



## Original Research

# Cost-effectiveness of symptom monitoring with patient-reported outcomes during routine cancer treatment



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## A B S T R A C T

**Background:** A recent study reported that inclusion of a patient-reported outcome (PRO) tool for symptom monitoring during routine cancer treatment for patients with advanced or metastatic disease leads to improved health-related quality of life, decrease in emergency room visits and hospitalization, and improvement in overall survival. Whether the implementation of such a tool would be cost-effective remains uncertain.

**Objectives and decision problem:** The purpose of the present study is to evaluate the cost-effectiveness of a patient-reported outcome tool for symptom monitoring in patients undergoing treatment for advanced or metastatic cancer in Alberta compared to standard of care symptom monitoring from the perspective of the public payer in Alberta.

**Methods:** A Markov model incorporating two health states (alive and dead) was used to calculate the incremental cost-effectiveness ratio of a web-based PRO tool for symptom monitoring compared to standard of care over a lifetime horizon. Clinical data was informed from the results of a North American randomized study of a similar web-based PRO tool for patients with metastatic cancer. Cost data was collected from provincial sources and prior Canadian publications. One-way sensitivity and probabilistic sensitivity analyses were performed to evaluate uncertainty in the model. A budget impact was performed to determine overall cost of implementation in the first three years.

**Results:** In the base-case analysis, the PRO tool provided 2.17 QALY's at a total cost of \$69,030 compared to SOC arm yielding 1.92 QALY's at a total cost of \$65,670. The deterministic incremental cost per QALY gained was \$13,450. A probabilistic sensitivity analysis of 14 variables over 1000 iterations gave a probabilistic mean ICER of \$13,110. Overall cost of implementation for Alberta in the first three years was estimated at \$1,488,160. Implementation however became cost-savings when savings for ER visits and hospitalizations were included.

**Conclusions:** The results of this analysis show that for a cost increase of \$3360 CAD, the use of a PRO tool for symptom monitoring yields an additional 0.25 QALYs. At a cost per QALY of ~\$13,450, this would be considered good value for money at the typically accepted Canadian standard of \$50,000 per QALY.

## 1. Introduction

Cancer is common in Canadians, with approximately one in two developing cancer in their lifetime, and one in four ultimately dying of the disease [1]. For patients with advanced cancers receiving systemic therapy, there is a high burden of symptoms related both to treatment, and to the disease itself [2]. In many cases, these symptoms go unnoticed with standard monitoring practices [3,4]. Studies evaluating the correlation between patient reported symptoms and physician recordings in cancer patients show poor agreement, and high variability [4]. Current standard of care, which includes monitoring symptoms using paper forms filled out at routine clinic visits in addition to patient

interviews, can be inefficient and vulnerable to error [5]. Much of the inefficiency of this practice lies in the timing of data collection, which is based on convenience. Ultimately, this leads to a reactive approach, where symptoms may be significant by the time they are treated. In addition to the clinical toxicities, symptom treatment is expensive. In a Canadian study evaluating hospital admissions for patients with metastatic cancer, poor symptom control accounted for ~70% of admissions, substantially driving up the cost of care for this population [6]

Patient-reported outcome (PRO) tools that utilize a systematic method of symptom collection have been shown to improve symptom control. Online tools have been put forth as an adjunct to current practice of symptom monitoring as a way to move towards a proactive

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approach [7,8]. Previous studies have demonstrated online systems result in more frequent interventions from physicians, better symptom control, and enhanced patient-physician communication [9–11]. In spite of these encouraging results, systematic reviews combining studies to evaluate the value of electronic PRO's, have not demonstrated consistent benefits due to issues with study structure such as small sample size, high degrees of bias, and varying endpoint measures [12].

In a recent, prospective randomized study by Basch and colleagues, patients with metastatic genitourinary (GU), breast, lung, or gynecologic cancers undergoing systemic treatment at Memorial Sloan Kettering Cancer Centre (New York, NY USA) were randomized to usual care, or a web-based self-reporting of symptoms tool [13]. Standard of care (SOC) consisted of usual practice, where symptoms are discussed and documented in the medical record at clinic visits, and patients are encouraged to contact via telephone between visits if needed. Patients randomized to the web-based tool used a platform known as STAR (Symptom Tracking and Reporting) to collect patient reported information on symptoms previously demonstrated to be easy to use for cancer patients at home, and in clinics [14–16]. At study enrollment, participants were trained to use STAR, and completion of a baseline report was observed. At subsequent clinic and treatment visits study staff invited participants to self-report on either a mobile device or computer kiosk. Participants also received a weekly e-mail reminders suggesting, but not requiring between-visit reports. The questionnaire itself contained 12 common symptoms experienced during chemotherapy adapted from the National Cancer Institute's (NCI-s) Common Terminology Criteria for Adverse Events (CTCAE). STAR triggered e-mail alerts to nurses when participants reported symptoms worsening by  $\geq 2$  points or reached absolute grade  $\geq 3$ . Patients were on study for a mean duration of 7.4 months with median of 3.7 months (range 0.25–49). Their primary outcome of change in health-related quality of life (HRQoL) at six months showed patients in the intervention arm had a statistically significant benefit, with a decrease of 1.4 vs. 7.1 points on the EuroQol-5 Dimensions questionnaire (EQ-5D) scale from baseline ( $p < 0.001$ ). Secondary endpoints also showed improvement with fewer emergency room visits (probability in 1 year 0.34 vs. 0.41,  $P = 0.02$ ) and hospitalizations (probability in 1 year 0.45 vs. 0.49  $P = 0.08$ ). In an updated analysis after a median of seven years of follow-up presented at the annual American Society of Clinical Oncology (ASCO) meeting in 2017, overall survival showed a statistically significant improvement from the use of the PRO tool, with an absolute benefit of 5 months (31.2 vs. 26.0 months,  $P = 0.03$ ) [17].

## 2. Objectives

The objective of this analysis was to evaluate the cost-effectiveness of a web-based patient-reported outcome tool for symptom monitoring in patients with advanced or metastatic solid tumours receiving systemic therapy in Alberta compared to current standard of care for symptom monitoring from the perspective of the public payer.

## 3. Methods

### 3.1. Model structure

In this study, we performed a cost-utility analysis to determine the incremental cost effectiveness ratio (ICER) in Canadian dollars per quality adjusted life year (QALY) of using a PRO-tool for symptom monitoring versus standard of care. A Markov model was developed

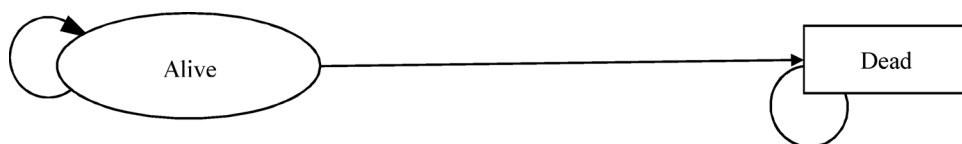


Fig. 1. Schematic of the Markov model representing the two health states.

incorporating two mutually exclusive health states: alive, and dead (Fig. 1). The perspective was that of the public payer. The target population was defined as patients with metastatic solid tumours receiving systemic therapy in Alberta. The cycle length of the model was set at 6 months based on the primary outcome of the Basch study (change in EQ-5D at 6 months). A time horizon of 10 years incorporating  $> 97\%$  of transitions was chosen to represent a lifetime horizon and to incorporate the change observed in overall survival. A 1.5% discount rate was applied to both costs and outcomes based on the Canadian Agency for Drugs and Technologies in Health (CADTH) guidelines (Tables 1 and 2). One-way sensitivity analyses incorporating 14 variables were performed, in addition to a probabilistic sensitivity analysis of the same 14 variables shown in Tables 1 and 2. The upper and lower limit for each value was determined from the 95% confidence interval (CI) reported in the Basch study where available, or calculated to be plus or minus 25% the deterministic value (Table 2).

### 3.2. Treatment strategies

In this model it was assumed that the SOC arm would receive treatment according to the current practice in Alberta. The SOC arm consists of symptom reporting at clinic visits, plus encouragement to call in from home or visit emergency if needed, matching the SOC arm in the Basch study. In this model, it was assumed that patients in the PRO arm would be trained at an initial clinic visit on how to properly fill out a web-based form, and then provided with assistance at subsequent clinic visits as needed. Every week they would receive an e-alert reminding them to record their symptoms that would subsequently get sent to a nurse, and printed out for physicians at regular clinic visits. This is also the same practice as the PRO arm in the Basch study.

### 3.3. Clinical effectiveness and quality of life

The transition probability at 6 months was calculated using the transition probability from alive to dead in 1 year reported in the Basch trial (Table 1). Utility scores were taken from the Basch study, using the observed decrease in EQ-5D score for each arm from baseline over the 6-month observation period. In the base-case, the benefits (utility and survival) associated with the PRO tool and cost savings from decreased ER visits and hospitalizations were observed in the first year only. After year 1, utility decreased at the SOC rate for both arms to a minimum value of 0.585, this minimum was extracted from a study evaluating HRQoL for cancer patients at the end of life [18]. The assumption was made that even after the year of benefit, patients would continue to receive the PRO tool, such that the maintenance costs were included over the full time frame. Probability of hospitalization and emergency room visits were taken from the Basch study. A one-year scenario analysis was performed including only the benefits and costs incurred after a single year of implementation in a static population (Table 3).

### 3.4. Cost data

All costs were based on Canadian dollars. Cost data for hospitalizations and emergency room visits were taken from provincial sources (Table 2). Cost of the PRO tool was estimated from a Canadian company's proposal to develop the tool. In order to calculate the cost per patient for start-up, the overall start-up cost was spread over the total number Alberta patients with metastatic solid tumours. Prevalence was

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