Cost-effectiveness of insulin analogues for diabetes mellitus

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Abstract

Background: Insulin analogues may be associated with fewer episodes of hypoglycemia than conventional insulins. However, they are costly alternatives. We compared the cost-effectiveness of insulin analogues and conventional insulins used to treat type 1 and type 2 diabetes mellitus in adults.

Methods: We conducted a cost-effectiveness evaluation of insulin analogues versus conventional insulins using the Center for Outcomes Research Diabetes Model. We compared rapid-acting analogues (insulin aspart and insulin lispro) with regular human insulin, and long-acting analogues (insulin glargine and insulin detemir) with neutral protamine Hagedorn insulin. We derived clinical information for the comparisons from meta-analyses of randomized controlled trials. We obtained cost and utility estimates from published sources. We performed sensitivity analyses to test the robustness of our results.

Results: For type 1 diabetes, insulin aspart was more effective and less costly than regular human insulin. Insulin lispro was associated with an incremental cost of Can$28 996 per quality-adjusted life-year. The incremental cost per quality-adjusted life-year was Can$87 932 for insulin glargine and Can$387 729 for insulin detemir, compared with neutral protamine Hagedorn insulin. For type 2 diabetes, insulin aspart was associated with an incremental cost of Can$22 488 per quality-adjusted life-year compared with regular human insulin. For insulin lispro, the incremental cost was Can$130 865. Compared with neutral protamine Hagedorn insulin, insulin detemir was less effective and more costly. Insulin glargine was associated with an incremental cost of Can$642 994 per quality-adjusted life-year. The model was sensitive to changes in the effect size of hemoglobin A1c, and to decrements applied to utility scores when fear of hypoglycemia was included as a factor.

Interpretation: The cost-effectiveness of insulin analogues depends on the type of insulin analogue and whether the patient receiving the treatment has type 1 or type 2 diabetes. With the exception of rapid-acting insulin analogues in type 1 diabetes, routine use of insulin analogues, especially long-acting analogues in type 2 diabetes, is unlikely to represent an efficient use of finite health care resources.

The cost of insulin analogues exceeds that of conventional insulins. More than US$7.3 billion was spent globally on the purchase of insulin products in 2005 — an increase of 19% over the previous year. It has been suggested that the increased expenditure was due to both the increasing prevalence of diabetes and the increased use of insulin analogues.

We performed an analysis of the cost-effectiveness of insulin analogues compared with conventional insulins in the management of type 1 or type 2 diabetes in adults.

Methods

The economic model

We used the Center for Outcomes Research Diabetes Model to calculate the cost-effectiveness estimates. This model, described in detail by Palmer and colleagues, has been validated against published clinical and epidemiologic studies (Figure 1). Using data derived from the published literature, the model uses mathematical equations to determine the diabetes-related complications that would occur throughout a patient’s life span. The equations take into consideration risk factors such as age and hemoglobin A1c levels, as well as patient characteristics, type of diabetes and history of diabetes-related complications. For type 1 and type 2 diabetes, correlation analyses produced $R^2$ estimates of 0.9778 and 0.8861, which demonstrate that simulations in the Center for Outcomes Research Diabetes Model provide a reasonably accurate representation of patient outcomes in real-life settings.

We derived the clinical effects of therapy (hemoglobin A1c, mild to moderate hypoglycemia and severe hypoglycemia), required as inputs for the model, from meta-analyses of randomized controlled trials (Table 1). We compared rapid-acting insulin analogues (insulin aspart and insulin lispro) with regular human insulin. We compared long-acting analogues (insulin glargine and insulin detemir) with neutral protamine Hagedorn insulin. For treatment comparisons, we
compared insulin products either alone or in combination with an equivalent basal-bolus insulin. We used a time horizon of 60 years for patients with type 1 diabetes and 35 years for patients with type 2 diabetes. We derived patient characteristics from the published literature; these are reported in detail elsewhere.13

**Determination of costs**

We used the perspective of a Canadian third-party payer such as a ministry of health or a single-payer insurance provider. Therefore, we included only direct health care costs in the model.12 We obtained costs for diabetes-related complications from the Ontario Diabetes Economic Model,13 the Alberta Health Costing Project14 and other published sources15-17 (Table 2). We included costs for inpatient and outpatient services, emergency department visits, subsequent prescriptions, and long-term care and home-care services.

We obtained unit costs for drugs from the Ontario Drug Benefit Formulary Comparative Drug Index (June 6, 2007)2 and the PPS Pharma Buyers Guide, Ontario Edition (July 2007) (Table 3).3 We assumed a cartridge-to-vial ratio of 65:35 based on utilization data from the Ontario Ministry of Health and Long-Term Care that was supplied by the Canadian Optimal Medication Prescribing and Utilization Service Advisory Committee. We assumed an average patient weight of 69 kg21-23 for adults with type 1 diabetes and 91 kg12,15 for those with type 2 diabetes.

We estimated the mean daily dose for each treatment (Table 3) based on data from a patient sample supplied by an endocrinologist member of the Canadian Optimal Medication Prescribing and Utilization Service Expert Review Committee. The committee is an advisory body that makes recommendations related to the identification, evaluation and promotion of optimal drug prescribing and use in Canada. Its 12 members include endocrinologists, family physicians, pharmacists, health economists and members of the public.

Using Canadian guidelines for the economic evaluation of health technologies,12 we applied a rate of discount of 5% to both costs and outcomes. Using the health component of the Consumer Price Index,25 we adjusted all costs to 2007 Canadian dollars.

**Outcome measures**

The primary outcome measure was the quality-adjusted life-year, which captures both length of life (expressed in years) and health-related quality of life.
and quality of life (expressed as a utility score). A utility score is a standardized measurement of a person’s preference about his or her state of health.26–27 A widely used instrument for determining utility scores is the EuroQol-5D.26–28 It consists of 5 dimensions: mobility, self-care, usual activities, pain or discomfort, and anxiety or depression.26–28 Each dimension has 3 levels of severity, for a total of 243 possible combinations of health states that are standardized against population norms.26–28 Based on a respondent’s information, a summary value can be calculated, with 0 representing death and 1 representing full health.26–28 Health states valued as being worse than death can have negative scores.26–28

We derived utility estimates for our analysis from a catalogue of EuroQol-5D index scores for the population of the United States.29,30 The scores in the catalogue are adjusted for chronic conditions and determinants of health such as age, comorbidities, sex, ethnic background, income and education.31 Patients with uncomplicated type 1 diabetes were assigned a utility score of 0.783.29,30,32 Those with type 2 diabetes were assigned a utility score of 0.800.29,30 For diabetes-related complications, we applied decrements to the utility scores, shown in Appendix 1 (available at www.cmaj.ca/cgi/content/full/180/4/402).

Episodes of hypoglycemia were assumed to reduce a patient’s ability to perform usual activities and to increase anxiety or depression,33 which would result in an intermittent decrement in the patient’s ability to perform usual activities and to increase anxiety or depression.33–35 Each dimension has 3 levels of severity, for a total of 243 possible combinations of health states that are standardized against population norms.26–28 Based on a respondent’s information, a summary value can be calculated, with 0 representing death and 1 representing full health.26–28 Health states valued as being worse than death can have negative scores.26–28

For each episode of mild to moderate hypoglycemia, the utility score was assumed to decrease by 0.16733 for a period of 15 minutes.36,37 We assumed that patients with type 1 diabetes would experience 24.36 episodes of hypoglycemia per year. Patients with type 2 diabetes were assumed to have 10.20 episodes per year.40

It has been suggested that a patient’s fear of future episodes of hypoglycemia may have a chronic detrimental impact on his or her health-related quality of life.41 Estimates of the impact of fear on utility scores, however, have varied considerably.41–43 Because patients with poorly controlled diabetes are more likely to have hypoglycemia, it is uncertain whether the lower utility scores that have been reported are attributable to hypoglycemia and fear of future episodes or to severity of disease.41 Moreover, the Center for Outcomes Research Diabetes Model6 accommodates fear of hypoglycemia by applying a chronic decrement to health-related quality-of-life scores in the conventional-insulin arm, but not in the insulin-analogue arm. We therefore did not apply a chronic decrement to the utility score for fear of future episodes in the base-case analysis. However, we explored the impact of applying a chronic decrement for this factor through sensitivity analysis.

### Sensitivity analysis

We assessed the effect of uncertainty across multiple model variables using nonparametric boot-strapping27,44 and second-order Monte Carlo simulations.45 We estimated the probability that a treatment was cost-effective at a particular threshold by plotting the results of the boot-strapping iterations using acceptability curves of cost-effectiveness. We performed one-way sensitivity analyses47 to examine the robustness of results to variation in parameters and model assumptions (reported in detail elsewhere41).

| Table 1: Estimates of effect size for hemoglobin A1c and hypoglycemia used in the cost-effectiveness analysis of insulin analogues and conventional insulins* |
|------------------|-----------------|-----------------|-----------------|
| Comparison | Hemoglobin A1c, weighted mean difference (95% CI), % | Mild to moderate, rate ratio (95% CI) | Severe, relative risk (95% CI) |
| **Type 1 diabetes** | | | |
| Insulin aspart versus regular human insulin | −0.12 (−0.19 to −0.06) | 0.97 (0.88 to 1.08) | 0.83 (0.66 to 1.05) |
| Insulin lispro versus regular human insulin | −0.01 (−0.11 to 0.08) | 1.02 (0.95 to 1.09) | 0.83 (0.64 to 1.07) |
| Insulin glargine versus neutral protamine Hagedorn insulin | −0.11 (−0.21 to −0.02) | 0.82 (0.52 to 1.28) | 0.82 (0.52 to 1.29) |
| Insulin detemir versus neutral protamine Hagedorn insulin | −0.05 (−0.13 to 0.03) | 0.84 (0.74 to 0.97) | 0.74 (0.58 to 0.96) |
| **Type 2 diabetes** | | | |
| Insulin aspart versus regular human insulin | −0.09 (−0.21 to 0.04) | 0.72 (0.64 to 0.80) | 0.39 (0.11 to 1.36) |
| Insulin lispro versus regular human insulin | −0.03 (−0.12 to 0.06) | 0.97 (0.91 to 1.03) | 0.43 (0.08 to 2.37) |
| Insulin glargine versus neutral protamine Hagedorn insulin | −0.05 (−0.13 to 0.04) | 0.82 (0.64 to 1.06) | 0.66 (0.29 to 1.48) |
| Insulin detemir versus neutral protamine Hagedorn insulin | 0.14 (−0.01 to 0.28) | 0.54 (0.50 to 0.58) | 0.75 (0.03 to 20.01) |

Note: CI = confidence interval.
*Estimates are derived from the meta-analyses by the Canadian Agency for Drugs and Technologies in Health.41–43
Results

Type 1 diabetes

The expected lifetime cost per patient with type 1 diabetes was lower for treatment with insulin aspart than for treatment with regular human insulin. The effectiveness of insulin aspart was higher than that of regular human insulin. The use of insulin aspart was thus shown to be cost-saving. Treatment of type 1 diabetes with insulin lispro was more effective, albeit more costly, than treatment with regular human insulin, which resulted in an incremental cost of Can$28 996 per quality-adjusted life-year (Table 4).

Insulin glargine and insulin detemir generated more quality-adjusted life-years than did neutral protamine Hagedorn insulin, albeit at an increased cost. When compared with neutral protamine Hagedorn insulin, insulin glargine was associated with an incremental cost of Can$387 729, and insulin detemir with an incremental cost of Can$87 932, and insulin detemir for insulin aspart remained cost-saving when compared with conventional insulin. However, the incremental cost per quality-adjusted life-year decreased to Can$1117 for insulin lispro, Can$17 225 for insulin glargine and Can$25 666 for insulin detemir. Conversely, when no difference in hemoglobin A1c between treatment comparators was assumed, the incremental costs per quality-adjusted life-year increased to Can$104 598 for insulin aspart, Can$673 041 for insulin lispro, Can$916 401 for insulin glargine and Can$1 958 928 for insulin detemir (Appendix 3, available at www.cmaj.ca /cgi/content/full/180/4/400/DC2). Results from other sensitivity analyses are reported elsewhere.10

Table 2: Management costs for diabetes-related complications used in the cost-effectiveness analysis

| Diabetes-related complication                          | Annual cost,* | Year 1 | Year ≥ 2 |
|--------------------------------------------------------|---------------|--------|----------|
| Myocardial infarction13                                 |               |        |          |
| Fatal                                                  | 9 177         | –      |          |
| Nonfatal                                               | 17 498        | 2 736  |          |
| Angina13                                                | 5 477         | 3 162  |          |
| Congestive heart failure13                              | 16 007        | 4 488  |          |
| Stroke13                                                |               |        |          |
| Fatal                                                  | 8 636         | –      |          |
| Nonfatal                                               | 23 834        | 3 307  |          |
| Peripheral vascular disease15,19                        | 1 508         | –      |          |
| Dialysis, ongoing therapy16,17                         | 75 772        | –      |          |
| Nephropathy, transplant cost16,17                       | 86 816        | 36 506 |          |
| Severe vision loss or blindness16                       | 2 928         | 2 086  |          |
| Cataract extraction13                                   | 3 871         | 2 437  |          |
| Symptomatic neuropathy15,24                            | 165           | –      |          |
| Foot ulcer15,20                                         |               |        |          |
| Uninfected                                             | 1 216         | –      |          |
| Infected                                               | 2 431         | –      |          |
| Gangrene15                                              | 8 687         | –      |          |
| Amputation15                                            | 36 973        | 5 064  |          |
| Ketoacidosis or lactic acid event15,20                  | 3 895         | –      |          |
| Episode of severe hypoglycemia16                        | 129           | –      |          |

*Costs are in 2007 Canadian dollars.

Type 2 diabetes

Our model showed that both insulin aspart and insulin lispro were more effective than regular human insulin in the treatment of type 2 diabetes in adults who required insulin therapy. Both were also more costly. Treatment with insulin aspart resulted in an incremental cost of Can$22 488 per quality-adjusted life-year. Treatment with insulin lispro resulted in an incremental cost of Can$130 865 per quality-adjusted life-year (Table 4).

Insulin glargine was more effective, albeit more costly, than neutral protamine Hagedorn insulin, which resulted in an incremental cost of Can$642 994 per quality-adjusted life-year (Figure 2). When fear of hypoglycemia was incorporated as a complication in the model, results from sensitivity analyses showed that insulin aspart remained cost-saving when compared with conventional insulin. However, the incremental cost per quality-adjusted life-year decreased to Can$1117 for insulin lispro, Can$17 225 for insulin glargine and Can$25 666 for insulin detemir. Conversely, when no difference in hemoglobin A1c between treatment comparators was assumed, the incremental costs per quality-adjusted life-year increased to Can$104 598 for insulin aspart, Can$673 041 for insulin lispro, Can$916 401 for insulin glargine and Can$1 958 928 for insulin detemir (Appendix 3, available at www.cmaj.ca /cgi/content/full/180/4/400/DC2). Results from other sensitivity analyses are reported elsewhere.10

Table 3: Unit costs for insulin agents used in the cost-effectiveness analysis, by type of diabetes

| Agent                          | Mean daily dose, units/kg | Mean daily cost,* $ |
|--------------------------------|---------------------------|---------------------|
| **Type 1 diabetes**            |                           |                     |
| Insulin aspart                 | 0.52                      | 1.10                |
| Insulin lispro                 | 0.52                      | 1.12                |
| Regular human insulin          | 0.68                      | 1.02                |
| Insulin glargine               | 0.28                      | 1.29                |
| Insulin detemir                | 0.28                      | 1.41                |
| Neutral protamine Hagedorn insulin | 0.34                 | 0.51                |
| **Type 2 diabetes**            |                           |                     |
| Insulin aspart                 | 0.98                      | 2.76                |
| Insulin lispro                 | 0.98                      | 2.81                |
| Regular human insulin          | 1.20                      | 2.38                |
| Insulin glargine               | 0.53                      | 3.24                |
| Insulin detemir                | 0.53                      | 3.54                |
| Neutral protamine Hagedorn insulin | 0.75                  | 1.49                |

*Costs are in 2007 Canadian dollars.
ity-adjusted life-year, the probability that each of the insulin analogues was more cost-effective than conventional insulin was 52.3% for insulin aspart, 46.3% for insulin lispro, 25.1% for insulin glargine and 10.8% for insulin detemir (Figure 2).

Results from the sensitivity analyses showed that, when fear of hypoglycemia was included in the model, the incremental costs per quality-adjusted life-year decreased to Can$4429 for insulin aspart, Can$73989 for insulin lispro, Can$72714 for insulin glargine and Can$234606 for insulin detemir. By contrast, when no difference in hemoglobin A1c between treatment comparators was assumed, the incremental costs per quality-adjusted life-year increased to Can$543584 for insulin glargine and Can$882155 for insulin detemir. Can$73989 for insulin aspart, Can$12115 for insulin lispro, Can$4429 for insulin aspart, Can$12115 for insulin lispro, Can$10976 for insulin glargine and Can$882155 for insulin detemir (Appendix 3). Results from other sensitivity analyses are reported elsewhere.11

**Interpretation**

Our results suggest that treatment with insulin analogues is associated with a reduction in diabetes-related complications (i.e., higher number of quality-adjusted life-years) relative to conventional insulins. However, benefits conferred and associated cost-savings do not offset the increased acquisition cost of insulin analogues. Consequently, compared to conventional insulin therapy, routine use of insulin analogues is likely to be associated with an incremental cost to third-party payers. For patients with type 1 diabetes, use of rapid-acting insulin analogues was associated with incremental costs per quality-adjusted life-year that were lower than widely cited cost-effectiveness thresholds.49–51 Results for rapid-acting analogues in adults with type 2 diabetes, and for long-acting analogues in adults with type 1 diabetes, were less clear. In some instances, the incremental costs per quality-adjusted life-year were lower than widely cited cost-effectiveness thresholds; however, in others, they exceeded these thresholds. Findings for long-acting insulin analogues in adults with type 2 diabetes were more consistent. In these instances, incremental costs per quality-adjusted life-year exceeded widely cited cost-effectiveness thresholds.

Using our approach to economic modelling, we found that the cost-effectiveness of insulin analogues depended overall on the type of insulin analogue used and whether patients receiving the treatment had type 1 or type 2 diabetes. In a health

| Table 4: Cost-effectiveness of insulin analogues for the treatment of diabetes in adults |
|----------------------------------|-------------------|-------------------|
| Variable                         | Type 1 diabetes   | Type 2 diabetes   |
|                                  | Insulin analogue  | Conventional insulin | Difference | Insulin analogue | Conventional insulin | Difference |
| Insulin aspart versus regular human insulin | Cost, * $     | 71 551              | 72 171              | –620        | 63 792              | 63 459              | 333        |
|                                  | Quality-adjusted life-years* | 11.016              | 10.961              | 0.055       | 5.899              | 5.884              | 0.015      |
|                                  | Incremental cost per quality-adjusted life-year gained, $ | Cost-saving† | 22 488 |
| Insulin lispro versus regular human insulin | Cost, * $       | 71 976              | 71 794              | 182         | 66 274              | 65 490              | 784        |
|                                  | Quality-adjusted life-years* | 10.997              | 10.991              | 0.006       | 5.773              | 5.767              | 0.006      |
|                                  | Incremental cost per quality-adjusted life-year gained, $ | 28 996 | 130 865 |
| Insulin glargine versus insulin neutral protamine Hagedorn | Cost, * $       | 70 751              | 67 328              | 3 423       | 67 132              | 62 187              | 4 945      |
|                                  | Quality-adjusted life-years* | 11.136              | 11.097              | 0.039       | 5.806              | 5.798              | 0.008      |
|                                  | Incremental cost per quality-adjusted life-year gained, $ | 87 932 | 642 994 |
| Insulin detemir versus insulin neutral protamine Hagedorn | Cost, * $       | 72 714              | 68 370              | 4 344       | 65 749              | 59 228              | 6 521      |
|                                  | Quality-adjusted life-years* | 11.045              | 11.034              | 0.011       | 5.944              | 5.978              | –0.034     |
|                                  | Incremental cost per quality-adjusted life-year gained, $ | 387 729 | Dominated† |

*Discounted at 5% per annum. Costs are in 2007 Canadian dollars.  
†A treatment strategy that is more costly and less effective. Meta-analysis results showed that patients taking insulin detemir had higher hemoglobin A1c values than those taking neutral protamine Hagedorn insulin.
care system without budgetary restraints, all medications would be accessible to all patients. However, if available resources are insufficient to support provision of all effective medications, the goal becomes one of achieving an optimal trade-off between allocating resources prudently and maximizing the overall health of the population. As in other instances in which new therapies are more expensive than traditional ones, the decision to fund insulin analogues seems to depend on how much a decision-maker is willing to pay per quality-adjusted life-year gained and on the availability of scarce resources. In light of the increasing prevalence of diabetes and increased acquisition costs for insulin analogues (particularly long-acting analogues), consideration must be given to the economic burden of providing these agents to all patients with diabetes.

It seems unlikely that routine use of insulin analogues, in particular long-acting analogues, in all patients with diabetes would represent an efficient use of finite health care resources. However, for some patients who are at high risk of hypoglycemia, the use of insulin analogues may prove to be cost-effective. Further research is needed to determine the cost-effectiveness of insulin analogues relative to conventional insulin in such patients.

Limitations

Limitations of our analyses warrant mention. First, our use of decision-modelling to estimate long-term diabetes-related outcomes is complex. For example, the model’s projections are based on trials of short duration with highly selective populations who may differ from real-world patients with respect to age, comorbidities, adherence to treatment and concomitant medication use. Thus, the effectiveness of these therapies in clinical practice may differ from the efficacy results observed in clinical trials. Nevertheless, the use of modelling to inform policy decisions in health care settings is increasing.

Second, hemoglobin A1c, a surrogate outcome, was used to forecast the occurrence of long-term diabetes-related complications. The validity of using the hemoglobin A1c test to forecast clinical outcomes has been debated, particularly for cardiovascular outcomes in patients with type 2 diabetes. The benefits conferred may thus be overstated. However, because hemoglobin A1c is routinely used in clinical practice as an indicator of treatment success, it likely represents the most acceptable measure of efficacy for these analyses.

Third, as shown by the acceptability curves for cost-effectiveness, there is considerable uncertainty around the results, and the base-case results should be interpreted with caution. For instance, because the acceptability curves for the cost-effectiveness of insulin aspart and insulin lispro plateau at about 50% for type 2 diabetes, it is equally likely that regular human insulin will be the most cost-effective strategy, at a lower acquisition cost.

Fourth, the model was very sensitive to changes in effect size of hemoglobin A1c, and decreases in utility scores for fear of hypoglycemia. Others have reported similar sensitivities to small changes in these model parameters. For example, the incremental cost per quality-adjusted life-year estimated by Grima and colleagues for insulin glargine in patients with type 1 diabetes increased from Can$20 799 to Can$87 132 when effect sizes of hemoglobin A1c were decreased from 0.40% to 0.20%. When fear of hypoglycemia was included in an evaluation by the National Institute of Clinical Excellence in London, England, the incremental cost per quality-adjusted life-year for insulin glargine compared with neutral protamine

![Figure 2: Cost-effectiveness acceptability curves of insulin analogues for the treatment of type 1 and type 2 diabetes mellitus in adults, by treatment comparison. Costs are in 2007 Canadian dollars.](image-url)
Hagedorn insulin was reduced from £32 000 to £3500 for type 1 diabetes and from £120 000 to £32 500 for type 2 diabetes.60

The Center for Outcomes Research Diabetes Model6 accommodates fear of hypoglycemia by applying a chronic decrement to health-related quality-of-life scores in the conventional-insulin arm only. No decrement is applied to utility scores in the insulin-analogue arm. Hypoglycemia has been reported in patients using insulin analogues,8,9 albeit less frequently than in patients prescribed conventional human insulin. The results for fear of hypoglycemia from our sensitivity analyses may therefore be biased in favour of insulin analogues. Further research is needed to better quantify the impact of fear of hypoglycemia on health-related quality of life.

Fifth, we did not include treatment effects for weight loss in our analyses.9 This limitation, however, should not be over-stated. Weight loss with insulin analogues is modest — less than 1 kg on average, which is unlikely to be considered a clinically important difference.11

Finally, results from the current analysis are specific to a primary care setting. It is uncertain whether they can be extrapolated to other countries, where the costs of insulin agents may vary.61

Our analyses also have a number of strengths. First, the ability of the Center for Outcomes Research Diabetes Model to predict long-term diabetes-related complications has been validated against published clinical and epidemiologic studies.7 Second, as recommended by the Washington Panel on Cost Effectiveness in Health and Medicine,20,30 we obtained our estimated decrements to utility scores from a catalogue of EuroQol-5D scores for the United States population.20,30 Third, our economic analyses adhere to the guidelines for the economic evaluation of health technologies of the Canadian Agency for Drugs and Technologies in Health.12 Finally, we derived our clinical inputs for the model from methodologically sound meta-analyses5,60 that reported robust results.

Conclusion
We found that the cost-effectiveness of insulin analogues depended on the type of insulin analogue and whether the patients receiving the treatment had type 1 or type 2 diabetes. With the exception of rapid-acting insulin analogues in type 1 diabetes, routine use of insulin analogues, especially long-acting analogues in type 2 diabetes, is unlikely to represent an efficient use of finite health care resources. In a companion paper (see page 385 of this issue),55 we report findings from a meta-analysis of clinical outcomes, the results of which serve to clarify further the optimal place of insulin analogues relative to conventional insulins in the management of diabetes in the Canadian health care system.

This article has been peer reviewed.

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