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Optimizing Value from Cardiac Rehabilitation: A Cost-Utility Analysis Comparing Age, Sex and Clinical Subgroups

Running Head: Cost-Utility Analysis of Cardiac Rehabilitation

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Abstract

Background: Cardiac rehabilitation reduces mortality and subsequent cardiac events in patients with coronary heart disease. While economic evaluations of cardiac rehabilitation have been published, none consider clinical, age and sex subgroups to demonstrate how the cost-effectiveness varies.

Methods: We performed a cost-utility analysis comparing cardiac rehabilitation with no cardiac rehabilitation, for patients who had a cardiac catheterization, using a health system payer perspective. The model was stratified by clinical presentation, age and sex. Clinical, quality of life and cost data were provided by the Alberta Provincial Project for Outcome Assessment in Coronary Heart Disease (APPROACH) and TotalCardiology. Data on efficacy was obtained from a meta-analysis of randomized controlled trials.

Results: The incremental cost per quality-adjusted life year (QALY) gained for cardiac rehabilitation is $37,662. The incremental cost per QALY gained varies by subgroup, from $18,101 per QALY gained to $104,518 per QALY gained. There is significant uncertainty in the estimates due to uncertainty in the clinical effectiveness of cardiac rehabilitation. Overall, the probabilistic sensitivity analysis found that 75% of the time, cardiac rehabilitation is more effective and expensive than no cardiac rehabilitation.

Conclusions: The cost-effectiveness of cardiac rehabilitation varies depending on patient characteristics. However, irrespective of baseline characteristics, the cost per QALY gained for cardiac rehabilitation is less than or similar to other technologies funded in many health systems. The current analysis indicates that cardiac rehabilitation is most cost effective for those who suffered an ACS and those who are at higher risk for subsequent cardiac events. The findings of the current study provide insight into who may benefit most from cardiac rehabilitation, with important implications for patient referral patterns.

Keywords: Health Care Costs, Quality of Life, Myocardial Infarction, Quality-Adjusted Life Years

INTRODUCTION

Patients who experience a cardiac event are at high risk of death and subsequent cardiac events[1]. One secondary prevention tool which can be used to reduce these risks is cardiac rehabilitation; a multidisciplinary intervention which focuses on exercise training (aerobic exercise and strength training). Cardiac rehabilitation may also include stress management, medication management, smoking cessation counseling, access to medical specialists, diabetes management and dietary counseling[1-3]. Programs can be offered in an outpatient clinic, or in the home and vary in length from one month[4] to four years[5, 6].

The overarching purpose of cardiac rehabilitation is to improve the health and quality of life of people who have had a cardiac event[7]. Following from these primary objectives, cardiac rehabilitation has also been found to reduce number of hospital days, prevent subsequent events, decrease risk of death, shorten recovery time, and reduce the need for subsequent surgical interventions[7-9].

A large body of literature supports the clinical efficacy of cardiac rehabilitation. Several meta-analyses of randomized controlled trials (RCT), which assess outpatient center-based cardiac rehabilitation, exist in the literature[1, 10, 11]. These meta-analyses demonstrate that completion of a cardiac rehabilitation program may reduce cardiovascular mortality[1, 10, 11], all-cause mortality[10, 11], the risk of a second cardiac event[10], and hospital readmission[1]. It is important to note that these analyses do not demonstrate consistent differences in the effectiveness of cardiac rehabilitation compared to no cardiac rehabilitation, with the 95% confidence intervals of some relative risks (RR) nearing[10, 11] or crossing the null[1].

However, the cost-effectiveness of cardiac rehabilitation remains unclear. In a recent systematic review, sixteen economic evaluations were identified (14 cost-effectiveness studies and 2 cost-utility studies)[12] with some reporting incremental cost-effectiveness ratios above $100,000 and some reporting cost savings. The two existing cost-utility analyses, the most appropriate design to assess the value of cardiac rehabilitation as it measures benefit using quality-adjusted life years (QALY) incorporating both length and quality of life[15, 16], also report conflicting findings. However, they adopted different perspectives (societal versus healthcare payer), were done in different contexts (Canada versus Hong Kong) ,were based on small sample sizes, are out of date, and do not broadly explore the costs and benefits of rehabilitation in a variety of cardiac population subgroups.

The objective of this study was to assess the cost-utility of a center-based outpatient cardiac rehabilitation program compared to no program, in patients who have undergone a cardiac catheterization, using a health system payer perspective. The secondary objective is to determine the cost-utility of cardiac rehabilitation within patient subgroups based on age, sex, and clinical presentation (Acute Coronary Syndrome (ACS) or non-ACS). A primary goal of the current study is to perform an analysis based on current data and practice using a large data set, which will inform healthcare systems about the value for money offered by cardiac rehabilitation.

METHODS

Study Design

A cost-utility analysis was conducted using cost per QALY gained as the primary outcome measure. A Markov model was built to compare two strategies, center-based cardiac rehabilitation versus no cardiac rehabilitation, for patients who have undergone a cardiac catheterization. The model uses two parts to assess costs, utilities and clinical outcomes; the first covering a one-year timeframe after cardiac catheterization, and the second using a Markov process to model subsequent years (**Figure 1)**. A cycle length of one year was used. The model was stratified by age (<65, 65-74, >75 years old), clinical presentation (ACS, non-ACS), and sex (male, female). A lifetime horizon was adopted to ensure all relevant costs and benefits were included in the analysis. Following best practice guidelines a discount rate of 5% was used for all cost and effectiveness estimates[17]. STATA 12 was used for all statistical analysis and Treeage Pro 2012 was used for economic modeling.

Perspective

We adopted a health system payer perspective so that the results will be informative to government decisions regarding funding cardiac rehabilitation programs. All costs that would be borne by a health system payer have been included such as operational, facility, hospitalization and ongoing care costs. Relevant benefits such as survival and quality of life are included in this perspective.

Target Population and Data Sources

The Alberta Provincial Project for Outcome Assessment in Coronary Heart Disease (APPROACH) database provided short and long term clinical, quality of life and cost data. APPROACH captures data from a prospective cohort of all patients undergoing cardiac catheterization in Alberta, a province in Canada of approximately 4 million people[18]. APPROACH data from January 2002-January 2013 were used.

Risk of Death and Second Event

Probability of death and the probability of having a second cardiac event in the year after cardiac catheterization were calculated for each age, sex, and clinical presentation subgroup. Probability of death in the year after catheterization was found using the number of people who died within the first year of cardiac catheterization as the numerator and the total population as the denominator. A second event was defined as any percutaneous coronary intervention (PCI), coronary artery bypass graft (CABG) or catheterization completed between 90 and 365 days after the index catheterization. The total number of second events was divided by the total alive at the end of the year.

Kaplan-Meier survival analysis was used to calculate the annual risk of death for each age, sex and clinical presentation subgroup from year two onwards to inform the Markov modeling segment of the model. Censoring was not required as patient loss to follow-up is less than 1%[19]. Death was used as the event, and time zero was defined as from the date of the initial cardiac catheterization. The end date was March 31st, 2012.

A RR was applied to the death and second event rates to simulate the impact of cardiac rehabilitation. The RR of death (0.82 [95% CI: 0.67-1.01)]) and the RR of second event (0.97 [95% CI 0.77-1.23]) were taken from a recently completed, high quality systematic review of RCTs[1].

Utility Estimates

The utility estimates were calculated using the EuroQol-5D (EQ-5D). The EQ-5D includes five domains: mobility, self-care, usual activities, pain, and anxiety and depression[20]. These domains are combined using an algorithm to produce an overall utility index score that provides a utility estimate on a scale of 0 (very poor health) to 1 (full health)[20]. APPROACH collects the EQ-5D as part of routine long-term follow-up at 1-, 3- and 5-year post catheterization. For this research, utility index scores were calculated for each participant using the United Kingdom algorithm [21]. For each of the age, sex and disease subgroups, 1-year post catheterization utility scores were calculated.

Costs

Costs considered in this analysis include: cost of providing cardiac rehabilitation; cost for the first year after cardiac catheterization for those who do not have a second cardiac event; cost for the first year after cardiac catheterization for those who did have a second cardiac event; annual cost of care after the first year; and cost of managing patients who died. All of the above costs were obtained from previously published APPROACH estimates[22]. Cost per patient of providing cardiac rehabilitation was obtained from the TotalCardiology Rehabilitation and Risk Reduction program, which provides cardiac rehabilitation to approximately 1,000 patients per year. TotalCardiology is a functioning cardiac rehabilitation facility in Calgary, Alberta. This rehabilitation facility provided detailed program costs from 2005-2009. The cost of providing cardiac rehabilitation includes costs such as salaries, employee benefits, professional development, office supplies, medical supplies and exercise equipment, as well as overhead costs such as annual facility costs, advertising, technology, insurance, and electricity. Annual costs were averaged to obtain a robust estimate of the average cost of providing cardiac rehabilitation per patient. All costs were inflated to 2012 Canadian dollars using the consumer price index[23].

Uncertainty

In order to investigate areas of uncertainty in the model, one-way sensitivity analyses, scenario analyses, and probabilistic sensitivity analyses were conducted.

One-way sensitivity analyses were conducted to assess the effect of uncertainty in input variables. Rehabilitation program costs may vary based on staffing, equipment, setting and location. To account for this, program costs were varied within ±50% of the average value observed by TotalCardiology (lower: $1216, upper: $3650). RR of death and RR of event were varied within the 95% confidence intervals. Discount rates (5% in the base-case) were varied from 0% to 3%. Uncertainty in the length of effectiveness of cardiac rehabilitation was modeled by completing two sensitivity analyses; one in which the RR of death was sustained for 5 years, and one which sustained the benefit of cardiac rehabilitation over the lifetime of patients. As the time from referral to program commencement is likely to vary by program, the timing of the effect of cardiac rehabilitation was varied. We completed sensitivity analyses considering commencement of cardiac rehabilitation 30 days post-event (risk of death excluded deaths within 30 days of initial catheterization), 60 days post-event (risk of death excluded deaths within 60 days of initial catheterization), and 90 days post-event (risk of death excluded deaths within 90 days of initial catheterization).

A scenario analysis was completed in order to model the cost-utility of a functioning cardiac rehabilitation program. Using RCT-based RRs from the literature makes the base-case generalizable; however, these RRs were obtained under experimental conditions. Therefore, a scenario analysis using RRs based on propensity matched data from TotalCardiology was conducted[9].

Using probabilistic sensitivity analysis, costs, probability of death, probability of second event, RRs and utilities for all subgroups were simultaneously varied according to their distributions in order to reflect the uncertainty surrounding their point values. Ranges and distributions were assigned to all variables. Lognormal distributions were used for costing estimates and RRs, while normal distributions were used for utilities, survival estimates, probabilities of death and probabilities of having a second event[24].Monte Carlo simulation was used to simultaneously vary each variable within its distribution for a hypothetical cohort of patients. This analysis was run 5,000 times.

RESULTS

Model Validity

The validity of the decision model was assessed in accordance with published guidelines[17]. Technical accuracy and internal validity was assessed by systematically modifying the inputs, using extreme or null values, and assessing the impact this had on outcomes. Outcomes were assessed for external validity by comparing costs per QALY found in this analysis with outcomes found in existing cost-utility analyses[25, 26].

Patient Cohort

The clinical inputs were calculated using a cohort of 121,763 patients captured in the APPROACH database (**Table 1**), 71.1% of whom were male. The mean age of the cohort was 62.9 years (SD: ±11.91). This cohort is comprised of 65% ACS patients and 35% non-ACS patients.

Clinical probabilities/utility inputs, and costs, are presented in **Tables 2** and **3** respectively. The long-term survival, by subgroup, is presented in **Figure 2**. As expected, the probability of death one year after a cardiac event was higher for older patients, and individuals with ACS were more likely to die than those with non-ACS conditions (6.97% versus 3.34%). Similarly, the survival analyses shows that those who are older have a lower survival function, and are therefore more likely to die (10 year survival: 87% for <65 years old, 73% for age 65-75, and 52% for over 75 years old). The utility scores were higher for individuals who did not have a second event, which indicates that these individuals reported a higher health related quality of life (0.82 versus 0.78).

Base-Case Results

The results from the base-case cost-utility analysis are presented in **Table 4.** When a health system payer perspective is taken, the cardiac rehabilitation strategy is the most expensive, but also the most effective strategy. Overall, the cost for post-cardiac event patients who do not participate in cardiac rehabilitation is $43,180 compared to $45,793 for the same population who go through a rehabilitation program; a cost differential of $2,613. Although the cardiac rehabilitation program strategy is more expensive, it results in more QALYs gained. Compared to no rehabilitation, the cardiac rehabilitation program has an incremental cost of $37,662 per QALY gained.

The cost and utility of cardiac rehabilitation varied within the sex, age and clinical presentation subgroups. Within the subgroups, the incremental cost per QALY gained ranged from $18,102 for ACS males over 75 years old, to $104,519 for non-ACS females under 65 years old. Broadly, cardiac rehabilitation was more economically attractive for individuals with ACS when compared to those with non-ACS, and for individuals who were older and at higher risk of subsequent events compared to those who were younger.

The results of the one-way sensitivity analysis are presented in **Table 5**, by subgroup. When program costs were varied from $1,216-$3,650, the cost effectiveness ranged from $10,602 to $156,023 cost per QALY gained. As expected, higher cost per QALYs were associated with higher program costs. When all utilities were set to 1 (full health), the cost per life year gained ranged from $15,069-$87,518.

When the lower 95% CI for RR of death (0.67) was used, the cost per QALY gained decreased compared to the base case (range: $11,291 to $62,432). When the upper 95% CI was used with the RR of death (1.01), cardiac rehabilitation was less effective and more costly than no cardiac rehabilitation (dominated) in ten of the twelve subgroups. Only in non-ACS under 65 males and females did cardiac rehabilitation remain a more effective option although with substantially higher costs per QALYs gained. Incorporating the RR of death (0.82) for five years in patients who underwent cardiac rehabilitation resulted in a decreased cost per QALY gained (range: $6,409-$24,800) compared to the base case. When the RR of death was incorporated throughout the lifetime of those who underwent cardiac rehabilitation, the cost per QALY gained lowered further (range: $5,169-$11,515).

When the RR of second event was reduced to the lower 95% CI bound (0.77), the cost per QALY gained decreased compared to the base case (range: $18,648 to 48,698). When RR of second event was increased to the upper 95% CI bound (1.23), in non-ACS under 65 females cardiac rehabilitation was dominated, and the other groups ranged between $17,512 and $100,036.

When the probability of death in the first year was reduced, by excluding deaths 30, 60 and 90 days after cardiac catheterization, cardiac rehabilitation became less economically attractive. When counting deaths from 30-365 days after cardiac catheterization, the cost per QALY gained varied from $33,874 to $122,543. Cost per QALY gained increased when deaths 60-365 days after cardiac catheterization were included (range: $36,169-$142,805), and further increased when deaths were counted from 90-365 days post-catheterization (range: $43,501-$157,362).

For the scenario analysis simulating a real-world cardiac rehabilitation program, the propensity matched RR of second event was found to be 0.67 (95% CI: 0.54-0.81), and the RR of death was found to be 0.9913 (95% CI: 0.86-1.18). The scenario analysis confirms the results found in the base-case analysis; cardiac rehabilitation remains the more effective and more expensive strategy. Compared to no rehabilitation, cardiac rehabilitation had an incremental cost per QALY gained of $22,481. Cardiac rehabilitation was most economically attractive in males over 75 with ACS (cost of $11,294 per QALY gained), while non-ACS females under the age of 65 had the highest cost per QALY gained ($67,055). Similar to the base-case, cardiac rehabilitation was a more economically attractive option for those with ACS, and for older individuals.

Probabilistic Sensitivity Analysis

The incremental-effectiveness scatterplot of cardiac rehabilitation versus no cardiac rehabilitation is presented in **Figure 3**, with each point representing one simulation. All points below and to the right of the willingness to pay line in **Figure 3** represent trials in which the incremental cost per QALY gained is below $50,000. This analysis shows that cardiac rehabilitation will be more effective and more expensive 74.84% of the time. Cardiac rehabilitation will be more expensive and less effective 18.56% of the time, more effective and less expensive 3.54% of the time, and less expensive and less effective 3.06% of the time.

DISCUSSION

In the base-case analysis, we found that cardiac rehabilitation resulted in greater cost but a better clinical outcome compared to no cardiac rehabilitation for patients who have had a cardiac event. Considering a health system payer perspective, the overall cost per QALY gained associated with center-based cardiac rehabilitation was $37,662. Amongst the subgroups assessed in the current study, this cost varied widely; from $18,102 to $104,519 per QALY gained, depending on age, clinical presentation and sex. Broadly, cardiac rehabilitation provides better value for money for individuals who have ACS and are at higher risk of subsequent cardiac events.

Program costs, RR of death, RR of second event, discount rates, probability of death in the first year, and utility estimates impacted the cost-effectiveness of cardiac rehabilitation in the one-way sensitivity analysis. Notably, when RR of death and second event were varied, cardiac rehabilitation became dominated in some subgroups; when the RR is greater or equal to 1.0, cardiac rehabilitation was more costly but no more effective than no cardiac rehabilitation. Given that the 95% confidence intervals associated with both the RR of death and second event include 1.0, cardiac rehabilitation may represent an investment that does not offer additional clinical benefit to all patients. The probabilistic sensitivity analysis demonstrates this is the likely case 18.56% of the time for patients overall.

Compared to the two other cost-utility analyses in the literature, by Yu et al.[26] and Oldridge et al.[25], we found a higher cost per QALY gained. Due to differences in sample size, perspective, currency, and year, the estimates of the previous cost-utility analyses are not easily comparable to the results of this cost-utility analysis. Our analysis is the largest to date, uses the longest follow-up and uniquely incorporates subgroups to identify patient groups that may benefit most from cardiac rehabilitation.

As shown in the sensitivity analysis, cardiac rehabilitation becomes more economically attractive when the RR of death is sustained over a longer period of time. There are participants who participate in cardiac rehabilitation who do not remain compliant with the program, for various reasons[27, 28]. Long-term noncompliance with cardiac rehabilitation programming may help to explain when the additional costs incurred do not result in clinical benefit. However, further evidence on the long-term impact and benefit of cardiac rehabilitation is required.

The scenario analysis modeling the cost-utility of an operational real-life cardiac rehabilitation program found cardiac rehabilitation to have an incremental cost-utility ratio of $22,482 per QALY gained. Subgroups in the scenario analysis ranged from $11,294 to $67,055 per QALY gained, based on age, sex and clinical presentation. This analysis provides confidence that our results are not limited to experimental settings, and are generalizable to practice.

The cost per QALY gained for cardiac rehabilitation compared to no intervention is similar to that of other technologies that are funded within many health care systems. Published estimates for coronary artery bypass surgery range from CAN $13,200 to $100,000 per QALY gained[29, 30], and cardiac defibrillators when implanted in cardiac arrest survivors with a low ejection fraction are an estimated CAN $75,000 per QALY gained[31]. Although the cost per QALY for cardiac rehabilitation overall, $37,662, is within what many would consider an "acceptable" range, cardiac rehabilitation does require a significant annual budget, in the range of $2-3 million dollars annually to support approximately 1000 participants. Thus, health care providers and insurers must understand that there would be an upfront investment in cardiac rehabilitation.

Within the context of a fixed healthcare budget, it is important to consider the opportunity cost (the health benefit that could have been derived from funding the next best alternative) associated with programs[29]. There is a growing body of literature documenting factors other than the cost per QALY are valued in funding decisions. These include 1) whether an intervention is immediately lifesaving, and less so, the expected gain in life expectancy, 2) the impact on quality of life, 3) the number of people eligible for treatment, 4) the age of the potentially treatable patients (younger versus older), 5) whether the treatment was for people with good or poor underlying baseline health, 6) the likelihood of the treatment being successful, and 7) its impact on equality of access to therapy[32-34]. Applying this checklist to cardiac rehabilitation, one could make the case that increasing the focus of cardiac rehabilitation towards those with ACS and those at higher risk of subsequent events is an attractive option as it would direct resources towards those likely to achieve the greatest impact on quality of life, those with lower underlying health and those with the greatest capacity to benefit.

In some health care systems, restricting funding of cardiac rehabilitation may be possible. However, in other systems, the most feasible implementation approach may be to target providers and patients, ensuring that those who are likely to experience the most benefit are strongly encouraged to participate in cardiac rehabilitation. Implementation must consider the "levers" available within the health care system.

Several limitations merit comment. We chose to examine the impact of cardiac rehabilitation on cardiovascular disease, particularly, the intervention's impact on second events and death. This model therefore does not intend to capture all of the benefits that may be associated with cardiac rehabilitation. Any other impacts on quality of life are not directly included in the model. For example, the impact of cardiac rehabilitation on other possible comorbidities, such as diabetes, or obesity, was not modeled directly. However, some of the effect on these other comorbidities will have been indirectly modelled as the patients enrolled in the RCTs, which informed the estimate of clinical effect, may have also had comorbidities. In addition, we are unable to distinguish those that underwent cardiac rehabilitation and those that did not within the cohort of APPROACH patients used to calculate the clinical probabilities in the base-case analysis. Thus, the clinical probabilities of death, second event and quality of life may be overestimates of the true values for patients who do not undergo cardiac rehabilitation. Lastly, we did not examine other perspectives that include patient-related health costs; no recent comprehensive patient-related costing data was found in the literature. Future research on patient-related costing data would facilitate the development of models capturing these broader costs.

In conclusion, cardiac rehabilitation appears to be an economically attractive intervention for individuals who have had a cardiac event. Our findings support the use of cardiac rehabilitation, particularly for those over 75 years old and those with ACS. Although cost-effective, this intervention is not cost-savings, and does represent an opportunity cost. The provision of cardiac rehabilitation does incur an "up-front" investment and is therefore dependent on the availability of additional resources.

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Conflict of Interest: The authors declare that they have no conflict of interest.

Table and Figure Legend

Figure 1: Structure of Tree for Modeling Cardiac Rehabilitation compared to No Cardiac Rehabilitation

Figure 2: Survival Analysis for Patients from year 2-15 after Cardiac Catheterization

Figure 3: Monte Carlo Incremental Scatterplot showing the Probabilistic Sensitivity Analysis of Cardiac Rehabilitation compared to No Cardiac Rehabilitation

Table 1: Cohort Demographics of Included Participants who have Undergone Cardiac Catheterization as Captured by the APPROACH Database

Table 2: Clinical Probabilities and Utility Inputs used in Economic Model

Table 3: Cost Inputs used in Economic Model

Table 4: Cost-utility Results Comparing Cardiac Rehabilitation to no Cardiac Rehabilitation

Table 5: One-way Sensitivity Analysis Results Comparing Cardiac Rehabilitation to no Cardiac Rehabilitation

TABLES AND FIGURES

Figure 1

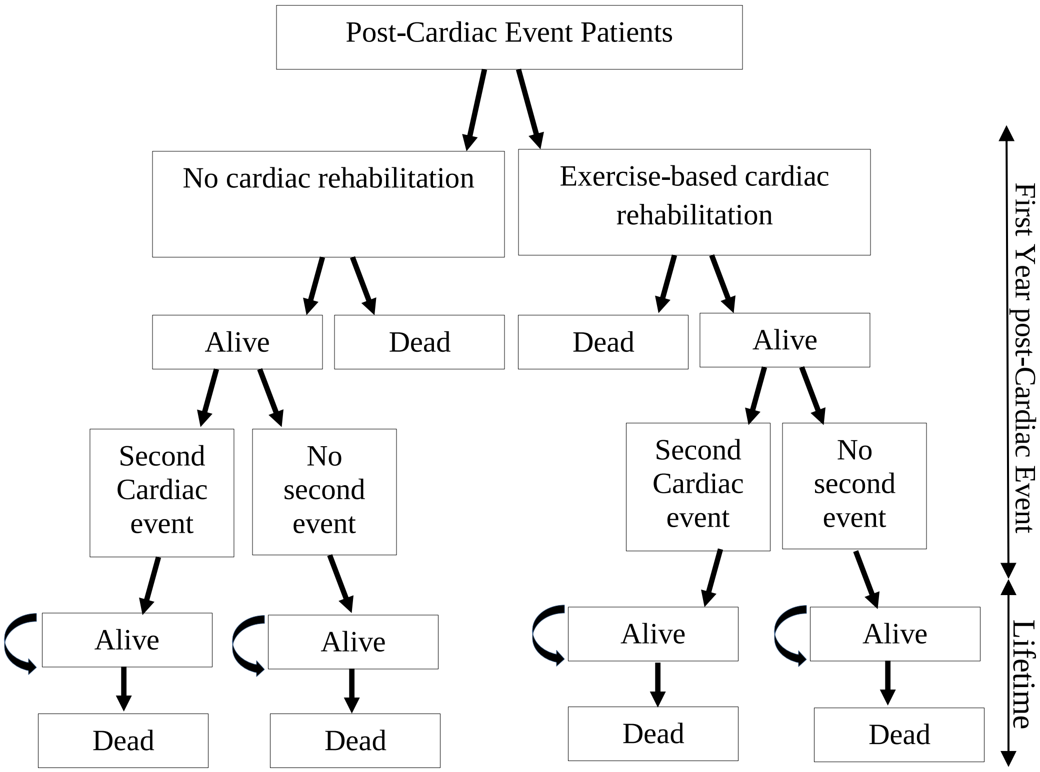

Figure 2
A: Males ACS, **B:** Females ACS, **C:** Males NACS, **D:** Females NACS

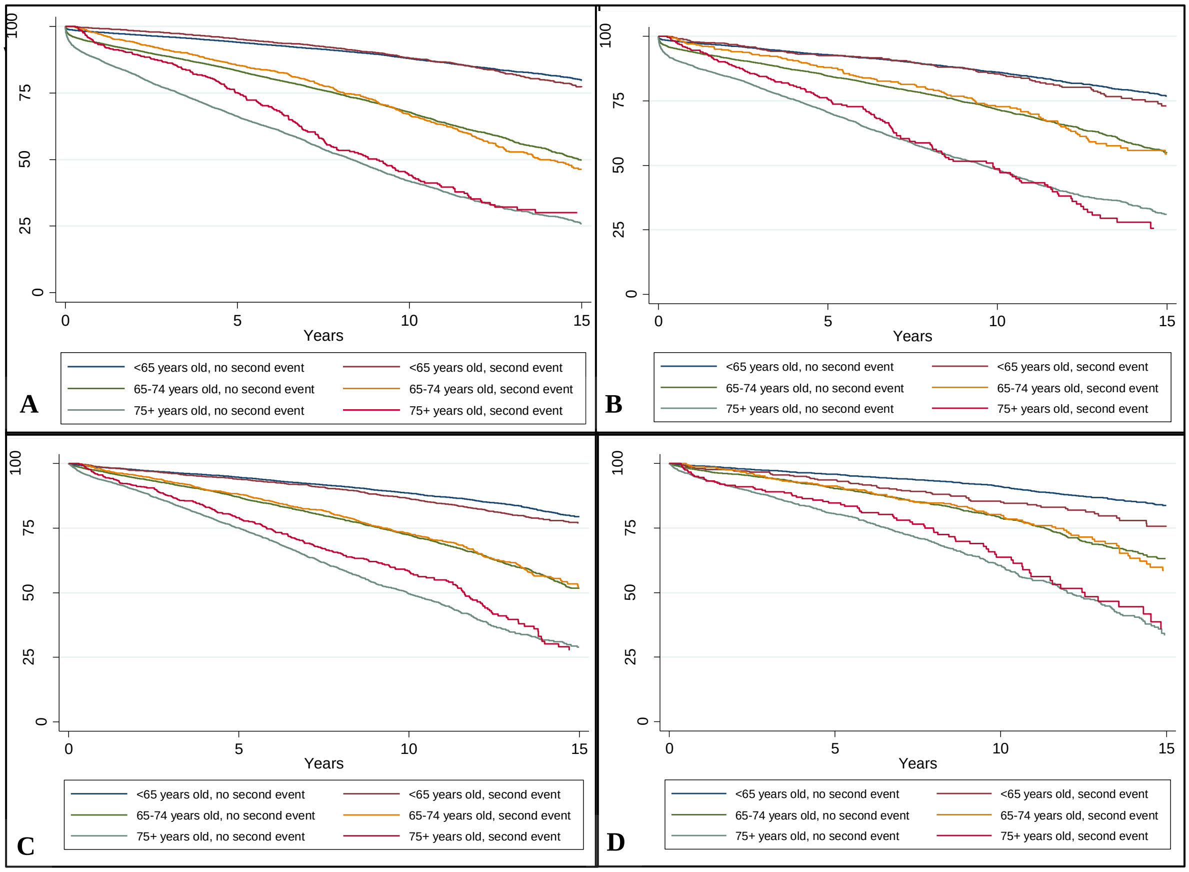

Figure 3

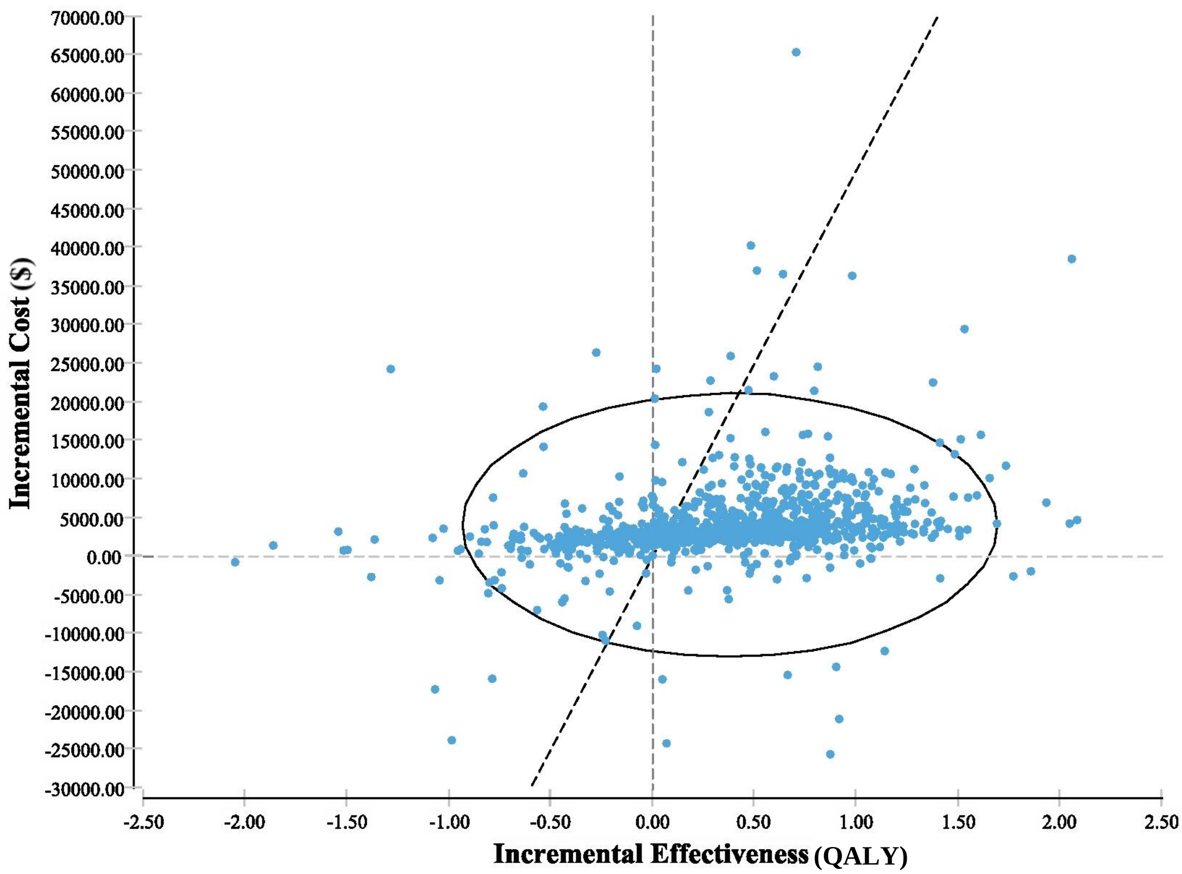

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Table 1

Demographic Characteristics	**Total Cohort**	**Age**			**Clinical Condition**	
		<65	*65-75*	*>75*	*ACS*	*Non-ACS*
Sample Size	121,763	67,390	33,232	21,141	79,398	42,365
Mean age (±SD)	62.94±11.91	54.19±7.59	69.87±2.87	79.89±3.69	62.66±12.42	63.46±10.88
Sex (% male)	71.11	75.82	68.59	60.05	70.79	71.70

Table 2

Variable	ACS						Non-ACS					
	<65		65-75		>75		<65		65-75		>75	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Probability of Second Event %(SD)	7.86 (0.27)	6.45 (0.25)	7.99 (0.27)	6.67 (0.25)	5.98 (0.24)	4.94 (0.22)	13.79 (0.34)	7.87 (0.26)	16.97 (0.38)	11.06 (0.31)	14.62 (0.35)	11.03 (0.31)
Probability of Death %(SD)	2.23 (0.15)	2.66 (0.16)	6.26 (0.24)	6.07 (0.24)	12.80 (0.33)	11.79 (0.32)	1.42 (0.12)	1.05 (0.10)	2.86 (0.17)	2.51 (0.16)	5.95 (0.24)	5.85 (0.23)
Utilities (No Second Event)	0.87 (0.19)	0.79 (0.24)	0.88 (0.17)	0.82 (0.197)	0.83 (0.19)	0.77 (0.23)	0.85 (0.21)	0.77 (0.23)	0.87 (0.18)	0.80 (0.20)	0.84 (0.19)	0.77 (0.19)
Utilities (Second Event)	0.78 (0.23)	0.69 (0.25)	0.85 (0.16)	0.78 (0.24)	0.84 (0.18)	0.69 (0.29)	0.79 (0.24)	0.71 (0.28)	0.85 (0.19)	0.79 (0.23)	0.83 (0.19)	0.79 (0.19)

Table 3

	Value	**Standard Deviation**	**Median**	**Source**
Costs (2012 CAD)				
Program costs per patient (facility, salaries/benefits, advertising, equipment, office and medical supplies, insurance)	$2,433	130	$2486	TotalCardiology (2005-2009)
Event-free (year 1)	$6,254	$3930	$1497	Shrive et al.[22]
Event (year 1)	$18,828	$8195	$5939	Shrive et al.[22]
Annual cost of care after first year	$2,813		$1397	Shrive et al.[22]
Cost of Death	$14,368		$1414	Shrive et al.[22]

Table 4

Inputs	Strategy	Cost ($)	Incremental Cost ($)	QALYs	Incremental QALY	Incremental cost per QALY gained
Overall	No Rehab	$43,179.57		9.70		
	Rehab	$45,792.91	$2,613.34	9.77	0.07	$37,662.00
ACS (Overall)	No Rehab	$42,310.08		9.51		
	Rehab	$44,975.61	$2,665.53	9.59	0.08	$32,178.75
ACS Males (Overall)	No Rehab	$42,759.39		9.90		
	Rehab	$45,398.13	$2,6398.74	9.98	0.08	$32,949.38
ACS Males (Under 65)	No Rehab	$45,852.59		11.26		
	Rehab	$48,390.01	$2,537.42	11.31	0.05	$50,237.56
ACS Males (65-74)	No Rehab	$40,136.19		8.75		
	Rehab	$42,845.39	$2,709.20	8.85	0.10	$26,082.83
ACS Males (75+)	No Rehab	$34,377.52		6.22		
	Rehab	$37,315.54	$2,938.01	6.38	0.16	$18,101.74
ACS Females (Overall)	No Rehab	$41,220.82		8.57		
	Rehab	$43,951.31	$2,730.49	8.66	0.09	$30,507.15
ACS Females (Under 65)	No Rehab	$45,049.92		10.07		
	Rehab	$47,610.47	$2,560.55	10.12	0.05	$49,044.73
ACS Females (65-74)	No Rehab	$40,666.94		8.52		
	Rehab	$43,379.58	$2,712.64	8.62	0.10	$27,519.07
ACS Females (75+)	No rehab	$35,211.31		6.05		
	Rehab	$38,255.82	$3,044.51	6.20	0.14	$21,151.82
Non-ACS (Overall)	No Rehab	$44,809.12		10.04		
	Rehab	$47,324.64	$2,515.52	10.09	0.04	$56,925.48
Non-ACS Males (Overall)	No rehab	$44,861.93		10.23		
	Rehab	$47,372.95	$2,511.01	10.28	0.05	$55,174.42
Non-ACS Males (Under 65)	No Rehab	$47,049.88		11.25		
	Rehab	$49,517.43	$2,467.56	11.28	0.03	$75,753.43
Non-ACS Males (65-74)	No Rehab	$43,464.19		9.56		
	Rehab	$45,987.45	$2,523.26	9.61	0.05	$49,471.90
Non-ACS Males (75+)	No Rehab	$39,105.33		7.63		
	Rehab	$41,763.95	$2,658.62	7.71	0.09	$31,099.69
Non-ACS Females (Overall)	No Rehab	$44,675.27		9.56		
	Rehab	$47,202.21	$2,526.94	9.61	0.04	$61,870.91
Non-ACS Females (Under 65)	No Rehab	$47,081.06		10.55		
	Rehab	$49,550.34	$2,469.728	10.58	0.02	$104,518.61
Non-ACS Females (64-74)	No Rehab	$44,180.38		9.50		
	Rehab	$46,710.37	$2,529.99	9.54	0.04	$56,335.14
Non-ACs Females (75+)	No Rehab	$39,304.39		7.12		
	Rehab	$41,974.86	$2,670.47	7.20	0.08	$34,065.37

Table 5

Variable	ACS						Non-ACS					
	<65		65-75		>75		<65		65-75		>75	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Base-case	$50,237	$49,044	$26,082	$27,519	$18,101	$21,151	$75,753	$104,518	$49,471	$56,335	$31,099	$34,065
Program Costs												
High	$74,328	$72,351	$37,797	$39,863	$25,598	$29.605	$113,108	$156,022	$73,328	$83,429	$45,333	$49,587
Low	$26,138	$25,730	$14,364	$15,170	$10,6021	$12,695	$38,385	$52,997	$25,607	$29,231	$16,861	$18,538
RR of Death												
Upper 95% CI	Dominated	Dominated	Dominated	Dominated	Dominated	Dominated	$1,330,028.86	$1,001,508.09	Dominated	Dominated	Dominated	Dominated
Lower 95% CI	$29,290	$28,731	$15,553	$16,383	$11,291	$13,060	$44,623	$62,432	$28,440	$32,442	$18,326	$20,063
RR of 0.82 sustained over 5 years	$15,196	$14,521	$8,269	$8,882	$6,409	$7,476	$18,357	$24,800	$11,157	$13,626	$8,018	$9,730
RR of 0.82 sustained over lifetime	$8,369	$8,490	$5,546	$6,082	$5,169	$5,860	$8,934	$11,515	$6,063	$7,232	$5,488	$6,203
Probability of Death Within One Year												
Probability of death 30-365 days after Catheterization	$103,524	$90,478	$46,086	$49,745	$33,873	$37,048	$86,325	$122,543	$60,324	$66,820	$35,277	$40,827
Probability of death 60-365 days after Catheterization	$118,151	$103,546	$56,536	$60,366	$36,169	$46,050	$93,693	$142,804	$66,549	$74,748	$39,757	$47,379
Probability of death 90-365 days after Catheterization	$132,103	$113,491	$66,679	$70,628	$43,500	$55,434	$104,517	$157,361	$73,897	$82,439	$47,570	$54,685

RR Second Event												
Upper 95% CI	$100,035	$95,282	$28,157	$28,645	$17,512	$23,018	$981,996	Dominated	$64,011	$79,258	$32,342	$34,343
Lower 95% CI	$34,463	$34,307	$24,438	$26,587	$18,648	$19,769	$38,509	$48,697	$39,363	$43,854	$29,882	$33,799
Discount												
None	$29,255	$28,944	$17,040	$17,788	$12,513	$14,540	$43,978	$57,993	$31,285	$33,559	$20,329	$23,137
3% rate	$41,194	$40,402	$22,271	$23,401	$15,778	$18,398	$62,090	$84,304	$41,813	$46,611	$26,612	$29,510
6% rate	$55,010	$53,596	$28,056	$29,658	$19,287	$22,560	$82,957	$115,265	$53,439	$61,421	$33,395	$36,405
Utilities												
Set to 1.0	$45,643	$40,615	$22,985	$22,716	$15,069	$15,540	$71,264	$87,517	$44,261	$45,729	$26,114	$26,231

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