ABSTRACT

OBJECTIVE: To compare cost and utilization among users of insulin lispro and regular (human) insulin.

METHODS: This was a retrospective analysis using administrative claims data for continuously enrolled subjects using insulin lispro or regular insulin between January 1, 1998, and December 21, 1999. Subjects were matched 1 to 1 on the propensity to receive lispro versus regular insulin using a score estimated from baseline characteristics such as age, gender, comorbidities, and oral hypoglycemic use. Once matched, 12 months of follow-up pharmacy and medical cost and utilization data (e.g., prescriptions, office visits, hospitalizations) from July 1, 1997, through December 31, 2000, were analyzed using univariate statistics.

RESULTS: Of 11,443 subjects, 3,341 (29.2%) had received a prescription for insulin lispro, while 8,102 (70.8%) had received a prescription for regular insulin. At baseline, lispro subjects tended to be younger, more often had type 1 diabetes and a history of insulin use, had fewer comorbidities, visited endocrinologists more often than family practice physicians, and had lower total costs. After matching on propensity score to within ±0.01, 1,832 subject pairs were retained. On average, lispro subjects had significantly more office visits (P=0.0022) and pharmacy prescriptions (P=0.0165) but fewer inpatient hospital visits (P=0.0028) compared to regular insulin subjects. Cost results were similar, with insulin lispro subjects having significantly higher average office visit costs (P=0.0027) and pharmacy costs (P=0.0001) but lower inpatient hospital costs (P=0.0277). Total costs were not significantly different between treatment groups (P=0.5266).

CONCLUSION: Total direct health care costs were not different between insulin lispro and regular insulin users. An association was observed between higher pharmacy costs (P=0.0002) and more intensive ambulatory care for insulin lispro users and lower inpatient hospital cost in the short-term.

KEYWORDS: Insulin, Lispro, Cost

J Managed Care Pharm. 2003(9):3: 263-68
Cost and Utilization Comparisons Among Propensity Score-Matched Insulin Lispro and Regular Insulin Users

### Study Period

All prevalent users of insulin from January 1, 1998, through December 31, 1999, were identified in the claims database. For each subject, the fill date of the first insulin prescription during that 24-month period was considered the study index date. Each subject’s health services utilization patterns were examined for a period from 6 months prior through 12 months following this study index date. Thus, the study included pharmacy and medical claims data from July 1, 1997, through December 31, 2000.

### Inclusion Criteria

Health plan enrollees meeting all of the following inclusion criteria were selected as study subjects: (1) at least 1 pharmacy claim for insulin lispro or regular insulin between January 1, 1998, and December 31, 1999; (2) continuous enrollment for at least 6 months prior to and 12 months following the study index date; and (3) drug benefit coverage during the entire 18-month continuous enrollment period.

### Treatment Groups

If a subject filled a prescription for insulin lispro between January 1, 1998, and December 31, 1999, the subject was included in the lispro group. If a regular insulin prescription was filled and no insulin lispro prescription was filled in this time frame, the subject was included in the regular insulin group.

### Propensity Score Matching

Subjects were matched on the propensity to receive lispro insulin versus regular insulin. Matching subjects on propensity scores is one method of controlling for confounding when numerous characteristics are related to the outcome of interest or when 2 populations are known to differ due to selection bias. This method serves to balance the treatment groups at baseline.11 While standard regression modeling can handle several regressor variables, results can be misleading because small differences in numerous covariates can accumulate into a substantial overall difference. Two treatment groups may differ in a multivariate direction to an extent that cannot be discerned in the separate analyses of each covariate.12 For this reason, propensity score methodology is a reasonable alternative. In this study, baseline characteristics were used as independent predictors in a multivariate logistic regression model. The model was constructed to predict the probability (score) of receiving lispro versus regular insulin. Subjects were subsequently matched (1 to 1) on propensity scores within ±0.01. Subjects who could not be matched were removed from further analysis. Baseline characteristics were compared before and after matching to insure that all significant differences between the treatment groups had become nonsignificant. The independent variables used in the logistic regression model are defined in Appendix A. Due to the large number of comparison tests (N=21), the alpha level for all comparison tests was adjusted using a Bonferroni correction procedure, which resulted in

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### Baseline Variables Used in Logistic Model to Derive Propensity Scores

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Continuous, as of 12/31/00</td>
</tr>
<tr>
<td>Gender</td>
<td>Male=1</td>
</tr>
<tr>
<td>Physician specialty</td>
<td>A categorical variable indicating dominant provider (family practice/internist or Ob/Gyn, endocrinologist, pediatrician, other)</td>
</tr>
<tr>
<td>Comorbidities</td>
<td>One continuous variable indicating total number of comorbidities based on chapters of the ICD-9-CM codebook</td>
</tr>
<tr>
<td>Related comorbidities</td>
<td>Eight (0,1) variables indicating presence or absence of cardiovascular disease, hypertension, lower extremity infections, other metabolic diseases, nephropathy, neuropathy, obesity, and retinopathy (details appear in Appendix B)</td>
</tr>
<tr>
<td>HbA1c tests</td>
<td>Continuous variable indicating total number of HbA1c tests on medical claims</td>
</tr>
<tr>
<td>Oral hypoglycemic use</td>
<td>Continuous variable indicating total number of oral hypoglycemic prescriptions filled</td>
</tr>
<tr>
<td>Insulin prescriptions</td>
<td>Continuous variable indicating total number of insulin prescriptions filled</td>
</tr>
<tr>
<td>Basal insulin use</td>
<td>A (0,1) variable indicating any prescriptions for basal insulin</td>
</tr>
<tr>
<td>Eye exams</td>
<td>A (0,1) variable indicating an eye exam on a medical claim</td>
</tr>
<tr>
<td>Diabetes education</td>
<td>A (0,1) variable indicating diabetes education on a medical claim</td>
</tr>
<tr>
<td>Benzodiazepine use</td>
<td>A (0,1) variable indicating any prescriptions for benzodiazepines</td>
</tr>
<tr>
<td>Plan</td>
<td>A categorical variable of plan by region (SW, NE, MW, W)</td>
</tr>
<tr>
<td>Total costs</td>
<td>A continuous variable, all-cause medical and pharmacy costs, including member cost-share as well as net health plan cost</td>
</tr>
</tbody>
</table>
TABLE 1  Bivariate Tests Before and After Matching Lispro and Regular Insulin Subjects

<table>
<thead>
<tr>
<th>Variable</th>
<th>P Value Before Matching</th>
<th>P Value After Matching</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lispro N=4,318</td>
<td>Lispro N=1,832</td>
</tr>
<tr>
<td></td>
<td>Regular N=11,155</td>
<td>Regular N=1,832</td>
</tr>
<tr>
<td>Basal insulin use</td>
<td>&lt;0.0001</td>
<td>0.7121</td>
</tr>
<tr>
<td>Diabetes education</td>
<td>0.0068</td>
<td>0.8268</td>
</tr>
<tr>
<td>Eye exam</td>
<td>&lt;0.0001</td>
<td>0.2445</td>
</tr>
<tr>
<td>Benzodiazepine use</td>
<td>&lt;0.0001</td>
<td>0.6746</td>
</tr>
<tr>
<td>Age (in years)</td>
<td>&lt;0.0001</td>
<td>0.3902</td>
</tr>
<tr>
<td>Dominant physician specialty</td>
<td>&lt;0.0001</td>
<td>0.7764</td>
</tr>
<tr>
<td>Number of baseline HbA1c tests</td>
<td>&lt;0.0001</td>
<td>0.8686</td>
</tr>
<tr>
<td>Number of baseline insulin presets</td>
<td>&lt;0.0001</td>
<td>0.9399</td>
</tr>
<tr>
<td>Health plan location</td>
<td>0.6352</td>
<td>0.3467</td>
</tr>
<tr>
<td>Number of baseline comorbidities</td>
<td>&lt;0.0001</td>
<td>0.6957</td>
</tr>
<tr>
<td>Cardiovascular disease in baseline</td>
<td>&lt;0.0001</td>
<td>0.8919</td>
</tr>
<tr>
<td>Hypertension in baseline</td>
<td>&lt;0.0001</td>
<td>0.5032</td>
</tr>
<tr>
<td>Infection in baseline</td>
<td>&lt;0.0001</td>
<td>0.4431</td>
</tr>
<tr>
<td>Metabolic disease in baseline</td>
<td>0.0708</td>
<td>0.8645</td>
</tr>
<tr>
<td>Nephropathy in baseline</td>
<td>0.1107</td>
<td>0.7189</td>
</tr>
<tr>
<td>Neuropathy in baseline</td>
<td>0.9233</td>
<td>0.7390</td>
</tr>
<tr>
<td>Obesity in baseline</td>
<td>&lt;0.0001</td>
<td>0.4127</td>
</tr>
<tr>
<td>Retinopathy in baseline</td>
<td>0.0011</td>
<td>0.3221</td>
</tr>
<tr>
<td>Gender (male=1)</td>
<td>0.0436</td>
<td>0.3903</td>
</tr>
<tr>
<td>Total baseline costs</td>
<td>&lt;0.0001</td>
<td>0.8554</td>
</tr>
<tr>
<td>Oral hypoglycemic use*</td>
<td>&lt;0.0001</td>
<td>0.3949</td>
</tr>
</tbody>
</table>

* Based on an algorithm combining diagnosis codes and presence/absence of oral hypoglycemics. 14.9% of lispro and 8.8% of regular insulin subjects appeared to have type 1 diabetes prior to matching compared to 11% and 10.4% after matching, respectively.

Using a corrected alpha of 0.0024.

Measuring Follow-up Cost and Utilization
Health services utilization and costs were analyzed by type of service (physician office visit, outpatient hospital visit, inpatient hospitalization, emergency room visit, pharmacy, and laboratory/radiology tests). For the purpose of this study, costs were defined as the sum of both health plan and enrollee liability; i.e., total allowed managed care organization charges before subtraction of member-cost share. T tests with an alpha level of 0.05 were used to detect significant differences between treatment groups with regard to follow-up cost and utilization.

Results

Study Population Selection
A total of 29,878 subjects had at least 1 insulin claim during the study identification period (January 1, 1998, through December 3, 1999), corresponding to a prevalence of 7 insulin-treated enrollees per 1,000 health plan enrollees. From this population, 11,443 subjects met the study inclusion criteria: 3,341 (29.2%) insulin lispro subjects and 8,102 (70.8%) regular insulin subjects. Of those excluded from study eligibility, 15,200 (82%) were dropped due to lack of continuous enrollment, while 3,235 (18%) were excluded due to receipt of an insulin prescription that was neither insulin lispro nor regular insulin. The majority of these 3,235 subjects had prescriptions filled for NPH, an intermediate-acting insulin often used in concert with either insulin lispro or regular insulin.

Summary of Matching Procedure
Prior to matching subjects by their propensity scores (predicted value of receiving insulin lispro versus regular insulin based on baseline characteristics), 21 different baseline characteristics were compared across the 2 treatment groups. For 15 of the 21 (71.4%) baseline characteristics, the 2 treatment groups differed significantly. Insulin lispro subjects tended to be younger, used fewer oral hypoglycemics, had fewer comorbidities, visited endocrinologists more often than family practitioners, and had lower total costs compared to subjects who received regular insulin (Table 1). Of 3,341 insulin lispro subjects, 1,832 (54.8%) subjects were matched to a regular insulin-using subject within ±0.01. All subsequent analyses were limited to this matched sample (N=3,664 subjects [1,832 subject pairs]). After matching, none of the 21 baseline comparison tests remained significantly different. Characteristics of subjects lost during the matching procedure are summarized below.

The lispro subjects who were not matched were more often type 1 diabetics (based on an algorithm combining ICD-9-CM diagnosis codes [250.xx, Appendix B] and presence or absence of prescriptions for oral hypoglycemic agents) who were younger; prevalent users of insulin; treated by specialists; had less circulatory disease, cardiovascular disease, hypertension, or obesity; filled more insulin prescriptions; and had more HbA1c tests compared to the lispro subjects who were matched. The regular insulin subjects for whom no match existed were more often older; treated by general practitioners; had more neoplasms and circulatory, digestive, cardiovascular and musculoskeletal disease, hypertension, ill-defined conditions, lower extremity infections, and obesity; had fewer pregnancy complications, HbA1c tests, and insulin prescriptions; had more oral hypoglycemic prescriptions; and had higher baseline pharmacy and total costs.

Follow-up Cost and Utilization Analysis
Health services utilization during the 12-month follow-up period was compared across the 2 treatment groups (Table 2). While average rates of outpatient hospital visits, emergency room visits, or lab tests did not differ significantly between the 2 treatment groups, there were significant differences detected in numbers of office visits, prescriptions filled, and inpatient hospitalizations. On average, insulin lispro subjects had signifi-
Cost and Utilization Comparisons Among Propensity Score-Matched Insulin Lispro and Regular Insulin Users

APPENDIX B  ICD-9-CM Codes for Comorbidities Related to Complications of Diabetes

<table>
<thead>
<tr>
<th>Comorbidity/Complication</th>
<th>ICD-9-CM Diagnosis Codes and CPT Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension</td>
<td>401.xx-404.xx</td>
</tr>
<tr>
<td>Infections related to diabetes</td>
<td>038.xx, 790.7x-790.9x</td>
</tr>
<tr>
<td>Other metabolic diseases</td>
<td>251.0x-251.3x, 270.3x, 276.xx</td>
</tr>
<tr>
<td>Nephropathy</td>
<td>583.81, 580.9x, 581.81, 581.9x, 582.9x, 583.xx, 588.8x, 593.9x</td>
</tr>
<tr>
<td>Neuropathy</td>
<td>358.01, 354.xx-355.xx, 713.5x, 337.1x, 357.2x</td>
</tr>
<tr>
<td>Obesity</td>
<td>278.xx</td>
</tr>
<tr>
<td>Retinopathy</td>
<td>362.0x, 362.1x, 362.41, 363.31, 369.xx, 366.41, 365.44</td>
</tr>
</tbody>
</table>

---

TABLE 2  Univariate Comparison of All-Cause Health Services Utilization During Follow-up Period on Propensity Score-Matched Subjects

<table>
<thead>
<tr>
<th>Site of Service</th>
<th>Total Number</th>
<th>Mean Number per Patient</th>
<th>P Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lispro</td>
<td>Regular</td>
<td></td>
</tr>
<tr>
<td>Office visits</td>
<td>1,777</td>
<td>1,754</td>
<td>11.68</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10.60</td>
</tr>
<tr>
<td>Emergency room</td>
<td>524</td>
<td>546</td>
<td>0.51</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.52</td>
</tr>
<tr>
<td>Outpatient hospital</td>
<td>1,114</td>
<td>1,051</td>
<td>2.02</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2.48</td>
</tr>
<tr>
<td>Inpatient hospitalization</td>
<td>290</td>
<td>388</td>
<td>0.24</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.32</td>
</tr>
<tr>
<td>Hypoglycemia hospitalization</td>
<td>19</td>
<td>27</td>
<td>0.08</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.20</td>
</tr>
<tr>
<td>Laboratory tests</td>
<td>1,505</td>
<td>1,483</td>
<td>4.70</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4.40</td>
</tr>
<tr>
<td>Pharmacy</td>
<td>1,826</td>
<td>1,821</td>
<td>47.16</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>44.44</td>
</tr>
</tbody>
</table>

* T test comparing mean number per patient between 1,832 subject-pairs for lispro versus regular insulin; significance level = 0.05.

---

Cantly more office visits ($P=0.0022$) and filled significantly more prescriptions (diabetes-related and nondiabetes-related prescriptions, $P=0.0165$) compared to regular insulin subjects. In contrast, insulin lispro subjects had, on average, significantly fewer inpatient hospitalizations compared to regular insulin subjects ($P=0.0028$). Among subjects who received at least one diagnosis of hypoglycemia in the follow-up period, insulin lispro subjects had a significantly lower average number of hypoglycemia-related hospitalizations ($P=0.0014$).

Cost during the 12-month follow-up period was compared across the 2 treatment groups (Table 3). Insulin lispro subjects had significantly higher average office visit costs and pharmacy costs compared to regular insulin subjects ($P=0.0237$ and $P<0.0001$, respectively) as well as significantly lower average inpatient hospital costs compared to regular insulin subjects ($P=0.0227$); there was no significant difference in average emergency room, outpatient, laboratory, or total costs. It is important to note that although lispro subjects did have significantly higher average office visit costs and pharmacy costs (+$106 and +$447, respectively) relative to regular insulin subjects, these higher costs were offset by lower average inpatient hospital cost ($-769), a cost savings for insulin lispro (albeit not statistically significant) of $216 during the 12-month follow-up period.

■ Discussion

With its faster onset and shorter duration of action compared to regular insulin, insulin lispro has demonstrated a decreased risk of severe hypoglycemia compared to regular insulin.5,6 Type 1 patients taking insulin lispro also report improved satisfaction with their treatment and its flexibility.13-17 This study sought to determine whether the use of insulin lispro would result in no additional health care costs (cost neutral) as compared to regular insulin therapy.

As anticipated, subjects at baseline who were treated with insulin lispro differed significantly from those treated with regular insulin. Insulin lispro subjects tended to be younger, use fewer oral hypoglycemics, were less likely to be a new insulin user, were more likely to be treated by an endocrinologist or pediatrician, had fewer comorbidities, received more preventive care (e.g. eye exams, diabetes education, HbA1c tests), and had fewer inpatient visits, pharmacy prescriptions, or laboratory tests during the 6 months prior to the study period as compared...
ical costs, the utilization of insulin lispro could be cost neutral here support our supposition that, when considering total med-
costs to include, for example, lower indirect costs associated
ations for insulin lispro patients may go beyond direct health care
hospitalizations. Cost savings associated with fewer hospitaliza-
 hypoglycemia during the follow-up period, insulin lispro sub-
patients.18,19 In fact, among subjects who received a diagnosis of
severe hypoglycemia, which could potentially result in an inpa-
observation may indicate that insulin lispro’s flexibility with
regard to dosing and timing of meals led to fewer incidents of
lower inpatient hospital expenditures incurred by insulin lispro
subjects were found to have significantly higher expendi-
their regular insulin matches, while having significantly lower
inpatient hospitalization expenditures. The significantly higher
pharmacy expenditures found in the insulin lispro group were
not surprising because the direct product cost of insulin lispro
is greater than for regular insulin. In addition, lispro users had
more prescriptions for blood glucose monitoring devices and
other insulin supplies. The significantly higher office visit
expenses for patients using insulin lispro may be a function of
those subjects being more conscientious about their follow-
up care. Because insulin lispro is often used in combination
with other longer-acting insulins, diabetes patients sufficiently
vigilant to comply with such types of dual therapy may also be
more vigilant regarding follow-up office visits.
This study did yield a result that indicates an association
between increased office visit and pharmacy expenditures and
lower inpatient hospital expenditures incurred by insulin lispro
subjects over the short-term, 12-month follow-up period. This
observation may indicate that insulin lispro’s flexibility with
regard to dosing and timing of meals led to fewer incidents of
severe hypoglycemia, which could potentially result in an inpa-
tient hospitalization, especially within a population of type 1
patients.16,19 In fact, among subjects who received a diagnosis of
hypoglycemia during the follow-up period, insulin lispro sub-
jects had significantly fewer hypoglycemia-related inpatient
hospitalizations. Cost savings associated with fewer hospitaliza-
tions for insulin lispro patients may go beyond direct health care
costs to include, for example, lower indirect costs associated
with lost workdays due to hospitalization. The results observed
here support our supposition that, when considering total med-
cal costs, the utilization of insulin lispro could be cost neutral
to regular insulin users.

After propensity score procedures were completed, insulin
lispro subjects were found to have significantly higher expendi-
tures for office visits and prescription drug use compared to
their regular insulin matches, while having significantly lower
inpatient hospitalization expenditures. The significantly higher
pharmacy expenditures found in the insulin lispro group were
not surprising because the direct product cost of insulin lispro
is greater than for regular insulin. In addition, lispro users had
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hospitalizations. Cost savings associated with fewer hospitaliza-
tions for insulin lispro patients may go beyond direct health care
costs to include, for example, lower indirect costs associated
with lost workdays due to hospitalization. The results observed
here support our supposition that, when considering total med-
cal costs, the utilization of insulin lispro could be cost neutral
to an employer in an administrative services-only arrangement
with health maintenance or preferred provider organization
plans. Further research is necessary to determine whether the
result of fewer hospitalizations would be corroborated over a
longer follow-up period.

**Limitations**

While this study faced some limitations, we believe these limi-
tations did not compromise the overall study findings. The fol-
lowing limitations should be observed when interpreting the
study results. First, subjects were categorized as “insulin lispro”
users if they had at least 1 lispro prescription during the subject
identification period. Therefore, a subject could have switched
therapy during the study period. However, <1% of regular
insulin users filled a lispro prescription during the follow-up
period, suggesting that alternative therapy did not attribute to
outcomes observed during the follow-up period. Second, com-
pliance with therapy was not measured and could account for
some of the differences in outcomes. Third, because the 2 pop-
ulations of subjects were quite different at baseline, the match-
ing technique likely resulted in the pairing of a “sicker” lispro
subject and a “healthier” regular insulin subject at baseline.
However, this method also had the advantage of taking away
much of the “noise” that would cloud true associations when
starting with 2 populations that were very different. Fourth, the
study design included prevalent insulin users. While prior
insulin use was controlled for in the propensity score-matching
procedure, it may be preferable to include only new users of
insulin in future studies. Due to the relatively small number of
lispro insulin subjects, both prevalent and incident insulin users
were retained for study as a way to preserve sample size. Fifth,
while propensity score matching can control for selection bias,
it can only control for known or measurable confounders.
As with many statistical techniques, residual confounding was
still a possibility. Finally, this study used only 12 months of fol-
low-up data and claims through December 31, 2000. It would
be beneficial to repeat this study with more current data and
also allow for a longer period of follow-up time. Studies such as
the United Kingdom Prospective Diabetes Study and the
Diabetes Control and Complications Trial determined patient
outcomes for an average of 10 and 7 years, respectively.20,21

**Future Research**

Based on the study results, there are several possibilities for
future research. First, further studies could examine only dia-
abetes-related costs and utilization, as opposed to all-cause costs
and utilization studied here, to determine whether the above
relationships remain similar. Second, results could be examined
separately for pediatric and adult populations. Differences in
utilization patterns by treatment type may vary even within the
pediatric population; the benefit of insulin lispro’s flexibility
with regard to dosing and timing of meals may be far more ben-
eficial in teenagers, a population prone to forgotten or otherwise

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**TABLE 3**

<table>
<thead>
<tr>
<th>Type of Cost</th>
<th>Mean Cost</th>
<th>P Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office visit</td>
<td>$822</td>
<td>$716</td>
</tr>
<tr>
<td>Emergency visit</td>
<td>$185</td>
<td>$177</td>
</tr>
<tr>
<td>Outpatient hospital</td>
<td>$1,008</td>
<td>$1,062</td>
</tr>
<tr>
<td>Inpatient hospital</td>
<td>$2,510</td>
<td>$2,510</td>
</tr>
<tr>
<td>Laboratory</td>
<td>$233</td>
<td>$251</td>
</tr>
<tr>
<td>Pharmacy</td>
<td>$2,244</td>
<td>$1,797</td>
</tr>
<tr>
<td>Total</td>
<td>$6,231</td>
<td>$6,511</td>
</tr>
<tr>
<td>Total PPPM†</td>
<td>$519</td>
<td>$543</td>
</tr>
</tbody>
</table>

* T test comparing lispro versus regular insulin for 1,832 subject-pairs.
† Per-patient-per-month.
missed doses, as compared to children under 6 whose dosing may be closely supervised by a parent. Third, results could be stratified according to type 1 or type 2 diabetes status because of the differences in comorbidities and demographic characteristics, qualities that may influence their health-seeking behavior and treatment outcomes. Fourth, a longer follow-up period may better illuminate treatment differences particularly with regard to hospitalization. Continuous enrollment requirements for retrospective database studies often limit sample size. However, results could be reported for each subset of subjects enrolled 12 months, 24 months, 36 months, etc. Finally, the addition of laboratory data, such as HbA1c tests, may better explain why insulin lispro users had significantly less hospital utilization as compared to regular insulin users.

**Conclusion**

This study aimed to show that despite its higher total product cost, use of insulin lispro would be associated with total direct medical care costs similar to regular (human) insulin therapy. Findings from this study supported this supposition. We observed lower inpatient hospital expenditures during the 12-month study period, which appeared to offset the higher cost attributable to more intensive ambulatory patient care and the higher direct drug cost of lispro insulin. These results should be weighed by managed care organizations in the context of prior evidence from clinical trials of lower risk of severe hypoglycemia and dosing flexibility for patients who use insulin lispro.

**ACKNOWLEDGMENTS**

The authors would like to thank Pam Erickson, MS; John Holcombe, MD; and Scott Jacobo, DO, CDE, for their helpful reviews of this paper.

**DISCLOSURES**

Funding for this study was provided by Eli Lilly & Company and was obtained by author Kent H. Summers, who is employed by Lilly. Author Robert L. Obenchain is also a Lilly employee and author of papers proposing and comparing alternative methods of propensity scoring. Author Jennifer A. Hall is an employee of Ingenix, which was contracted by Eli Lilly & Company to complete the research. Hall served as principal author of the study and was responsible for the analysis and interpretation of data and drafting of the manuscript. Study concept and design and critical revision of the manuscript were the work of Summers and Obenchain. Statistical expertise was contributed by Obenchain.

An abstract of this research was printed in *Value in Health* following a poster presentation at the May 2002 Annual International ISPOR meeting.

**REFERENCES**