we expected that long-term health-related costs would not be constant over the lifetime of HF patients.[23] Instead, we expected that there would be a phase of high costs associated with the time period immediately after hospital discharge, followed by a phase of clinical stability characterized by relatively constant costs ,and finally a phase of increasing costs prior to death.[23] To validate our phased-based costing approach and determine the duration of the post-discharge and pre-death phases of increased costs, we performed exploratory analyses of our linked cohort.

We evaluated the cost per 30-patient days for patient subgroups that survived 9-12 months, 21-24 months, and 33-36 months post-discharge (Figure 1). As seen in Figure 1, the mean 30 patient-day costs curves confirmed our hypothesis of discrete cost phases. Using join-point analyses, inflection points separating the post-discharge and stable phases, and the stable and pre-death phases were estimated to occur at three months, and 6 months prior to death, respectively. 30-day costing blocks were created within each costing phase, with three blocks for the post-discharge phase, 6 blocks for the pre-death phase, and a single 30-day costing block for the stable phase (See Table 3).

We then assigned individual patient costs to each 30 day costing block within the three phases in a hierarchical fashion, first to the post-discharge phase, then to the pre-death phase, and finally to the stable phase. For example, if a patient survived for 12 months post-discharge, the mean cost for each of the first three months were assigned to each of the corresponding three 30-day costing blocks of the post-discharge phase; the mean cost for each of the last 6 months of life were assigned to each of the corresponding six 30-day costing blocks in the pre-death phase; finally, the remained three months were assigned to the stable category.

Costs for each of the 16,443 patients in our cohort were assigned in this manner. Table 3 summarizes the mean cost for each of the 30 patient-day costing blocks of interest. The cumulative lifetime costs for the *standard care* cohort were estimated by first determining the proportion of the original cohort in each costing block for each 30-day time point in the model over its 12 year time horizon. The total costs at each 30-day time point was then calculated by multiplying the mean cost per block (in Table 3), by the number of patients in the costing block.

The cumulative costs were the sum of the costs across all the time blocks.

To model the life-time costs for the HF clinic group, we adjusted the standard care cost per 30-patient day costing block using estimates from our systematic review (Table 1). For example, we found that all-cause hospitalization increased by 12% (Table 3). Therefore, the acute care hospitalization component of the mean 30 patient-day cost for standard care in each of the costing blocks in Table 2 was increased by 12%. Only a minority of the studies in the systematic review provided data on medication utilization. These suggested that although HF clinic patients had dose intensification compared to those in standard care, the number of medication classes prescribed was not statistically different. As medication costs are proportional to the number of medication classes rather than dose, we assumed medication costs to be similar between treatment strategies. We expected that care in a specialized HF clinic would result in a greater number of subsequent cardiac investigations, such as cardiac magnetic resonance imaging (MRI) or coronary angiography; based on expert opinion, we assumed a 20% increase in diagnostic testing in the HF clinic strategy. The modelled cost per 30 patient-days for each of the costing blocks for the HF groups is summarized in Table 3.

Sensitivity Analyses

One-way deterministic sensitivity analyses were performed to evaluate the robustness of our results. The ranges for the sensitivity analysis were obtained from the 95% confidence intervals from the source documentation (Table 3). We also performed a probabilistic sensitivity analysis (PSA), using second-order Monte-Carlo simulation with 10,000 trials. Beta distributions were used to define all probabilities, and log-normal distributions were used to define costs and ORs; mean and standard deviations to define distributions were obtained from source documentation. Where standard deviations were not available, we assumed a standard deviation that was 50% of the mean. A cost-effectiveness acceptability curve was produced at varying willingness-to-pay thresholds by drawing parameter values at random from all distributions.

The cost-effectiveness analysis model was conducted in Microsoft Excel (Version 2007), and the PSA was conducted using Oracle Crystal Ball (Version 11.1.1). Long term health related costs were estimated using SAS Version 9.1 (SAS Institute).

Budget Impact Analysis

A budget impact analysis was conducted over a 5 year time horizon. The inception HF clinic cohort included all 16,443 cases previously described. We estimated the number of new HF cases per year based on projected population and incidence of HF in Ontario from 2009-2013. (http://www.fin.gov.on.ca/english/economy/demographics/projections/2007). Similar to the cost-effectiveness model, we incorporated an annual 10% attrition rate into the budget impact analysis. The only cost included in the budget impact analyses was the implementation cost of the specialized multidisciplinary HF clinics.

Results

Cost-effectiveness Analysis

The estimated cost of treatment at a multi-disciplinary HF clinic was estimated to be $52 per 30 patient-days, or $624 per patient per year. The individual components of care are summarized in Table 2. The major contributors to the overall cost of care were the physician assessment fee and diagnostic tests performed in the clinic, including echocardiography. Costs associated with nurse practitioner care were only 6% of total costs. Costs associated with other allied health services represented nearly 25% of clinic costs.

The mean cost per 30 patient day costing block for long term costs are presented in Table 3. Within both the post-discharge and pre-death phases, there were substantial differences in mean cost between costing blocks. For example, the mean cost was $10,675 in the first 30 days after discharge, followed by a 75% reduction to $2,961 for the second month post-discharge. Similarly, in the 6 months prior to death, there was a steep increase from $3,062 in the first pre-death costing block, to $8,308 immediately prior to death. The largest contributor to overall health related future costs was hospitalizations for all the costing blocks. Hospitalization costs were most prominent during the more acute phases of the diseases (i.e. the post-discharge and pre-death phases), when they represented over 80% of total costs. In contrast, in the stable phase hospitalizations represented only approximately 50% of costs, during which time costs associated with medications (5%) and physician services (15%) played a larger role.

At 12 years, nearly all of the patients in either cohort were projected to have died (94.6% in the standard care group versus 92.1% in the HF clinic group). However, death was delayed in the HF clinic cohort. The life expectancy of HF patients treated with standard care was estimated to be 3.21 years (Figure 2). In comparison, as seen in Figure 2, those treated at HF clinics were estimated to have an average survival of 3.91 years, a survival gain of approximately 8.5 months. The cumulative lifetime cost associated with standard care was $53,638 compared to $66,532 for patients in the HF clinic group. Thus, HF clinics cost $18,259 for each additional life year gained (ICER is $17,443 for costs and health effects not discounted) (Table 3).

Deterministic (one-way) sensitivity analyses demonstrate that these results were robust, across the range of plausible values. Specifically we did not find that our results varied if medication and diagnostic tests costs associated with specialized HF clinics increased by 50%. Importantly, if the mortality benefit associated with HF clinics was assumed to be the upper limit of the 95% confidence interval from the systematic review (RR 0.91), the HF clinic strategy remained cost-effective. 99.4% of the 10,000 simulations of the PSA were cost-effective at a willingness to pay threshold of $50,000 as seen in the cost-effectiveness acceptability curve displayed in Figure 3.

Budget Impact Analyses

The annual incidence of new HF cases was estimated to be 9.85 per 10,000 persons. Results of the budget impact analysis are found in Table 5. We estimated approximately 13,000 new HF cases per year. As the number of eligible HF patients increased, the implementation costs associated with specialized HF clinics rose from $10,260,432 at baseline to $21,207,178 in year 5. The average annual budget impact was $17,112,302.

Discussion

We performed a cost-effectiveness analysis from the perspective of the MOHTLC of Ontario comparing multi-disciplinary HF clinics to standard care for patients discharged after a hospitalization for HF. We found that HF clinics were associated with an improvement in estimated life expectancy of approximately 8.5 months over the 12 year time horizon of our model, a substantial increase given the poor prognosis associated with this condition. This survival benefit balanced against the increased costs associated with the implementation of the multidisciplinary clinic itself and a small increase in future hospitalizations. Our results were robust across a wide plausible range of inputted parameters, and alternative assumptions regarding costs and benefits of HF clinics, thereby providing evidence to suggest that specialized multi-disciplinary clinics are a cost-effective means of providing ambulatory care to HF patients.

The prognosis for patients with HF has improved tremendously over the last two decades with the introduction of neurohormonal modulating therapies such as angiotensin-converting enzyme (ACE) inhibitors, β-blockers, and aldosterone inhibitors as the main stay of pharmacological therapy for this complex condition. In the past 5 years, improvements in device therapy with the use of automated internal cardiac defibrillators (AICD) for the primary prevention of arrhythmic deaths and re-synchronization therapy in suitable candidates has further reduced mortality. Nonetheless, despite the availability of these therapies, uptake remains poor in part because the optimal use of these treatments requires close supervision by appropriately trained personnel. The majority of HF patients are treated by primary care physicians, who may lack the knowledge or expertise to optimize their patients' medications or identify suitable candidates for advanced device therapy.[24]

Multi-disciplinary clinics likely improve disease management through a number of mechanisms. Given the focus on one particular disease, and enhanced ability for close monitoring, patients at a HF clinic may be more likely to receive appropriate medications and, more importantly, receiving optimal doses.[1;6] Dose intensification to the levels used in clinical trials is critical in order for patients to realize the maximum benefit of these medications. Such dose intensification is facilitated by the specialized supervision available at HF clinics. Furthermore, these complex patients often have concomitant medical, behavioural and social challenges, all of which need to be addressed.[1;6] As such, the availability of allied health professions such as pharmacists, dieticians, social workers and exercise therapist likely contribute to the survival benefit associated with HF clinics.

Current American and Canadian practice guidelines suggest as a Type 1 recommendation that certain subsets of HF patients, specifically those recently admitted to hospital for a HF exacerbation, should be referred to a specialized HF clinic.[1;6] Our study reinforces this recommendation by suggesting that this benefit was cost-effective compared to the traditional willingness to pay threshold of $50,000. This cost-effectiveness persisted despite an apparent increase in long-term hospitalizations and their associated costs.

Our study has important implications for HF care. Given the current climate of limited health care resources, it is essential that any new treatment strategy demonstrate a favourable incremental cost for its additional health benefit. We found that HF clinics had an ICER of approximately $18,000 per life year gained, which compares favourably to other recently adopted cardiac technologies, such as AICD's (ICER $34,000-$70,200 per quality-adjusted life-year gained) and drug eluting stents (ICER >$27,000 per quality-adjusted life year gained).[25-27] As our perspective was that of the 3rd party payer (MOHLTC), we did not incorporate indirect costs, such as caregiver expenses or productivity costs. Given the mortality benefit of HF clinics, and the evidence that disease management strategies improve functional status, we expect that a greater proportion of

patients treated at HF clinics would be able to return to work; thus from a societal perspective, we would anticipate an even greater cost-effectiveness associated with this approach to HF care.

In contrast to previous economic evaluations of HF clinics, our study examined a large, real-world cohort over a long time-horizon.[3;7-11] Moreover, ours is the first study in the literature to use accurate administrative datasets to estimate long term health related costs.[3;7-11] Nonetheless, this study must be interpreted within the context of several important limitations. First, our estimates for the benefits of HF clinics are based on efficacy values from randomized controlled trials with restrictive enrolment criteria and therefore highly selected populations. These are not necessarily generalizable to real world effectiveness in unselected populations. Second, our estimates for the impact of HF clinics are limited to changes in mortality and hospitalizations. We assumed that HF clinics would results in a greater use of subsequent tests and likely medication use, but did not have any data upon which to base our estimates. However, since our results were robust in the sensitivity analyses to a wide range of plausible values for the relative effect of HF clinics on these parameters, we do not expect that our overall conclusions would change significantly. Finally, our model did not account for any quality of life differences between treatments as we restricted our outcomes to life-years and did not incorporate utility weights. With more closely managed care, we would anticipate that there would be greater identification of symptomatic deterioration and subsequent titration of diuretics for example, to improve symptoms and therefore overall quality of life. Therefore, we would expect that incorporating quality of life weights would in fact amplify the differences we observed between HF clinics and standard care.

Finally, our budget impact analysis was restricted to the implementation costs of the HF clinic only and we did not incorporate differences in long term health-related costs. We would expect that these costs in patients enrolled in HF clinics are substantially different. However, we lacked real world estimates and instead modelled long term costs based on multiple assumptions for our primary analysis. Accurate real world estimates for these differential costs are essential to evaluate the cost implications of specialized HF clinics.

In conclusion, in our cohort model examining the cost-effectiveness of multi-disciplinary HF clinics for post-hospitalized patients, we found that these clinics are a cost-effective intervention with substantial mortality benefits. Our results reinforce the guidelines' recommendations that these complex patients be treated at such clinics.

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Figures and Tables

Table 1: Model Input Parameters

Parameter	Base-case Value (95% CI)	Source	Parameter Distribution for PSA
RR for all- cause mortality	0.71 (0.56-0.91)	meta-analysis[13]	log-normal
RR for all- cause hospitalization	1.12 (0.92 – 1.35)	meta-analysis[13]	log-normal
RR for emergency visit	1 (0.5-1.5)	assumption	log-normal
RR for physician assessment/lab test	1.2 (0.7-1.7)	assumption	log-normal
RR for same day surgery	1 (0.5-1.5)	assumption	log-normal
RR for medication	1 (0.5-1.5)	assumption	log-normal
Annual attrition rate from Heart Failure clinics	0.1 (0-1)	assumption	beta

CI: confidence interval; OR: odds ratio; PSA = probabilistic sensitivity analysis

Table 2: Costs Associated with Heart Failure Clinic

Variable	Total Cost / Year ($ CAD 2008)	Cost / 30 Patient-Days* ($ CAD 2008)
Cardiac Technician†	38,311	2.86
Physician†	176,735	13.20
Clerical (booking) †	58,523	4.37
Clerical (charting, data entry) †	17,136	1.28
Dietician†	4,539	0.34
Kinesiologist†	13,322	1.00
Nurse Practitioner†	42,822	3.20
Pharmacist†	9,326	0.70
Social Worker†	2,731	0.20
Operating Costs	6,178	0.46
Utility Charge	2,265	0.17
Blood Work	35,255	2.63
Electrocardiogram**	32,455	2.42
Echocardiogram**	255,860	19.11
Cost per 30 patient-days		***52***

* cost per 30 patient-day block was calculated by dividing the 1 year total costs by the total number of patient visits in the clinic for 1 year, and multiplied by (30/365 days) to determine the cost per 30 patient-days.

† 1 year cost calculated by product of yearly salary (including benefits) by average proportion of time spent in HF clinic

** patients assumed to have one echocardiogram per year, and one EKG per visit

Table 3: Long-term Costs (All costs are reported in 2008 Canadian Dollars)

	Observed Costs (Standard Care)						*Modelled Costs (HF Clinics)*
30 day block	Physician Services	Hospitalization	ER	Same day surgery	Medications	**OVERALL COSTS**	**OVERALL COSTS**
				Post-Discharge phase			
1 block post-discharge	1,170	8,725	617	103	59	10,675	11,955
2 block post-discharge	462	2,267	129	47	56	2,961	3,326
3 block post-discharge	373	1,599	105	42	52	2,172	2,438
				Stable phase			
stable phase	144	384	36	23	31	617	692
				Pre-death phase			
6 block pre-death	437	2,344	178	37	66	3,062	3,430
5 block pre-death	480	2,721	195	37	67	3501	3,923
4 block pre-death	530	3,241	211	30	65	4,077	4,571
3 block pre-death	608	4,162	251	34	63	5,119	5,740
2 block pre-death	872	7,389	356	41	57	8,716	9,777
1 block pre-death	842	7,020	405	20	21	8,308	9,318

ER: emergency room HF: heart failure;

Table 4: Life expectancy, Cumulative costs and Incremental Cost-effectiveness of Heart Failure Clinics and Standard Care

UNDISCOUNTED		
	Cost (CAD 2008)	Life expectancy (years)
Standard care	$61,870	3.87
Heart failure clinic	$77,882	4.78
Δ	$16,012	0.92
ICER	**$17,427**	
DISCOUNTED (Costs and Life Expectancy: 5%)		
	Cost (CAD 2008)	Life expectancy (years)
Standard care	$53,638	3.21
Heart failure clinic	$66,532	3.91
Δ	$12,895	0.71
ICER	**$18,259**	

HF: heart failure; ICER: incremental cost-effectiveness ratio; Δ: difference;

Table 5: Budget Impact Analysis

	Baseline	Year 1	Year 2	Year 3	Year 4	Year 5
Incident Cases	16,443	12,893	13,057	13,221	13,383	13,546
Eligible patients	16,443	24,022	30,452	35,651	39,889	43,376
Cost per 30-day patient ($ 2008 CAD)	52	50	47	45	43	41
Cost per patient per year ($ 2008 CAD)	624	594	566	539	513	489
Budget impact	**$ 10,260,432**	**$ 14,275,951**	**$ 17,235,346**	**$ 19,217,304**	**$ 20,477,600**	**$ 21,207,178**

Figure 1: Exporatory Analysis on Phases of Long Term Cost associated with HF care

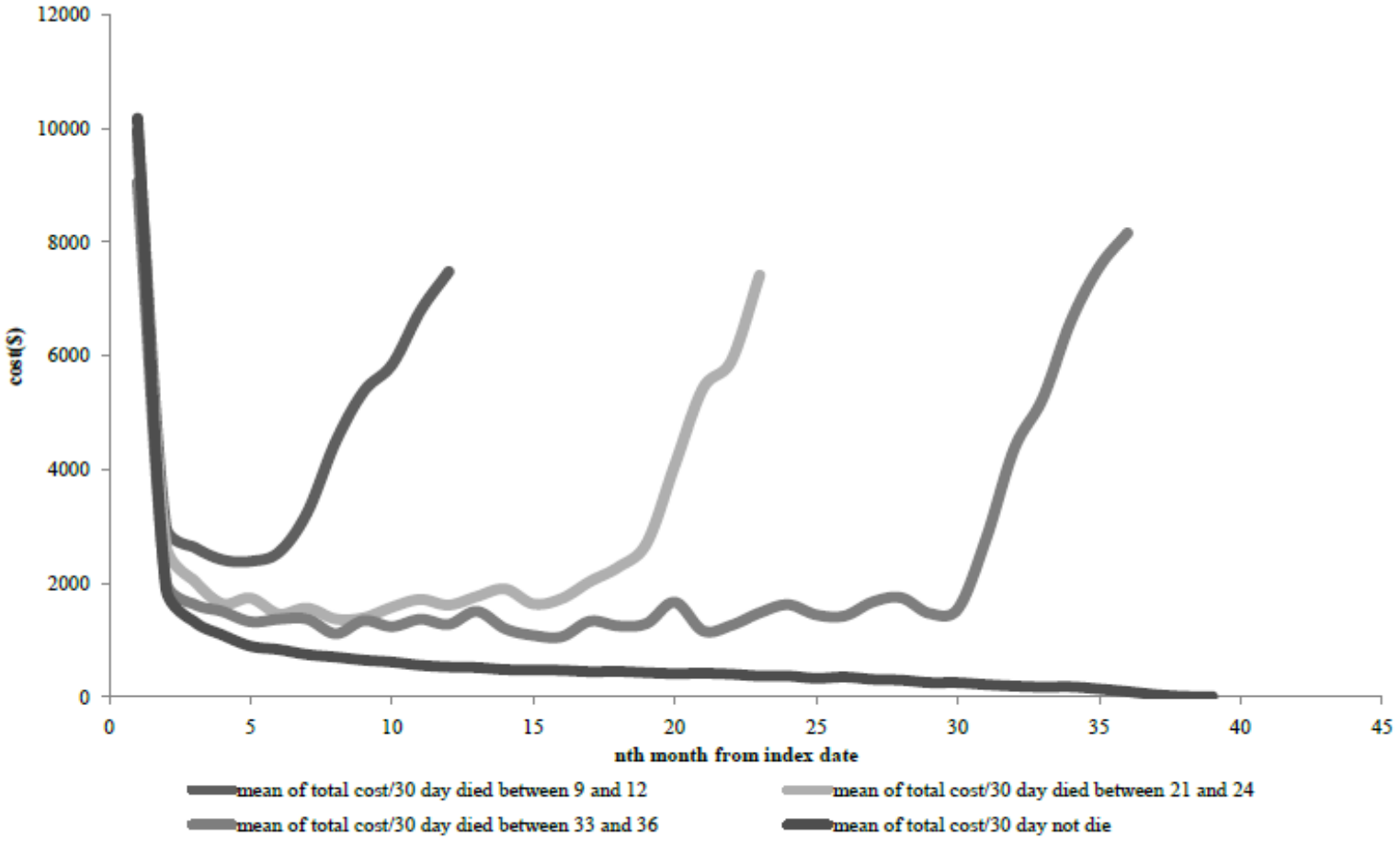


Figure 2: Survival Curves for Patients treated in Health Failure clinic versus Standard Care

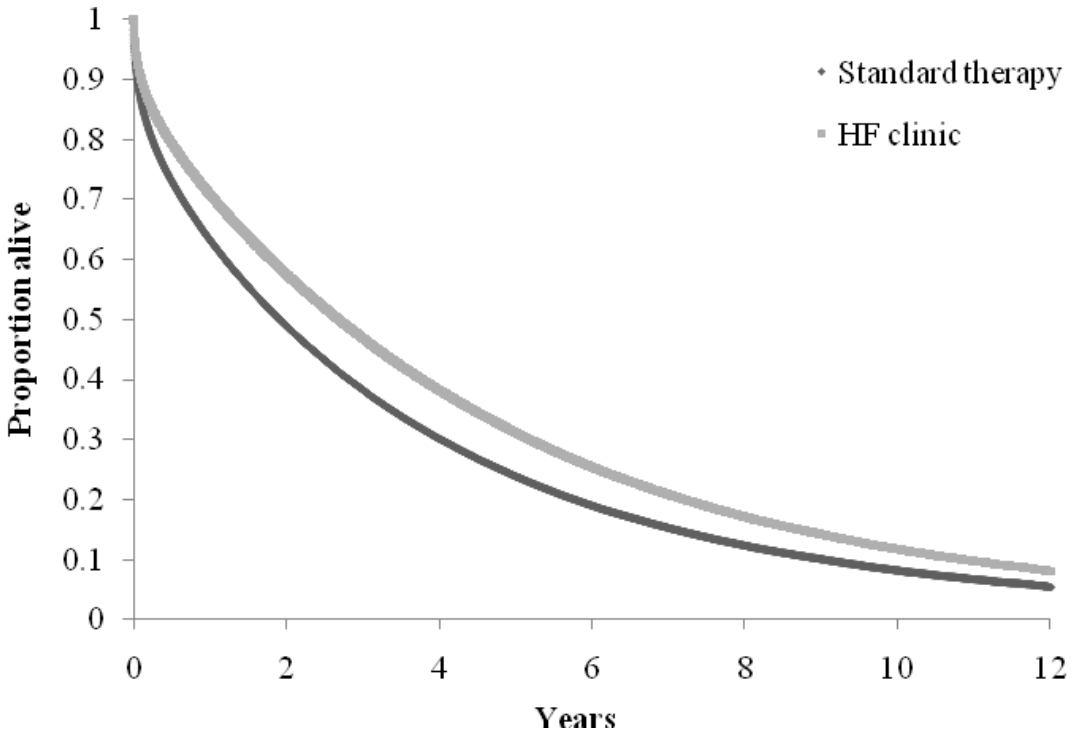
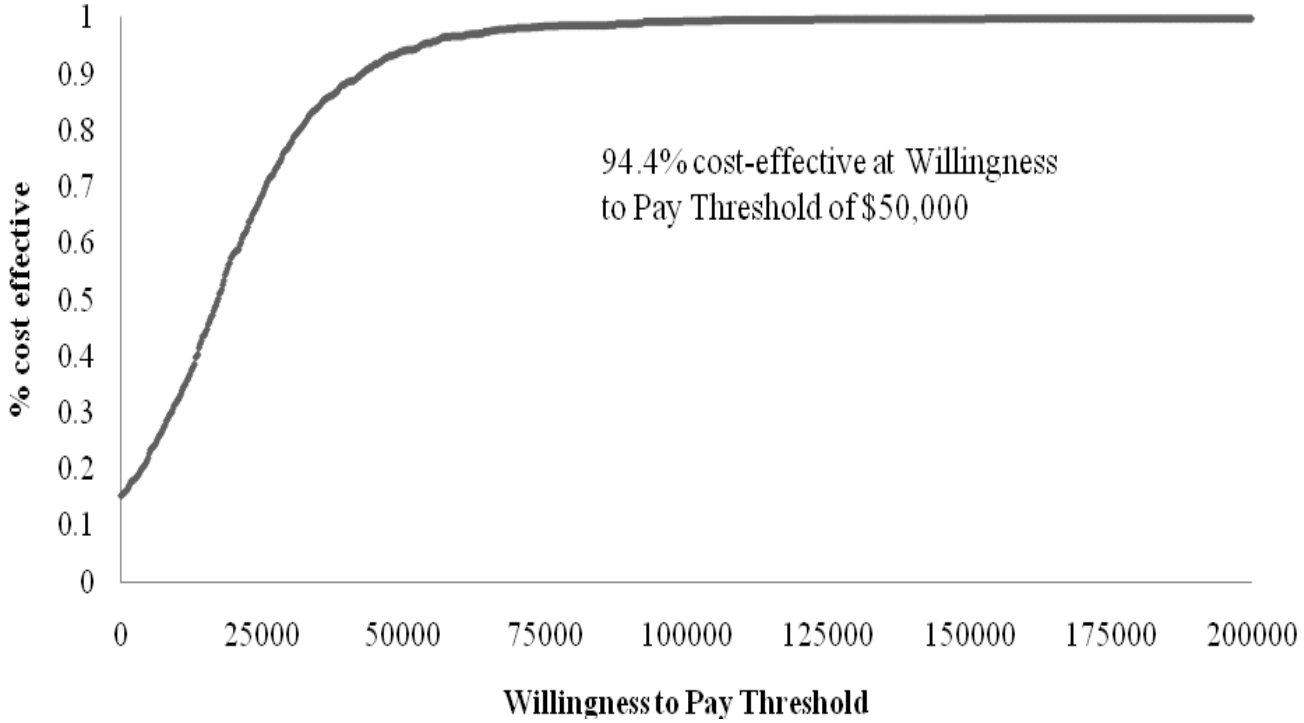


Figure 3: Cost-Effectiveness Acceptability Curve



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