Background: Health care expenditures continue to escalate, and pressures for increased spending will continue. Health care decision makers from publicly financed systems, private insurance companies, or even from individual health care institutions, will continue to be faced with making difficult purchasing, access, and reimbursement decisions. As a result, decision makers are increasingly turning to evidence-based platforms to help control costs and make the most efficient use of existing resources. Most tools used to assist with evidence-based decision making focus on clinical outcomes.

Health Technology Assessment: Health technology assessment (HTA) is increasing in popularity because it also considers other factors important for decision making, such as cost, social and ethical values, legal issues, and factors such as the feasibility of implementation. In some jurisdictions, HTAs have also been supplemented with primary data collection to help address uncertainty that may still exist after conducting a traditional HTA.

Role of Primary Data Collection: The HTA process adopted in Ontario, Canada, is unique in that assessments are also made to determine what primary data research should be conducted and what should be collected in these studies. In this article, concerns with the traditional HTA process are discussed, followed by a description of the HTA process that has been established in Ontario, with a particular focus on the data collection program followed by the Programs for Assessment of Technology in Health Research Institute. An illustrative example is used to show how the Ontario HTA process works and the role value of information analyses plays in addressing decision uncertainty, determining research feasibility, and determining study data collection needs.

Key Words: Health technology assessment, economic evaluation, evidence-based decision making, conditionally funded field evaluations, value of information analysis, drug-eluting stents


INTRODUCTION

Although internationally, Canada is largely viewed as having a publicly financed and operated health care system, in truth, the delivery of and funding for health care is complex and dynamic. The delivery of most health care is largely a provincial responsibility, but increasingly, residents pay, either in whole or in part and either privately or through private insurance plans, for a number of health care services, including dental and eye care, prescription medications, rehabilitation services, ambulatory care, long-term care, services deemed not to be “medically necessary,” and even ambulance services. For example, there is wide variation across provinces in Canada in who is covered for prescription drugs, which drugs are covered for which indications, and how much patients pay compared with the government for these drugs (ie, copayments). Similarly, since some provinces have
moved away from centralized health care systems to systems in which local municipalities make important health care coverage and purchasing decisions, differences across hospitals and regions, even within the same province, have naturally arisen.

What is constant across provinces, however, is that all levels of the health care system—federal, provincial, regional, and even individual hospital—have been under increasing pressure to devote additional resources to health care programs and services. For example, health care spending per capita in Canada, even after controlling for inflation, has increased by more than 40% since 1984, and health care spending as a proportion of gross domestic product has increased steadily by 1% per decade since the 1970s to represent more than 10% of the gross domestic product today [1,2]. Concerns over these rising health care costs have tended to focus on drugs (eg, a 425% increase in 20 years) [1], but medical devices and products, surgical procedures, and other advances and technologies have been important cost drivers, accounting for as much as 30% of the increases in health care costs [3-5]. An aging population, increasingly expensive pharmaceuticals and medical devices, and increases in the prevalence of various chronic diseases are projected to put further pressures on health care systems.

This cost pressure is not unique to just Ontario or Canada. Although health care delivery and reimbursement are unique to each jurisdiction, the health care industry is very much an international market. As a result, the same tough choices about what to make available and what to fund and at what level are faced by health care decision makers around the world. Even in health care systems in the United States, which rely more on patient private insurance, decision makers face these difficult challenges. Private insurance companies (eg, health maintenance organizations, Blue Cross Blue Shield) and public plans (eg, the Centers for Medicare & Medicaid Services) need to make similar difficult coverage and funding decisions.

It is not surprising, therefore, that health care decision makers are increasingly looking at evidence-based decision-making platforms in an effort to make more consistent, rational, and fair decisions; to increase efficiencies in the system; and to maximize the health benefits of the populations they serve. There are several examples of evidence-based approaches implemented at national levels (eg, the National Institute for Health and Clinical Excellence in the United Kingdom [6], the Agency for Healthcare Research and Quality in the United States [7], and the Medical Services Advisory Committee in Australia [8]).

A number of “tools” exist to assist with evidence-based decision making, each with a different focus and each providing different types of information. Evidence-based medicine (EBM) is concerned with the use of current best evidence in making decisions about how best to manage patients [9]. Evidence-based medicine consolidates the vast literature of new technologies in a systematic fashion that makes evidence more accessible to clinicians and decision makers. A number of professional associations (eg, the American College of Physicians, the American Heart Association) and private associations (eg, Blue Cross Blue Shield) use the systematic review techniques of EBM to consider evidence from experimental and observational studies and then use this information to make recommendations for coverage, to develop clinical guidelines, or to develop drug formularies [10].

More recently, the term comparative effectiveness research (CER) has been used, largely in the United States, to refer to evidence on the effectiveness of alternative treatments for a particular condition. The term has been used primarily to refer to head-to-head comparative trials that assess treatments in more of a “real-world” setting, as opposed to the sometimes artificial confines of an explanatory randomized controlled trial (RCT). As such, CER has tended to be associated more with pragmatic trials [11,12], but the term has also been used to refer to comparisons using existing clinical and administrative databases [11].

Although invaluable for assessing the clinical efficacy or effectiveness of alternative treatments, both EBM and CER have a narrow focus by restricting the scope of the assessment to clinical outcomes only. Clinical outcomes are essential to consider in evidence-based decision making, but other factors, such as cost, social and ethical values, legal issues, and factors such as the feasibility of implementation are important considerations as well. In other words, clinical outcomes assessment is a necessary but not sufficient condition for broader evidence-based decision making.

Health technology assessment (HTA) is another evidence-based decision-making tool, but it adopts a broader perspective by considering some of the other important factors necessary for evidence-based decision making. More traditional HTA approaches rely on evidence synthesis from secondary data sources (eg, systematic literature reviews), but a number of variations of HTA approaches have emerged around the world, some of which include supplemental “local” primary data collection. The objectives of this paper are to describe the traditional HTA approach, outline problems and concerns with this approach, describe the HTA process that has been developed in Ontario, and describe the primary data collection program that has been developed by the Programs for Assessment of Technology in Health (PATH) Research Institute to deal with situations in which there is high uncertainty in decision making. An example is used to illustrate how these studies have been
used and some of the unique features of this program for ongoing decisions in an iterative evidence-based framework.

HEALTH TECHNOLOGY ASSESSMENT
Health Technologies and HTA

There is no one definition of health technologies or HTA, and definitions range from narrow to broad. For example, the International Network of Agencies for Health Technology Assessment [13] defines health care technology broadly as “prevention and rehabilitation, vaccines, pharmaceuticals and devices, medical and surgical procedures, and the systems within which health is protected and maintained.” Similarly, definitions of HTA vary from the narrow, such as the sensitivity of a new diagnostic test, to the broad, which includes clinical, economic, social, ethical, and legal aspects. The International Network of Agencies for Health Technology Assessment [13] defines HTA as “a multidisciplinary field of policy analysis, studying the medical, economic, social and ethical implications of development, diffusion, and use of health technology.” Similarly, the Canadian Agency for Drugs and Technologies in Health [14] also defines HTA more broadly as “the process of systematically reviewing existing evidence and providing an evaluation of the effectiveness, cost-effectiveness, and impact of health technology and its use, both on patient health and on the health care system.”

Process, Stages, and Components of a Traditional HTA Report

Because definitions of health technologies and HTA vary, it is not surprising that the approaches used for HTA also vary. Although there is no general consensus on the overall approach for HTA, the basic components of an HTA generally include a systematic literature review of the clinical safety and efficacy or effectiveness of a technology, an economic evaluation (usually through the use of a decision-analytic model), and perhaps a budget impact analysis showing the budgetary impact on the health care system of introducing the technology. For example, Canada’s national HTA agency, the Canadian Agency for Drugs and Technologies in Health [14], produces a series of HTA reports on a range of topics, and the agency includes 3 main sections in these reports: a systematic literature review, an economic analysis, and the health systems impact.

The general process and stages of a traditional HTA are outlined in Figure 1. Although it may be intuitively obvious, a critical first stage of any HTA involves the identification of the topic for assessment and a clear specification of the problem. It is common to consider the patient, intervention, comparator, outcomes, and setting framework when clarifying the scope of an HTA. The second stage is the review of possible data sources as research evidence for an HTA. This is essentially the literature search strategy of an HTA (generally similar to the EBM approach) and can include numerous electronic databases and search engines, supplemental databases, searching of the gray literature (eg, Web sites, reports, student theses), and hand searching of selected journals or references of key papers. The third stage involves the conduct of the literature review itself, the retrieval and aggregation of the information. The fourth stage involves evidence synthesis and consolidation through statistical techniques such as meta-analysis. The fifth stage involves conducting an economic evaluation (ie, comparing two or more alternatives in terms of both costs and consequences) and a budget impact analysis on the health care system of introducing the technology. Finally, the sixth and seventh stages involve the documentation and dissemination of findings.

Fig 1. Process and stages of a traditional health technology assessment (HTA). PICOS = patient, intervention, comparator, outcomes, setting.
Concerns With Traditional HTAs

The general HTA approach outlined in Figure 1 has become popular with a number of agencies and producers of HTAs worldwide. This is not surprising, as one of the main components of the HTA framework is based on the principles of EBM that are well-developed and accepted. However, although a systematic review of explanatory RCTs may have high internal validity, decision makers are often concerned about the generalizability (applicability) of this evidence to a real-world setting or to their own local jurisdictions or contexts. In addition, there are components of an HTA, when produced elsewhere, that may not transfer well across countries (eg, practice patterns, unit costs, patient preferences). Finally, the traditional HTA approach generally does not include other issues that are important from a decision maker’s perspective, such as ethical and social values or legal and implementation issues. It is for these reasons that some jurisdictions have found the traditional HTA approach to be of limited use for making evidence-based decisions and that HTAs produced in other jurisdictions may not be applicable for meeting local decision making needs.

To better understand some of the concerns with the more traditional HTA process, consider the different dimensions of a health technology as presented in Table 1. The main components that determine the clinical utility of a technology relate to its quality, safety, and efficacy. These 3 dimensions are typically referred to in the pharmaceutical industry as the first 3 hurdles of product formulary listing and reimbursement [15]. The other 2 dimensions, effectiveness and value for money, are often referred to as the fourth hurdle [15], as this is where manufacturers need to demonstrate not only that technologies do work in a real-world setting but that they represent good value for the money as well. The typical questions HTAs address for each of these 5 dimensions are listed in the second column of Table 1. In terms of quality, an HTA addresses the question of whether a technology is manufactured consistently and whether it consistently provides high quality. In terms of safety, the HTA addresses whether the technology provides an acceptably low risk for patients and health care providers. This may seem straightforward, but it is complex because there are a number of issues around the definition of “acceptable risk.” In terms of efficacy, the HTA addresses whether the technology “can” work under ideal experimental conditions (eg, an explanatory RCT). In terms of effectiveness, the HTA addresses the question of whether the technology “does” work when used in a real-world practice setting. Finally, in terms of value for the money, the HTA addresses the question of how cost effective the

<table>
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<td>Safety</td>
<td>Does the technology harm patients or health care professionals?</td>
<td>Safety concerns in general or in context-specific application of the technology</td>
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<td>Efficacy</td>
<td>Can the technology work under ideal experimental trial conditions?</td>
<td>Poor-quality evidence, lack of evidence, or conflicting evidence of efficacy</td>
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<td>Effectiveness</td>
<td>Does the technology work in real-world practice?</td>
<td>Concerns over generalizability of efficacy evidence or transferability of clinical evidence from another jurisdiction</td>
<td>Pragmatic RCTs, observational studies (eg, cohort, registries)</td>
</tr>
<tr>
<td>Value for money</td>
<td>Is the technology cost effective compared with alternative ways of treating patients?</td>
<td>Concerns over transferability of economic and patient preference evidence from another jurisdiction</td>
<td>Effectiveness studies, including collection of resource use, practice pattern, unit cost, and patient preference information</td>
</tr>
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</table>

Note: CFFE = conditionally funded field evaluation; HTA = health technology assessment; RCT = randomized controlled trial.
Technology is compared with alternative ways of treating patients.

Traditional HTAs may fall short in answering these questions for a number of reasons, most of which relate to different aspects of uncertainty in decision making. Shown in the third column of Table 1 are examples of uncertainty that may remain under each dimension even after an HTA has been conducted. For example, under quality, there may be a lack of evidence around the consistency of the technology. Similarly, under safety, there may be concerns about the level of risk (eg, radiation exposure) a technology produces. Assessing efficacy for new technologies may be particularly difficult because the evidentiary base for new technologies tends to be limited, of poor quality, and often conflicting. In terms of effectiveness, decision makers may be concerned about the generalizability of efficacy evidence to real-world practice or concerned about the transferability of clinical evidence from another jurisdiction. Finally, in terms of value for money, decision makers may have residual uncertainty related to the transferability of economic data (eg, practice patterns, unit costs) or patient preference data (eg, quality-of-life values) from another location, both of which have been shown to vary significantly across jurisdictions.

It is for these reasons of residual uncertainty, even after a traditional HTA has been prepared locally or is available from another jurisdiction, that decision-making bodies have started adopting evidence-based platforms that also include additional local and context-specific data collection. These local data collection studies serve slightly different purposes, are structured differently, and go by different names such as Only in Research in the United Kingdom [16,17] or Coverage With Evidence Development in the United States [12,18], but they all have the common element of reducing uncertainty to assist with making decisions more evidence based.

**Ontario’s Evidence-Based Health Technology Assessment Process**

**The Ontario Health Care System**

The Ontario health care system has been summarized elsewhere [2,19,20]. In brief, the Ontario system is a mixture of public and private provision covering the full continuum of health care, including acute, chronic, and rehabilitation hospitals; health care professional services; ambulatory care; home care; long-term care; mental health; community programs and services; and drugs. Most health care is a provincial responsibility, but patients, employer or private insurance coverage to pay for prescription drugs. In terms of nondrug devices and health technologies, an important distinction must be made between “medically necessary” and unnecessary products, programs, and services. For products, programs, and services considered medically necessary, provinces have a responsibility under the Canada Health Act to provide these services to receive federal funding. This includes physician services, hospital care, ambulatory care, and a number of other programs and services. Most devices and health technologies enter the health care system through services provided in hospitals, but there are a number of other points of entry into the system (eg, home care services, community services, long-term care facilities).

For the most part, hospitals are funded on a global budget basis and make decisions, within their global budgets, about which technologies to purchase or services to provide at their hospitals. However, there are separate funding programs. In terms of physician services, a list of services reimbursed by provincial plans determines whether governments pay for services or whether patients or private insurance plans must pay. For example, for a new surgical procedure or diagnostic test that does not have a fee code under the Ontario Health Insurance Plan, the hospital cost of the procedure and physician fee for performing the surgery or test would not be covered by the public insurance plan [21].

**Overview of the HTA Process for Nondrug Devices and Health Technologies**

Requests for publicly financed reimbursement of new surgical or diagnostic procedures, new devices or products, new programs and services, and physician fee schedule listing for new procedures are made directly to the Ontario Ministry of Health and Long-Term Care (MOHLTC). In 2003, the Ontario Health Technology Advisory Committee (OHTAC) was struck as a first step in developing a single provincial point of entry for the uptake and diffusion of devices and health technologies, using as a basis an evidence-based platform. The OHTAC’s mandate is to undertake reviews of health technologies as requested by hospitals, community-based health services, or the MOHLTC and make recommendations to the deputy minister of health regarding the uptake and diffusion of these technologies.
The committee consists of approximately 30 members, including clinical epidemiologists, clinicians, health economists, health policy analysts, health services researchers, senior hospital administrators, bioethicists, a bioengineer, and representatives from the Ontario Hospital Association, the Ontario Medical Associations, and community-based health care programs. The OHTAC meets once a month and considers evidence generated internally by the Ministry of Health.

An overview of the evidence-based HTA process followed in Ontario is presented in Figure 2. Requests for reviews can come from health care facilities, health care professionals, or the MOHLTC and are shown in the top box of Figure 2. These requests are then submitted to the Medical Advisory Secretariat (MAS), a division of the MOHLTC. The MAS consists of clinical epidemiologists, health economists, and health policy advisors and provides a secretariat function for OHTAC by receiving and managing requests and by performing scientific clinical and economic analyses on behalf of OHTAC. Once requests are received, MAS conducts an initial scan of the technology and prepares a prioritization using a scoring algorithm. This information is presented to OHTAC at monthly meetings, and at this point OHTAC may request additional information about the technology, reject the request for review, or request that MAS conduct a traditional HTA of the technology (ie, the middle boxes in Figure 2).

Within a 16-week period of time, the MAS conducts a literature review of the technology’s safety, efficacy, effectiveness, and cost-effectiveness on the basis of the Grades of Recommendation, Assessment, Development and Evaluation [22,23] scheme. During this process, the MAS engages experts, the industry, and other stakeholders about the technology before reporting back the findings to OHTAC. The MAS review and analyses form the basis for discussions within OHTAC. Guided by the grading process of weighing risks and benefits, OHTAC may either make policy recommendations regarding the uptake and diffusion of the technology or conclude that there is not enough information for making an evidence-based decision. The type of uncertainty in decision making OHTAC faces was discussed previously and was presented in the third column of Table 1. This uncertainty may lead OHTAC to recommend that a conditionally funded field evaluation (CFFE) be undertaken to reduce uncertainty, and this could take the form of studies on quality, safety, efficacy, effectiveness, and cost-effectiveness (see the black boxes at the bottom of Figure 2 or the fourth column of Table 1).

PATH’s Reduction of Uncertainty Through Field Evaluation (PRUFE) Iterative Evidence-Based Decision-Making Framework

The role of CFFEs and the process for conducting these studies have been reported previously [2,19,24]. There are unique features of the CFFE program that differ from other HTA programs with supplementary primary data collection. These unique features are summarized in Figure 3 and are highlighted in the illustrative example section that follows. The unique features are embedded in an iterative evidence-based framework called PRUFE, named after the developers of the framework from the PATH Research Institute [25].

The process begins when the PATH Research Institute first receives a request from OHTAC or MAS to conduct a CFFE. As shown in Figure 3, two interdependent research activities are then initiated. First, using the HTA and literature review conducted by MAS, a preliminary economic model is constructed comparing the longer term costs and outcomes of the technology to...
alternative treatment, diagnostic, or screening technologies. This process involves an update and expansion of the original MAS literature review (ie, systematic review) and also the collection of disease progression information necessary for the construction of an economic model. The development and analysis of the economic model usually takes between 3 and 6 months. At the same time, expert advisors around the technology are assembled and a working group is established consisting of key stakeholders in the province. Industry stakeholders are consulted at this stage but are not formally included in the working group. The working group discusses broader issues around the technology, possible research questions, and study designs and prepares a study (proposal synopsis).

One of the unique features of this framework is that the preliminary economic model is used to determine whether the CFFE is worthwhile before actually conducting the study. In particular, the economic model is set up to incorporate uncertainty around the parameters that define the model on the basis of the systematic review of the literature, administrative databases, and other data sources (eg, chart reviews, expert opinion). Parameters in the model are expressed as probability distributions (reflecting uncertainty), and the entire model is set up as a probabilistic model [26]. Using simulation techniques (ie, making random draws of the probabilistic model), the overall level of uncertainty in the model is assessed. This is important because it was uncertainty in the first place that prevented OHTAC from making evidence-based recommendations on the technology. Using techniques of value of information (VOI) analyses [27,28], the expected value of perfect information (EVPI) is determined and compared with the cost of conducting a study to determine if the CFFE is worthwhile in the first place (see the box on the left-hand side of Figure 3 on CFFE feasibility). If the CFFE is determined not to be worthwhile (ie, the cost of research is greater than the VOI gained from the research), this information is fed back to OHTAC and the MAS.

If it is determined that the CFFE is worthwhile, information on uncertainty from the economic model is relayed to the working group for further refinement of the CFFE study design. During this process, additional VOI analyses, called expected value of partial perfect information (EVPPI) analyses, are conducted to determine which variables contribute most to overall uncertainty in the model and which should be the primary focus of data collection in the CFFE [27]. This is another unique feature of the PRUFE framework, in that underlying uncertainty is used to determine research data collection requirements. For example, EVPPI analyses may determine that the primary focus of data collection should be on reducing uncertainty around the diagnostic accuracy of a test or perhaps on reducing uncertainty around the implications, in terms of disease progression and cost, of obtaining a false-negative diagnostic test result.

Once the EVPI and EVPPI analyses have been conducted, the study design is finalized and the study is conducted. Depending on the research question, patient recruitment, and patient follow-up requirements, the CFFE may take between 1 and 3 years to complete. Once the CFFE is completed, the results are used to update the original preliminary economic model, and the overall results are presented back to OHTAC for possible policy recommendations. At this time, OHTAC may decide that there is now enough information to make evidence-
based recommendations or that further data collection is needed to further reduce decision uncertainty. This highlights another unique feature of this framework (shown at the bottom of Figure 3), in that additional VOI analyses are conducted (EVPI and EVPPI) on the updated economic model to help in the discussions with OHTAC about whether additional data collection is worthwhile and, if so, what should be the focus of further data collection. These analyses determine the possible iterative nature of the CFFE.

CONDITIONALLY FUNDED FIELD EVALUATION EXAMPLE: DRUG-ELUTING STENTS

To demonstrate how Ontario’s evidence-based process works and where CFFEs and the PRUFE framework fit into the overall process, it is perhaps best to illustrate with an example. The example used will be a CFFE recently completed in which drug-eluting stents (DES) were compared with bare-metal stents (BMS) for the treatment of patients with coronary artery disease.

Study Background

Coronary artery disease (CAD) results from a buildup of atherosclerotic plaques in the coronary arteries. A major concern with coronary artery disease is narrowing of the blood vessels, which increases the risk for myocardial infarction and death. Percutaneous coronary intervention, in which a balloon catheter is inserted and inflated to unblock the narrowed artery, is typically done to treat CAD. However, because percutaneous coronary intervention alone is associated with a high restenosis rate, a

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**Fig 4.** Expected value of perfect information (EVPI) and expected value of partial perfect information (EVPPI) for drug-eluting stents on the basis of available evidence in 2003. (A) Population EVPI, by assumed useful life of technology. (B) Per patient EVPPI for parameters. QALY = quality-adjusted life-year.
coronary artery stent, known as a BMS, is typically inserted. Drug-eluting stents were developed as an enhancement to BMS to address high restenosis rates, and early RCTs showed that DES were significantly more efficacious than BMS. Because DES were also significantly more expensive, in 2002, the Ontario MOHLTC conducted a review of the evidence comparing DES with BMS [29], and on the basis of this review, OHTAC concluded that there was insufficient evidence for the MOHLTC to make an evidence-based, long-term funding decision on DES. Concerned with both a paucity of existing data and the generalizability of the existing efficacy evidence to the Ontario setting, OHTAC commissioned the PATH Research Institute to conduct a CFFE to compare the real-world clinical effectiveness and cost-effectiveness of DES relative to BMS.

**Fig 5.** Expected value of perfect information (EVPI) and expected value of partial perfect information (EVPI) for drug-eluting stents on the basis of updated information and available evidence in 2007. (A) Population EVPI, by assumed useful life of technology. (B) Per patient EVPPI for parameters. QALY = quality-adjusted life-year.

**CFFE Findings and OHTAC Recommendations**

The MOHLTC agreed to provide conditional funding for DES in the province in the amount of $12 million per year. All patients with stent procedures in the province between December 1, 2003, and March 31, 2005, with a minimum of one year of follow-up were included in the study. A preliminary economic model based on available evidence at the time of starting the CFFE was constructed. On the basis of this economic model, VOI analysis was conducted to determine whether the study was worthwhile. The EVPI analysis, based on available evidence in 2003, is presented in Figure 4A. Expected value of perfect information curves for different decision-making thresholds (eg, willingness to pay per quality-adjusted life-year gained) are presented for 3

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**A**

![Graph A: Population EVPI](image1)

**B**

![Graph B: Per Patient EVPPI](image2)
alternative assumptions about the useful life of DES (ie, 5, 10, and 15 years). It was found that the cost of conducting the CFFE was considerably lower than the total EVPI for each of these useful lifetime assumptions and for all decision-making thresholds typically considered. This provided the justification that the CFFE was worthwhile. In addition, the EVPI analysis on the basis of available information at the time of starting the study (Figure 4B) suggested that the CFFE should focus primarily on reducing uncertainty about revascularization rates between DES and BMS.

A working group of experts in the province was established, and a study was designed that focused primarily on the collection of data around revascularization rates. Because early trial data suggested that there may be differences in effectiveness for patients with selected high-risk factors, the study was designed to collect information on a sufficiently large number of patients from each high-risk subgroup (eg, diabetes). The final study results were reported back to OHTAC in 2007 and subsequently published [30]. On the basis of the 2007 CFFE results, OHTAC recommended that DES should be made available to patients in the province with 2 or more high-risk factors (eg, diabetes, long lesions, small vessels).

On the basis of the results of the CFFE, the original cost-effectiveness model was updated to determine the value of additional data collection beyond the 2007 study results. The CFFE revealed an unexpected finding, which was subsequently confirmed through other studies, that DES may have a mortality benefit rate compared with BMS. In early trial data, there was no suggestion of a mortality benefit with either type of stent. The revised EVPI calculations (based on useful life assumptions of 5, 10, and 15 years) for various decision-making thresholds are presented in Figure 5A. On the basis of projected study costs and the EVPI analysis, it was determined that as long as decision-making thresholds were greater than $40,000 per quality-adjusted life-year, continued data collection for this study would be worthwhile. Expected value of partial perfect information analysis (Figure 5B) provided support for data collection to reduce uncertainty around mortality associated with DES and BMS. As a result, the other recommendation from OHTAC in 2007 was that the PATH Research Institute should continue to collect data and in particular focus on reducing the uncertainty around mortality in patients treated with DES or BMS. This second iterative phase of data collection is currently ongoing.

CONCLUSIONS

Faced with spiraling health care costs and relatively fixed budgets, health care decision makers, from public plans, private plans, or at local levels such as individual hospi-

calstitutional tools are increasingly looking at evidence-based decision-making platforms to control costs and increase efficiencies in the system. A number of countries, provinces, and states have adopted, or are in the process of adopting, evidence-based decision-making processes, and a number of tools exist to assist with evidence-based decision making. Evidence-based medicine and CER focus primarily on assessments of clinical outcomes, and although these are essential to consider in evidence-based decision making, other factors, such as cost, social and ethical values, legal issues, and factors such as the feasibility of implementation, are important considerations as well. Health technology assessment, by considering other factors in addition to clinical outcomes, is a useful tool that has gained enormous popularity internationally over the past decade.

Traditional HTAs, which include a systematic literature review, an economic evaluation, and a budget impact analysis, provide a useful evidence-based framework for decision making. However, despite its broad appeal, HTA is not without shortcomings. Even after careful consideration of the evidence from well-conducted HTAs, decision makers may still have residual uncertainty around a number of issues. There may be uncertainty remaining about the quality of the technology or its safety or efficacy, concerns about the generalizability of efficacy evidence to real-world effectiveness, or concerns about the transferability of clinical effectiveness, economic data, or patient preference information across jurisdictions.

It is for these reasons that primary data collection is often considered a supplement to evidence available from traditional HTAs. Several jurisdictions now conduct primary data collection to help further reduce uncertainty (eg, Only in Research in the United Kingdom, Coverage With Evidence Development in the United States, and CFFEIs in Ontario). The HTA process in Ontario represents an interesting adaptation to the traditional HTA approach because primary data collection is used to supplement the HTA, and the iterative evidence-based PRUFE framework, through the use of VOI analysis, is used to help determine research feasibility and data collection needs within studies. The PRUFE framework represents an enhancement to existing evidence-based decision making processes by collecting useful local and context-specific data needed to help inform decisions while providing direction for research and data collection needs on the basis of current information and associated uncertainty.

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