510(k) SUBSTANTIAL EQUIVALENCE DETERMINATION
DECISION SUMMARY

I Background Information:

A 510(k) Number

K232382

B Applicant

Tandem Diabetes Care, Inc.

C Proprietary and Established Names

Control-IQ Technology

D Regulatory Information

Product Code(s)	Classification	Regulation Section	Panel
QJI	Class II	21 CFR 862.1356 – Interoperable Automated Glycemic Controller	CH - Clinical Chemistry

E Purpose for Submission:

Modification to a cleared device to expand the age indication (from ≥ 6 years old to ≥ 2 years old) and to provide configurable parameters for the more insulin sensitive and insulin resistant device users with expansion of programmable ranges (i.e., total daily insulin dose, body weight, correction factor), extension of the maximum bolus duration, availability of temporary basal rates with Closed-Loop active, and elimination of the prior hourly basal rate limit.

II Intended Use/Indications for Use:

A Intended Use(s):

See Indications for Use below.

B Indication(s) for Use:

Control-IQ technology is intended for use with compatible integrated continuous glucose monitors (iCGM) and alternate controller enabled (ACE) pumps to automatically increase, decrease, and suspend delivery of basal insulin based on iCGM readings and predicted glucose values. It can also deliver correction boluses when the glucose value is predicted to exceed a predefined threshold.

Control-IQ technology is intended for the management of Type 1 diabetes mellitus in persons 2 years of age and greater.

Control-IQ technology is intended for single patient use and requires a prescription.

C Special Conditions for Use Statement(s):

Due to an administrative error, a special condition for use limiting use to the Dexcom G6 iCGM was erroneously included and is now removed.

Rx - For Prescription Use Only

Only use U-100 Humalog or U-100 NovoLog with your pump. Only U-100 Humalog and NovoLog have been tested and found to be compatible for use in the pump. Use of insulin with lesser or greater concentration can result in under delivery or over delivery of insulin. This can cause hypoglycemia (low BG) or hyperglycemia (high BG) events.

When the CGM reading is automatically populated into the bolus calculator, only the current CGM reading is used to calculate the correction bolus. The trend arrow is not used in the dose calculation. Speak with your healthcare provider for recommendations on how best to utilize the arrows for your correction bolus dosing.

Control-IQ technology should not be used in anyone under the age of two years old. Control-IQ technology should also not be used in patients who require less than a total daily insulin dose of 5 units per day or who weigh less than 20 pounds, as those are the required minimum values needed in order for Control-IQ technology to operate safely.

When using the Control IQ algorithm, wear an iCGM.

The t:slim X2 pump, transmitter, and sensor must be removed before Magnetic Resonance Imaging (MRI), and Computed Tomography (CT) scan. Exposure to MRI, CT, or diathermy treatment can damage the components.

DO NOT use Control-IQ technology if you are taking hydroxyurea, a medication used in the treatment of diseases including cancer and sickle cell anemia. Your Dexcom G6 CGM readings may be falsely elevated and result in over-delivery of insulin that could result in severe hypoglycemia.

III Device Description

Control-IQ technology (Control-IQ, the device) is a software-only device intended for use by people with diabetes. The device controls insulin delivery from a compatible alternate controller enabled insulin pump (ACE pump) based on inputs provided by a compatible integrated continuous glucose monitor (iCGM) and inputs provided the user (e.g., carbohydrate intake, exercise, and sleep schedule). Control-IQ technology is meant to be installed on a compatible ACE pump.

Control-IQ technology works to control glucose towards a glucose target range of 112.5-160 mg/dL during normal use. Glucose targets are not customizable but can be changed by a user if sleep or exercise modes are set or announced. During sleep mode, this range is changed to 112.5-120 mg/dL, and it is changed to 140-160 mg/dL during exercise mode.

Control-IQ technology includes an integrated feature whereby iCGM values are automatically populated into the glucose field of the integrated bolus calculator when the Control-IQ technology is active (i.e., the device is operating in closed-loop mode). This feature is disabled when Control-IQ is turned off.

Using Control-IQ technology requires that users input their weight and their total daily insulin requirement, which should be established with the help of a health care provider before using the device.

IV Substantial Equivalence Information:

A Predicate Device Name(s):

Control-IQ Technology

B Predicate 510(k) Number(s):

K200467

C Comparison with Predicate(s):

Device & Predicate Device(s):	K232382	K200467
Device Trade Name	Control-IQ Technology	Control-IQ Technology
General Device Characteristic Similarities		
Intended Use/Indications For Use	Intended for use with compatible integrated continuous glucose monitors (iCGM) and alternate controller enabled (ACE) pumps to automatically increase, decrease, and suspend delivery of basal insulin based on iCGM readings and predicted glucose values. It can also deliver correction boluses when the glucose value is	Same

	predicted to exceed a predefined threshold.	
General Device Characteristic Differences		
Intended User Population	2 years and older with Type 1 diabetes mellitus.	6 years and older with Type 1 diabetes mellitus.
Profile delivery	The user's profile basal rate may be set as high as 15 units/hr when Control-IQ is off and when Control-IQ is enabled same basal rate is applied.	The user's profile basal rate may be set as high as 15 units/hr when Control-IQ is off, but is clipped to 3 units/hr when Control-IQ is enabled.
Correction Factor	The personal profile correction factor ranges from 10 to 600 mg/dL/U.	The personal profile correction factor ranges from 10 to 200 mg/dL/U.
Body weight range	20 – 440 pounds	55 – 308 pounds
Total Daily Insulin Range	User setting: 5 – 200 U/day Automatic adjustment: 2.5 – 200 U/day	User setting: 10 – 100 U/day Automatic adjustment: 5 – 200 U/day
Extended Bolus	Up to 8-hour duration while Control-IQ is enabled or disabled and extended boluses are uninterrupted when enabling Control-IQ.	Up to 2-hour duration when Control-IQ is enabled and 8-hours with Control-IQ disabled.
Temporary Basal Rates	Can be enabled without turning off Control-IQ.	For using Temporary rates, Control-IQ must be turned off.

V Standards/Guidance Documents Referenced:

Special controls established under 21 CFR 862.1356.

ISO 14971:2007: Medical Devices - Application of Risk Management to Medical Devices FDA Recognition No: 5-40

VI Performance Characteristics:

A. Analytical Performance

For the purposes of analytical and clinical validation testing, the Control-IQ algorithm was installed on the t:slim X2 Insulin Pump with Interoperable Technology ACE pump (K232380), which was paired with the Dexcom G6 continuous glucose monitoring system (K223931).

B. Other Supportive Instrument Performance Characteristics Data

1. Summary of Clinical Testing

The sponsor conducted a 13-week randomized controlled trial (RCT) in subjects 2 to 6 years old with type 1 diabetes to evaluate the performance of the original Control-IQ algorithm (i.e., Control-IQ 1.0 and the predicate device and not the modified 1.5 version that is the subject of this clearance) to support the expansion of the age indication of this device to include Type 1 diabetes users down to 2 years old. The sponsor then conducted an Extension Phase of the pivotal study in which all subjects who participated in the RCT transitioned to Control-IQ 1.5 for 13 weeks. This version of Control-IQ 1.5 (device being cleared) does not alter the control algorithm of the device itself, rather, it includes a wider range for several configurable parameters (e.g., weight, total daily insulin, etc.) which are intended to make the system amenable to address the unique needs of very insulin sensitive and very insulin resistant users. The sponsor refers to this updated version as Control-IQ 1.5 in the clinical performance section of the device user guide. To be consistent with the user guide of the subject device, throughout this section of the document, we refer to it as Control IQ 1.5.

After the Extension Phase was completed, the sponsor offered study subjects the opportunity to continue using the Control-IQ 1.5. This phase is being referred to as Extended Use phase. This phase ran for in two phases, first for 13 weeks, following which it continued with fewer patients for another 13 weeks.

In summary, the clinical data to support the age expansion in the IFU of the device is comprised of (1) the RCT comparing previously cleared Control-IQ (K200467) with standard care, (2) the Extension phase prospectively evaluating the performance of Control-IQ 1.5 by users who were already experienced in using the cleared Control-IQ 1.0 in the RCT as well as subjects naïve to Control-IQ 1.0 who continued to use standard care (e.g. multiple daily injections and insulin pump use that do not possess the hybrid closed loop capabilities that Control-IQ offers) during the RCT, and (3) the prospective evaluation for up to 1 year, referred to as Extended Use of Control-IQ 1.5 primarily for safety of the same subjects who had used the modified Control-IQ for 13 weeks in the Expansion Phase. Further details about the study is provided below.

Study Feature	Description
Title	The Pediatric Artificial Pancreas (PEDAP) trial: A Randomized Controlled Comparison of the Control-IQ technology Versus Standard of Care in Young Children in Type 1 Diabetes
Study Design	Randomized, prospective, multicenter clinical trial
Number of Sites	3
Population	Children under 6 years of age who were diagnosed with type 1 diabetes and were using insulin for at least a year were eligible for the study.
Sample Size	102 participants
Treatment Groups	Pediatric (2 to < 6 years): Participants were randomly assigned 2:1 to an intervention using Tandem t:slim X2 with Control-IQ Technology or the standard care (SC) control group using existing insulin therapy in conjunction with study CGM.
Study Duration	13 weeks
Protocol Overview/Synopsis	To assess efficacy, quality of life, and safety of a closed loop control (CLC) system (t:slim X2 with Control-IQ Technology) in a randomized controlled trial. **Key Eligibility Criteria** *Inclusion* 1. The study cohort included children 2 to <6 years old with type 1 diabetes (T1D) for at least 6 months and using insulin for at least 6 months. 2. Participants' total daily insulin dose had to be at least 5 U/day, with body weight at least 20 lbs. *Exclusion* 1. use of any non-insulin glucose-lowering agent; hemophilia or any other bleeding disorder. 2. >1 severe hypoglycemic event with seizure or loss of consciousness in the last 3 months 3. >1 DKA event in the last 6 months not related to illness, infusion set failure, or initial diagnosis 4. history of chronic renal disease or currently on hemodialysis; 5. history of adrenal insufficiency 6. hypothyroidism that was not adequately treated or any other condition, which in the opinion of the investigator or designee, would put the participant or study at risk 7. current use of a hybrid closed-loop (HCL) system. The study also had a run-in phase. Eligible participants not using a Dexcom G5 or Dexcom G6 continuous glucose monitor (CGM) meeting minimum usage requirements initiated a run-in phase of 2 to 6 weeks that was customized based on whether the participant was already a CGM user. Participants who were already using Dexcom G5 or G6 could skip the run in-phase.

Study Feature	Description
	Primary Endpoints CGM-measured % in range 70–180 mg/dL *Key Safety Outcomes* • severe hypoglycemia • diabetic ketoacidosis • other serious adverse events

Demographics

Pediatric Study	Standard Care (N = 34)	Control-IQ 1.0 (N = 68)
Age Mean (SD)	*4.06 (1.25)*	*3.84 (1.23)*
2 to < 4	16 (47%)	31 (46%)
4 to < 6	18 (53%)	37 (54%)
Sex – Female n (%)	19 (56%)	33 (49%)
Diabetes Duration (years)		
Median (IQR)	1.04	1.40
Range	0.50 to 4.00	0.51 to 5.00
HbA1c Level at Randomization (%)		
Mean (SD)	7.7 (0.9)	7.5 (1.2)
<7.0	8 (25%)	23 (36%)
7.0 to < 8.0 %	8 (25%)	20 (31%)
8.0 to % <9.0 %	15 (47%)	15 (23%)
≥9.0 %	1 (3%)	6 (9%)
Range	6.0 to 9.7	5.2 to 11.5
Race/Ethnicity		
White non-Hispanic	25 (74%)	50 (74%)
Black non-Hispanic	2 (6%)	4 (6%)
Hispanic or Latino	5 (15%)	11 (16 %)
Asian	1 (3%)	1 (1 %)
More than one race	1 (3%)	2 (3%)

Observed Results for PEDAP Study

	Control-IQ 1.0 (N=67)	Standard of Care (N=34)
% Time<54 mg/dL		
Baseline Mean (SD)	0.6 (0.7)	0.5 (0.6)
Week 13 mean (SD)	0.6 (0.6)	0.5 (0.5)
Adjusted Group Difference over 13 weeks (95% CI) [p-value]	0.01 (-0.1, 0.1)	
% Time 70-180 mg/dL		
Baseline Mean (SD)	57 (18)	55 (15)
Week 13 mean (SD)	69 (11)	56 (13)

Adjusted Group Difference over 13 weeks (95% CI) [p-value]	12.4 (9.5, 15.3) [< 0.001]	
Mean Glucose (mg/dL)		
Baseline Mean (SD)	173 (36)	176 (36)
Week 13 Mean (SD)	155 (20)	174 (22)
Adjusted Group Difference over 13 weeks (95% CI) [p-value]	5.4 (-7.3, -3.6) [<0.001]	
Change in HbA1c after 13 Weeks		
Baseline	7.5 (1.2)	7.7 (0.9)
Week 13	7.0 (0.8)	7.5 (0.9)
Adjusted Group Difference over 13 weeks (95% CI) [p-value]	-0.42 (-0.62, -0.22), [<0.001]	

Extension Phase of PEDAP Study

The extension phase assessed the change in time in range for each of the treatment groups (Control-IQ 1.5 versus Standard of Care) compared to the RCT phase of the study. The key safety outcomes were severe hypoglycemia and ketoacidosis. In this phase the standard care group switched over to use of Control-IQ 1.5. The data used in the table below was based on 63 subjects continuing Control-IQ 1.5, and 33 switching over from Standard of Care to Control-IQ 1.5. The HbA1c measurements were taken from 55 of the subjects who remained on Control IQ and 28 of the subjects who migrated from Standard of Care to Control-IQ 1.5.

	Control-IQ 1.0 to Control-IQ 1.5	**Standard of Care to Control-IQ 1.5**
% Time<54 mg/dL		
Baseline Mean at 13 weeks (SD)	0.6 (0.5)	0.5 (0.6)
Weeks 14 - 26 (SD)	0.5 (0.4)	0.4 (0.3)
Adjusted Group Difference over 13 weeks (95% CI) [p-value]	-0.1 (-0.2, 0.02) [0.08]	-0.1 (-0.2, -0.02) [0.02]
% Time 70-180 mg/dL		
Baseline Mean (SD)	70 (11)	56 (13)
Week 13 mean (SD)	70 (11)	68 (9)
Adjusted Group Difference over 13 weeks (95% CI) [p-value]	0.1 (-1.2, 1.4) [0.86]	11.8 (9.6, 14.1) [< 0.001]
Mean Glucose (mg/dL)		
Baseline Mean at 13 weeks (SD)	154 (18)	173 (23)
Weeks 14 - 26 (SD)	155 (20)	159 (15)
Adjusted Group Difference over 13 weeks (95% CI) [p-value]	1.2 (-1.5, 3.8) [0.40]	-15.7 (-20.1, -11.2) [<0.001]
Change in HbA1c after 13 Weeks		
Baseline Mean at 13 weeks (SD)	7.0 (0.7)	7.5 (0.9)
Weeks 14 - 26 (SD)	7.1 (0.8)	7.2 (0.7)
Adjusted Group Difference over 13 weeks (95% CI) [p-value]	0.09 (0.01, 0.17), [0.03]	-0.36 (-0.53, 0.19) [<0.001]

Ancillary Meal Challenges

The sponsor also provided the incorporation of stress challenges during the Extension Phase to further characterize the safety of the modified Control-IQ glycemic controller by evaluating the potential risks of device use in less frequently encountered, but plausible scenarios. The challenges included 38 of the Extension Phase study subjects using predicate device and consisted of a missed meal bolus, full meal bolus + exercise, and an exercise only challenge. Glycemic control was not optimal during stress challenges as observed during non-stress periods but the trends were within ranges to be expected during these challenges. The sponsor reported no events of severe hypoglycemia or hyperglycemia/ketosis/DKA during or after (including overnight) any of the challenges.

Extended Use Study

The sponsor also provided clinical data for the Extended Use period in which 80 of the original 96 subjects in the Extension Phase opted to continue using Control-IQ 1.5. Some subjects used Control-IQ 1.5 for 3 to < 6 months (35 subjects of 102 from the original RCT, 34%) and 6 to <9 months (49 subjects of 102 from the original RCT, 48%). Sixty (60) subjects completed 13 weeks and ten (10) subjects completed 26 weeks of the Extended use Phase although 43 subjects continued with Control-IQ 1.5 beyond 13 weeks, but completed their final study visit sometime before 26 weeks. The reported CGM-metrics and safety data from the extended phase is consistent with the observed performance of Control-IQ 1.5 in the Extension study and further supports that the updated iAGC is generally comparable and no worse than Control-IQ 1.0 as observed in the RCT Phase of the PEDAP study.

Safety Results for PEDAP Study including Extension Phase and Extended Use

Since the extension phase involved those receiving standard care in the first 13 weeks to cross over to using the Control-IQ hence the extension phase and the subsequent extended use phases safety results have been presented in a combined fashion. Note that the first 13 weeks of the Extended Use study had 80 participants following which 52 participants completed the second 13-week period of the Extended Use Study.

	PEDAP Study		**Extension Phase of PEDAP Study**	**Extended Use of PEDAP Study**
	Control - IQ 1.0 (N=68)	**Standard of Care (N=34)**	**Control-IQ 1.5 (N=96)**	**Control-IQ 1.5 (N ≥ 52)**
Total Number of Adverse Events (AEs)	41	14	75	33
Number of Severe Hypoglycemia Events per Participant *n (%)*				
≥1	2 (3 %)	1 (3 %)	2 (3 %)†	0
Incidence Rate per 100 Person-Years	11.6	11.7	12.5	0
Diabetes Ketoacidosis (DKA Events)				

	PEDAP Study		Extension Phase of PEDAP Study	Extended Use of PEDAP Study
	Control - IQ 1.0 (N=68)	**Standard of Care (N=34)**	**Control-IQ 1.5 (N=96)**	**Control-IQ 1.5 (N ≥ 52)**
Number of DKA Events per Participant *n (%)*	1 (1%)	0 (0 %)	0 (0 %)	0
0	27	23	0	0
1	24	8	0	0
Incidence Rate per 100 Person-Years	413	163	0	0
Other Serious Adverse Device Events (SADEs)				
Number of Events	2		2†	1
Other Adverse Events *(N Events/N Participants)*				
Hyperglycemia with or without Ketosis Not Related to Study Device	12/9	8/7	28/26	31/14
Hyperglycemia with or without Ketosis Related to Study Device	39/26	-	22/12	29/18

† Includes only those who migrated from Control IQ to Control IQ 1.5

Higher IQ Study Using Control-IQ1.5

The sponsor conducted a small study to address the safety of modified configurable parameters that aim to improve the user experience for T1D individuals with insulin resistance. The changes from Control-IQ 1.0 to Control-IQ 1.5 include (1) allowed entry of a maximum body weight up to 440 pounds, (2) allowing a basal rate of 3 units/hour to continue from manual mode when users activate CIQ 1.5, (3) enabling use of temp rates during Control-IQ 1.5 active, (4) enabling extended bolus delivery with Control-IQ 1.5 being active. Subjects in this study were allowed to continue medications for glucose control and or weight loss. Fifteen subjects in this study used a basal rate >3 units/hour 24 hours per day during the study

Study Feature	Description
Title	Control-IQ Technology for High Insulin Users with Type 1 Diabetes (Higher-IQ)
Study Design	Single-arm, multi-center, prospective clinical study. Existing insulin pump users (to include automated insulin delivery (AID) users) used the study system (pump and Continuous Glucose Monitoring (CGM)) in closed-loop mode for 13 weeks
Number of Sites	4
Population	Study participants enrolled based on protocol-defined inclusion/exclusion criterion
Sample Size	A total of 37 participants were enrolled (signed the consent form), and 34 passed screening and started the treatment period with Control-IQ technology v1.5
Treatment Groups	Participants were randomly assigned 2:1 to an intervention using Tandem t:slim X2 with Control-IQ Technology or the standard care (SC) control group using existing insulin therapy in conjunction with study CGM.
Study Duration	13 weeks
Protocol Overview/Synopsis	The study was a prospective, single-arm study of 13 weeks of home use of the Control-IQ 1.5 automated insulin delivery (AID) system in individuals with type 1 diabetes who planned to use at least one basal rate > 3 units/hour, age 18 and older. Control-IQ technology 1.5 removes the 3 unit/hour basal rate clipping that was present in earlier versions of Control-IQ technology, and allows for a wider range of weight and total daily insulin (TDI) input to the system. This study was designed to show the system functioned safely when used with user profile basal rates above 3 units/hr. **Key Eligibility Criteria** *Inclusion* 1. Age ≥ 18 years 2. Diagnosed with type 1 diabetes for at least 1 year. 3. Weight ≤ 440 pounds 4. Using an insulin pump of any brand for at least 3 months, and planned to use at least one basal rate > 3 U/h with the study pump *Exclusion* 1. Use of glucocorticoids or other medications determined by investigator to interfere with the study 2. Hemophilia or any other bleeding disorder. 3. >1 severe hypoglycemic event in the last 6 months 4. >1 DKA event in the last 6 months 5. Currently pregnant or planning to become pregnant during the time period of study participation 6. History of adrenal insufficiency

Study Feature	Description
	7. History of abnormal thyroid stimulating hormone that was not adequately treated or any other condition, which in the opinion of the investigator or designee, would put the participant or study at risk *Primary Endpoints* • Severe hypoglycemia (with cognitive impairment such that assistance of another individual is needed for treatment) during study compared with data on severe hypoglycemic events reported by T1D Exchange clinic registry over a three-month time period • Diabetic ketoacidosis (event rate) • Number of unanticipated adverse device effects (UADEs) • Number of other serious adverse events (SAEs) *Secondary Safety Endpoints* • All adverse events • Overall % time < 54 mg/dL • Overall % time < 70 mg/dL

Demographics

Higher IQ Study	**Standard Analysis Set (N = 34)**
Age Mean (SD)	*39.9 (11.9)*
Sex – Female n (%)	14 (41 %)
Diabetes Duration (years)	
Mean (SD)	21.8 *(11.2)*
Range	2.7 – 42.7
Body Mass Index (BMI)	
Mean (SD)	37.6 (5.2)
HbA1c Level at Randomization (%)	
Mean (SD)	7.7 (1.08)
Range	6.0 to 10.0
Race and or Ethnicity*	
White	34 (100%)
Black or African American	2 (6%)
Hispanic or Latino	3 (8.8%)

* Some subjects chose more than one race that they identified with.

Observed Results for Higher-IQ Study Using Control-IQ 1.5

	Time (%) in BG < 54 mg/dL	Time (%) in BG < 70 mg/dL	Time (%) in BG 70 – 180 mg/dL	Time (%) in BG > 180 mg/dL	Time (%) in BG ≥ 250 mg/dL
During non-challenge periods					
Overall Mean ± SD	0.20 ± 0.22	1.04 ± 0.98	64.75 ± 10.75	34.21 ± 11.05	10.45 ± 6.78
95 % CI for Mean	[0.13, 0.28]	[0.70, 1.38]	[61.00, 68.50]	[30.36, 38.07]	[8.08, 12.81]
Nighttime during non-challenge period					
Mean ± SD	0.35 ± 0.42	1.44 ± 1.48	68.47 ± 14.81	30.09 ± 15.01	9.58 ± 10.39
95 % CI for Mean	[0.21, 0.50]	[0.92, 1.95]	[63.30, 73.64]	[24.85, 35.33]	[5.95, 13.20]
During Skipped Bolus					
Overall Mean ± SD	0.00 ± 0.00	1.59 ± 4.17	46.99 ± 33.35	51.42 ± 34.35	27.17 ± 28.30
95 % CI for Mean	[0.00, 0.00]	[0.14, 3.05]	[35.35, 58.63]	[39.43, 63.40]	[2.53, 12.37]
Nighttime following challenge period					
Mean ± SD	0.12 ± 0.71	0.69 ± 2.74	79.33 ± 26.02	19.98 ± 25.64	4.44 ± 11.56
95 % CI for Mean	[-0.13, 0.37]	[-0.26, 1.65]	[70.25, 88.41]	[11.03, 28.92]	[0.41, 8.48]
During Meal challenge – half bolus					
Mean ± SD	0.31 ± 1.81	0.61 ± 3.17	68.39 ± 29.58	31.07 ± 30.07	4.49 ± 12.11
95 % CI for Mean	[-0.32, 0.94]	[-0.50, 1.72]	[58.07, 78.71]	[20.50, 41.49]	[0.26, 8.72]
Nighttime following challenge period					
Mean ± SD	0.54 ± 2.34	1.58 ± 5.46	76.66 ± 27.33	21.77 ± 26.21	4.04 ± 14.90
95 % CI for Mean	[-0.28, 1.36]	[-0.33, 3.48]	[67.12, 86.19]	[12.62, 30.91]	[-1.16, 9.24]
During Meal challenge – full bolus					
Mean ± SD	0.23 ± 1.35	0.70 ± 3.62	63.97 ± 32.38	35.33 ± 32.96	8.58 ± 17.06
95 % CI for Mean	[-0.24, 0.70]	[-0.57, 1.96]	[52.67, 75.17]	[23.83, 46.83]	[2.63, 14.54]
Nighttime following challenge period					
Mean ± SD	0.12 ± 0.71	0.86 ± 3.28	67.97 ± 32.13	31.17 ± 32.21	6.45 ± 15.82
95 % CI for Mean	[-0.13, 0.37]	[-0.29, 2.00]	[56.76, 79.18]	[19.94, 42.41]	[0.93, 11.97]
During Exercise challenges					
Mean ± SD	0.27 ± 0.90	1.81 ± 3.30	72.15 ± 15.87	26.05 ± 16.42	3.30 ± 5.45
95 % CI for Mean	[-0.04, 0.59]	[0.66, 2.96]	[66.61, 77.69]	[20.32, 31.78]	[1.39, 5.20]
Nighttime following challenge period					
Mean ± SD	0.05 ± 0.32	0.71 ± 2.65	70.41 ± 20.56	28.88 ± 20.15	8.16 ± 13.98
95 % CI for Mean	[-0.06, 0.17]	[-0.21. 1.64]	[63.24, 77.58]	[21.84, 35.91]	[3.28, 13.03]
Change in HbA1c at 13 week follow up					
HbA1c (%) at Baseline	7.69 ± 1.08				
HbA1c 95% CI for mean at Baseline	[7.32, 8.07]				
HbA1c (%) at 13 weeks	6.87 ± 0.57				
HbA1c 95% CI for mean at 13 weeks	[6.67, 7.07]				

Safety Results for Higher IQ study

There were no severe hypoglycemia and diabetic ketoacidosis events, and one serious adverse event of Atrial Fibrillation during the non-challenge period. This serious adverse event was unrelated to both the study procedures and the investigative device. There was a total of 37 non-serious adverse events, but majority were unrelated to the study procedure and the device.

Additional Study

The lead-in period of another study that included 179 subjects who used Control IQ 1.5 with Humalog was used in the substantial equivalence determination. This study required every subject to complete a no-bolus meal challenge and an extended 2-hour exercise challenge was also included to provide safety data in those stress scenarios for the subject device. The sponsor reported the results for pediatrics (6 to <14-year-old) and adults (≥14 years old). Since all subjects in this study were already Control IQ users, the HbA1c was well controlled with only 57 of 179 subjects (32%) screening into the study with an HbA1c of ≥7.5%. The sponsor reported time in range 70-180 mg/dL in the ≥ 14-year-old cohort (N=70) of 69% +/- 13% and 62% +/- 15% in the 6 to <14-year-old subject cohort which is similar to the values used for > 6-year-old in the predicate device. The sponsor reported % time <70 mg/dL and <54 mg/dL as low (<1%) which is also consistent with prior evaluations of predicate device. Additional safety data in this 6- to 81-year-old cohort from the no-bolus challenge and extended exercise challenge did not yield any severe hypoglycemia or DKA events including in the overnight period after the challenge was completed.

Postmarket Surveillance Study:

There is uncertainty remaining regarding the risk/benefit profile of the device when used in the broader intended use population. While the premarket clinical study provided to support this premarket notification showed some benefits, the study included device users and their caregivers with relatively high levels of education relative to the general use population, and it was not adequately powered to assess differences in the rates of safety events (e.g., diabetic ketoacidosis and severe hypoglycemia). Furthermore, due to the nature of the study design, the apparent unfavorable difference in the rates of hyperglycemia/ketosis events (not rising to the level of severity of diabetic ketoacidosis) between the treatment and control arms may be due to reporting differences between users rather than a true difference from the device itself.

Accordingly, the manufacturer will be performing a post-market surveillance study with subjects ages 2-5 years old.

2. Human Factors

The summative human factors study conducted under DEN190034 included assessment of the 2–6-year pediatric age group and their care providers, and the results were found to be acceptable.

3. Software

The software changes made to this device were reviewed and found to be acceptable.

VII Proposed Labeling:

The labeling supports the finding of substantial equivalence for this device.

VIII Conclusion:

The submitted information in this premarket notification is complete and supports a substantial equivalence decision.