Regular Insulin Administered With the V-Go Disposable Insulin Delivery Device in a Clinical Diabetes Setting: A Retrospective Analysis of Efficacy and Cost

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People with diagnosed diabetes incur high average medical expenditures of ~$13,700 per year, creating a cost burden for themselves and their health plan insurers (1). According to the American Diabetes Association (ADA), 97% of the $245 billion cost for diabetes care in the United States is provided by government and commercial insurance payers (2). The cost of diabetes therapy, including insulin, accounts for 12% of the total cost of diabetes care, and managing diabetes to prevent complications is becoming less affordable (2).

Insulin is still considered the most potent glucose-lowering agent available. ADA and the European Association for the Study of Diabetes recently issued guidelines for the treatment of type 2 diabetes that identified insulin replacement therapy as a key component of effective diabetes management over the course of the disease (3). The use of rapid-acting insulin analogs (RAIs) has surpassed the use of regular human insulin (RHI) in the majority of basal-bolus and bolus-only therapy regimens (4). Ninety-six percent of patients with type 2 diabetes who take insulin in the United States now use an analog insulin for basal and/or prandial coverage—an increase from just 19% in 2000 (5). This increase in utilization may be the result of many factors, including the pharmacokinetic differences among the insulins, marketing developments, and formulary health plan coverage (6).

Along with this increase in the utilization of RAIs, there has been an increase in costs to patients and health plans. This is especially apparent when the costs of RAIs are compared to those of RHI as a therapy alternative. The steep increase in the cost of RAIs has led many patients to partially or totally discontinue their insulin therapy because of affordability issues (1). Several studies have shown that low adherence to diabetes therapy is also associated with higher medication costs (3,7,8).

The increase in the cost of insulin that has led to a lack of affordability of RAI therapy for some patients has forced clinicians to reconsider the clinical effects and economic benefits of RHI. Using RHI may be an appropriate clinical consideration for patients given the lack of data demonstrating a significant difference between RAIs and RHI in A1C, long-term outcomes, or severe hypoglycemia (4). The utilization of RHI may address the issue of affordability for many patients on insulin therapy and their insurance plans.

V-Go (Valeritas, Inc., Bridgewater, N.J.) is the first fully mechanical, disposable insulin delivery device. It is a wearable device that delivers a continuous preset basal rate of insulin infusion as well as on-demand mealtime (bolus) dosing in 2-unit increments. V-Go is filled with U-100 fast-acting insulin (e.g., insulin aspart or insulin lispro) and is removed and replaced with a new device every 24 hours (9). The device adheres to the

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skin using a hypoallergenic and latex-free adhesive. The push of a button inserts a 4.6-mm, 30-gauge stainless steel needle subcutaneously and thus initiates delivery of a continuous preset basal rate of 20, 30, or 40 units/24 hours (9).

The purpose of this retrospective chart review was to observe the impact on glycemic control and therapy costs when patients were transitioned to RHI administration with the V-Go insulin delivery device from other diabetes therapies in a large, endocrine-based, clinical practice in Florida.

Design and Methods

A retrospective analysis was conducted utilizing the electronic medical record (EMR) database at a large endocrine specialty center. Inclusion criteria were a baseline A1C value, administration of RHI with V-Go, and a minimum of one follow-up office visit with another A1C value after V-Go initiation. Patients who had U-500 regular insulin or an insulin pump device at any time from 6 months before to during V-Go use were excluded. An economic analysis was conducted to assess the direct pharmacy cost impact of RHI administration with V-Go. The principal investigator oversaw the review of subject records to determine study eligibility and data collection.

Data Collection

A retrospective analysis of de-identified data was initiated by collecting the baseline characteristics of patients who transitioned to RHI delivered with V-Go. A query in the EMR database using keywords including "V-Go" and "U-100 RHI" identified patients switched to RHI between 1 May 2012 and 28 August 2015. Data collected included A1C, insulin dosage, insulin brand, delivery system (i.e., vial and syringe, pen, or V-Go), concomitant antidiabetic medications, and body weight. The same data were collected for up to two subsequent office visits after V-Go initiation. The choice of diabetes therapy was based on the standard of care at this clinical site. Insulin dosing information included allowances for titration and correction doses.

Data Analysis

Baseline characteristics, clinical outcomes, and cost-effectiveness were compared from baseline to each follow-up visit. Descriptive statistics were used for baseline patient characteristics. A repeated-measures *t* test was conducted for change in A1C and change in insulin dosing from baseline to each of the first and second office visits (OV1 and OV2). Clinical and cost data were imputed for one patient at OV2 using a last-observation-carried-forward (LOCF) method. Wholesale acquisition cost (WAC) pricing and retail pricing (RP) based on 2015 U.S. dollars for units of insulin (adjusted average wholesale price minus 20%), pen needles or syringes, and the delivery system were used to assess the cost of therapy at baseline and subsequent office visits. All insulin costs were normalized based on a 30-day supply. The ReliOn brand of U-100 RHI, which is manufactured for Walmart by Novo Nordisk, was used for cost calculations of RHI (10). Cost of therapy was evaluated by comparing the total costs of insulin delivery per patient per month (PPPM) at baseline versus the total costs PPPM at OV1 and OV2.

Results

Study Population

The EMR database query identified 11 patients based on inclusion criteria. The median durations of RHI with V-Go for the OV1 and OV2 efficacy assessments were 84 days and 186 days after initiation, respectively. The change in direct pharmacy therapy cost PPPM was calculated. The majority of patients were receiving basal-bolus therapy with multiple daily injections at baseline. For the 11 identified patients receiving RHI with V-Go, previous therapies included basal-bolus insulin therapy (7 patients), basal insulin therapy (1 patient), premixed insulin therapy (2 patients), and insulin naiveté (non-insulin glucose-lowering agents only) (1 patient). The mean ± SD baseline A1C for this population was 8.6 ± 1.2%, and patients had a mean ± SD body weight of 100 ± 10.9 kg.

Efficacy and Cost Findings at OV1

At OV1 (median 84 days after initiation), there was a statistically significant decrease in A1C from 8.6% at baseline to 7.8% (P = 0.032) for all patients. A baseline total daily dose (TDD) of insulin of 82 units/day was reduced to 63 units/day, representing a 23% reduction. A statistically significant mean reduction in basal insulin dose from 47 to 31 units/day (P = 0.001) was also observed. This basal insulin dose represented 51% of the TDD and aligned with other published findings that basal insulin requirements are typically 50% of a patient's total daily insulin requirement (3). Weight at OV1 was 100 kg, which was similar to weight at baseline. The baseline total cost of insulin therapy of $568 PPPM was reduced to $347 PPPM with administration of U-100 RHI. This represented a 39% reduction in direct pharmacy cost compared to baseline therapy.

Efficacy and Cost Findings at OV2

At OV2 (median 186 days after initiation), data were available for 10 patients administering RHI with V-Go; 1 patient did not have a subsequent follow-up visit during the data collection period. A statistically significant decrease in A1C of 0.7 percentage points from baseline was observed, resulting in a mean A1C of 7.9% (P = 0.029). Mean TDD decreased to 61 units/day, representing a reduction of 21 units/day or 26% from baseline. A statistically significant mean reduction in basal insulin dose was observed from 47 units/day at baseline to 31 units/day (P = 0.001). Body weight was largely unchanged, with an observed nonsignificant 1.4-kg

TABLE 1. Reduction in Direct Pharmacy Cost* by Using RHI With V-Go (*n* = 11)

	Before V-Go (Baseline)	On V-Go (at OV2, 6 months)
Prescribed insulin TDD (units/day)	82	61
Prescribed insulin therapy, PPPM ($)	568*	—
Prescribed insulin TDD + V-Go, PPPM ($)	—	309
Insulin therapy savings with V-Go, PPPM ($)		259
Projected insulin therapy savings with V-Go, PPPY ($)		3,108**

**Cost average based on WAC specific to patient baseline regimen. Pricing for insulin and other diabetes agents based on Elsevier Gold Standard. ProspectoRx. [Database Online] Available from https://prospectorx.com/Home.aspx. Accessed 2 December 2015.*

***Cost savings were projected for 1 year based on 6-month savings.*

Data are means, and all costs are normalized. PPPY, per patient per year.

increase from baseline. The cost of therapy from baseline was reduced to $309 PPPM, a cost differential from baseline of $259 PPPM, representing a 46% reduction in direct pharmacy cost within 6 months when administering RHI with V-Go (Table 1).

Discussion

The price of analog insulins has increased much faster than the inflation rate since they were launched in the marketplace. Patients who require bolus (mealtime) insulin have seen an increase in the cost of RAIs of 585% between 2001 and 2015, from $34 to $234 per vial (5). In 2011, $8.3 billion was spent in the United States on insulin (11). Much of this expenditure can be attributed to the cost of insulin analogs, which are often seven to eight times more expensive than human insulins and are especially costly for people who take large doses of RAI daily (12). The escalating cost of RAIs has caused both patients and clinicians to consider the use of RHI for diabetes management when cost is an issue (13).

The rising cost of RAIs and changes in health plan insurance coverage are hurdles to some patients who are attempting to pay for their medications. This may be especially true for Medicare Part D recipients, who face gaps in coverage once they enter the "donut hole" (annual expenditures greater than their plan's prescription coverage limit but less than its out-of-pocket spending limit, above which coverage will resume) (14).

Because the cost of therapy affects adherence, this dilemma supports the need to seek treatment alternatives that are equally efficacious but more affordable. A recent analysis of 27,897 diabetes patients receiving insulin showed that >50% had an A1C >8%, with almost one-third having an A1C ≥9% (15).

Evidence suggests that, for most patients with type 2 diabetes, RHI may be just as effective as an RAI in reducing A1C (16–18). Using RHI may be a viable option in many cases where the cost of an RAI is prohibitive to adherence to insulin therapy and has a subsequent negative effect on glycemic control. Introducing RHI by using a disposable insulin delivery device for continuous infusion may also provide a more affordable option for insulin therapy compared to RAI but would additionally utilize a method that may require fewer injections per day and less insulin dosed compared to delivery with syringes or insulin pens.

This retrospective chart analysis provides an observation of the change in cost and glycemic control when RHI was administered with the V-Go disposable insulin delivery device in a real-world setting. V-Go has proven to be an appropriate therapy for a broad range of patients, resulting in significantly reduced A1C levels (19,20). Stability studies have been conducted for the administration of U-100 RHI with V-Go, and RHI was found to be stable in this delivery device (21). Additionally, case series illustrating the clinical use of RHI with V-Go have been presented (22). Gathering clinical information regarding RHI administration with V-Go has shown this to be a viable option for improving glycemic control more affordably than with other antidiabetic therapies.

In this analysis, there was a significant decrease in mean A1C (0.7 percentage points) for the overall patient population across the analysis period (Figure 1). The mean A1C of 8.6% at baseline improved to 7.8 and 7.9% after ~3 (OV1) and 6 (OV2) months, respectively.

Data were gathered from the EMR database to observe the impact of patients transitioning to RHI delivered with V-Go with no change in the frequency of patient contact and related interaction with the prescribing provider. Standard of care therapy algorithms were employed for all patients at this clinical site. RHI dosing and titration were similar to RAIs, with the clinician using a weight-based dosing algorithm.

In addition to significant improvements in A1C, there were substantial reductions in direct pharmacy costs for improving glycemic control with RHI delivered with V-Go. Data collected from the EMR database provided a history of diabetes medica-

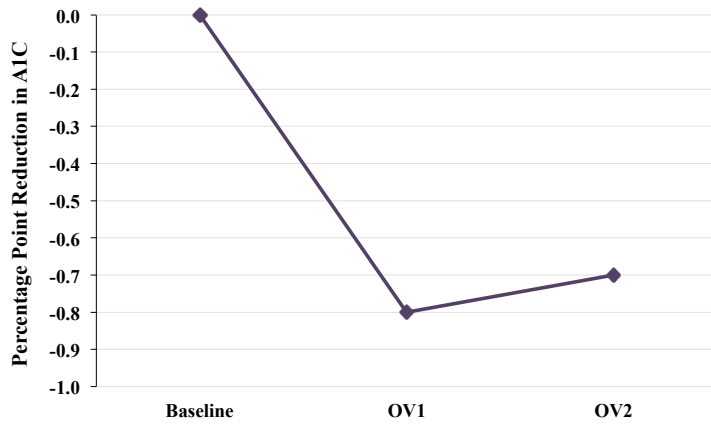

FIGURE 1. Impact of U-100 RHI administered with V-Go at OV1 (3 months after initiation) and OV2 (6 months after initiation) (n = 11) at 3 months (P = 0.32) and at 6 months with LOCF (P = 0.029) compared to baseline A1C of 8.6%. Insulin TDD was 82 units at baseline, 63 units at OV1, and 61 units at OV2.

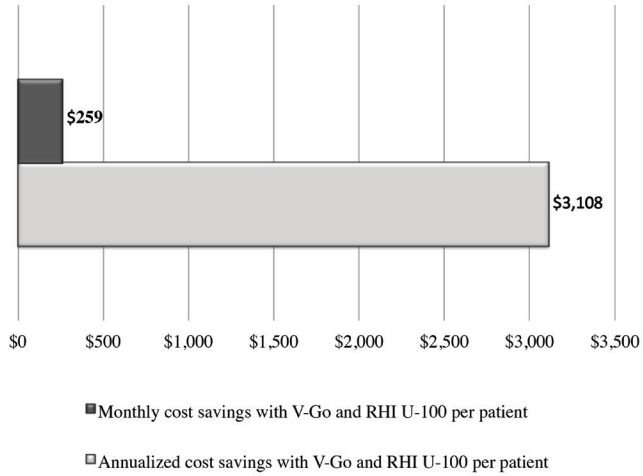

FIGURE 2. Comparative monthly and annual cost savings with RHI administered with V-Go. Costs are based on WAC specific to patient baseline regimen. Cost analysis was based on 11 patients at 6 months, with 1 LOCF. Baseline total cost of insulin therapy was $568 PPPM. RHI refers to the ReliOn brand of U-100 RHI, which is manufactured for Walmart by Novo Nordisk. The cost of concomitant medications used at baseline is not factored into this analysis. Pricing for insulin and other antidiabetic agents was based on Elsevier Gold Standard. ProspectoRx. [Database Online] Available from https://prospectorx.com/aspx. Accessed 2 December 2015. Insulin costs were normalized to 30 days based on prescribed daily dose.

tions and doses prescribed at baseline that served as a basis for analysis and comparison of direct pharmacy cost incurred with RHI used in V-Go. There was a direct cost savings of $259 PPPM, which translated to a pharmacy cost savings of $3,108 per patient per year (Figure 2). The main factors determining decreased pharmacy costs were the use of RHI instead of an RAI and, to a lesser extent, the reduction in insulin TDD.

In this retrospective analysis, administering RHI insulin therapy with V-Go was observed to be an effective lower-cost alternative to RAI therapy. Glycemic control was significantly improved, and the overall pharmacy cost burden was reduced in this patient population. Additional studies are recommended to validate these findings on the cost-effectiveness, efficacy, and safety of using RHI as a viable alternative to RAI when cost considerations are paramount. Whether the improved glucose control was the result of increased accessibility to or affordability of insulin, the V-Go device and its simplicity of delivery, or a combination of both remains to be explained.

Conclusion

The number of people diagnosed with diabetes continues to increase, as does the number of therapies used to treat this growing population. Given the high costs associated with some antidiabetic therapies, there is a need for more observational studies to ascertain the necessary costs of glycemic control. Efficacious treatments that provide an efficient use of pharmacy plan disbursements and reduce health care expenditures for patients are also needed.

This study of the use of RHI administered with V-Go showed an improvement in glycemic control in concert with a reduction in the cost of insulin therapy. Combining a more affordable insulin formulation with an alternative delivery system that allows for simple, physiological, and efficacious insulin delivery with only one daily injection should be considered as an option when insulin therapy is required. Further studies are recommended to validate these findings.

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Duality of Interest

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