SUMMARY OF SAFETY AND EFFECTIVENESS DATA (SSED)

I. GENERAL INFORMATION

Device Generic Name: Continuous Glucose Monitoring (CGM) System

Device Trade Name: Guardian Connect system

Device Procode: MDS

Applicant's Name and Address: Medtronic MiniMed, Inc.
18000 Devonshire Street
Northridge, CA 91325

Date(s) of Panel Recommendation: None

Premarket Approval Application (PMA) Number: P160007

Date of FDA Notice of Approval: March 8, 2018

II. INDICATIONS FOR USE

The Guardian Connect system is indicated for continuous or periodic monitoring of glucose levels in the interstitial fluid under the skin, in patients (14 to 75 years of age) with diabetes mellitus.

The Guardian Connect system provides real-time glucose values and trends through a Guardian Connect app installed on a compatible consumer electronic mobile device. It allows users to detect trends and track patterns in glucose concentrations. The Guardian Connect app alerts if a Guardian Sensor (3) glucose level reaches, falls below, rises above, or is predicted to surpass set values.

The Guardian Sensor (3) glucose values are not intended to be used directly for making therapy adjustments, but rather to provide an indication of when a finger stick may be required. All therapy adjustments should be based on measurements obtained using a home glucose monitor and not on values provided by the Guardian Sensor (3).

The Guardian Connect system is comprised of the following devices: Guardian Connect app, Guardian Sensor (3), and the Guardian Connect transmitter.

Guardian Sensor (3):
The Guardian Sensor (3) is intended for use with Medtronic Diabetes glucose-sensing systems, to continuously monitor glucose levels in persons with diabetes. The Guardian Sensor (3) is indicated for 7 days of continuous use. It is indicated for use as an adjunctive device to complement, not replace, information obtained from standard blood

glucose monitoring devices. The sensor is intended for single use and requires a prescription.

Guardian Connect Transmitter:
The Guardian Connect transmitter is intended for use with the Guardian Connect System. The Guardian Connect transmitter powers the glucose sensor, collects and calculates sensor data, and sends the data via Bluetooth version 4.0 to the Guardian Connect app installed on a compatible mobile device. The transmitter is only compatible with the Guardian Sensor (3). The transmitter is indicated for multiple uses on a single patient as a component of the Guardian Connect system.

The Guardian Connect transmitter requires a prescription.

Guardian Connect App:
The Guardian Connect app is intended for use only by patients using a compatible mobile device, and who have sufficient experience to adjust mobile device audio and notification settings. The app displays sensor glucose data, and also provides a user interface for sensor calibration, entering data such as exercise and meals, and uploading information to the CareLink Personal website. It allows users to detect trends and track patterns in glucose concentrations. The app provides alerts if a Guardian Sensor (3) glucose level reaches, falls below, rises above, or is predicted to surpass set values.

The Guardian Connect app is available over-the-counter (OTC) but requires the Guardian Sensor and Guardian Connect transmitter to function.

III. CONTRAINDICATIONS

Continuous glucose monitoring is not recommended for people who are unwilling or unable to perform a minimum of two meter blood glucose tests per day or for people who are unable or unwilling to maintain contact with their healthcare professional. Successful CGM use requires sufficient vision or hearing to allow recognition of the alerts generated by the Guardian Connect app.

IV. WARNINGS AND PRECAUTIONS

The warnings and precautions can be found in the Guardian Connect system labeling.

V. DEVICE DESCRIPTION

The Guardian Connect system ("The system") provides real-time glucose values and trends through a Guardian Connect app installed on a compatible mobile device platform (e.g., iPhone or iPad). The Guardian Connect app is a mobile medical application that allows users to track patterns in glucose concentrations and to possibly identify episodes of low and high glucose. The system is designed to provide continuous glucose monitoring for up to seven days. The system consists primarily of a sensor, transmitter, and mobile medical app.

The Guardian Sensor (3) glucose values are not intended to be used directly for making therapy adjustments, but rather to provide an indication of when a finger stick may be required. All therapy adjustments should be based on measurements obtained using a home glucose monitor and not on values provided by the Guardian Sensor (3).

The Guardian Connect is comprised of the following devices:

Guardian Sensor (3)

The Guardian Sensor (3), MMT-7020, is a sterile, disposable, single-use, single patient, glucose sensing component intended for the continuous monitoring of glucose levels in the user's interstitial fluid. The Guardian Sensor (3) is intended for abdominal and arm use for no more than 7 days. The Guardian Sensor (3) is inserted into the subcutaneous tissue using the One-Press Serter and is secured to the patient's skin. Once connected to the transmitter, the sensor requires a brief initialization period of up to two hours.

The Guardian Sensor (3) was first approved as part of the MiniMed 670G System (P160017).

Guardian Connect Transmitter

The Guardian Connect transmitter (MMT-7821) is a single-patient, multi-use, non-sterile, portable, electrical-current meter intended to process and store glucose-sensor values, as well as to transmit these values to the Guardian Connect app. Once connected to an initialized sensor, the Guardian Connect transmitter converts the digital sensor signal into sensor glucose values. These sensor glucose values are then transmitted wirelessly (using the Bluetooth Low Energy version 4.0 wireless communication protocol) for display on the Guardian Connect app. The Guardian Connect transmitter is calibrated, using blood glucose measurements, at least once every 12 hours. The user calibrates the Guardian Connect system by entering blood glucose values (from any FDA cleared Blood Glucose Meter) into the app. The app then transmits this blood glucose measurement wirelessly to the Guardian Connect transmitter for calibration purposes.

Guardian Connect App

The Guardian Connect app (CSS7200) is a native iOS software application installed on to a mobile device platform (currently iOS based hardware such as an iPhone or iPad). The Guardian Connect app is intended as the primary and only display for sensor glucose levels in the continuous glucose monitoring system. The app displays sensor glucose values for tracking and trending purposes only.

The Guardian Connect app receives sensor glucose values wirelessly from the Guardian Connect transmitter via a Bluetooth Low Energy version 4.0 wireless communications protocol. The app then displays these sensor glucose values both numerically and graphically. The app also alerts the user to low and high sensor glucose values, based on alert settings programmed by the user. The user can also enter events, such as blood glucose measurements, meals or exercise, or insulin dosing, using the app.

The Guardian Connect app is designed for connectivity to CareLink Personal (MMT-7333) and CareLink Connect (MMT-7333), for the purposes of retrospective analyses and passive remote monitoring, respectively.

Additional Items Provided with the Guardian Connect System:

The following devices have additional items that are provided with the Guardian Connect System:

Guardian Sensor (3):

One-press serter (MMT-7512)
The serter is used as an aid for inserting the sensor. It is indicated for single-patient use and is not intended for multiple patient use.

Oval Tape (*MMT-7015)*
The tape is indicated for use with Medtronic glucose sensor products. It is indicated for one-time use.

Guardian Connect Transmitter:

Charger (MMT-7715)
The charger is used to charge the transmitter battery. For best results, recharge the transmitter between each use to ensure full transmitter battery life.

Tester (MMT-7736L)
The tester is intended for use with the Guardian Connect transmitter. It is a device used as a watertight cleaning plug during transmitter cleaning and disinfection. It is also used for simulating a sensor to test that the transmitter is working properly.

Key Features of the Guardian Connect system:

The functionality of the system is accomplished through the interactions of the Guardian Sensor (3), the Guardian Connect transmitter, and the Guardian Connect app. The key features for functionality of the system using the Guardian Connect app are summarized below:

Guardian Connect App	
Key Feature	**Description**
Menu Screen	Provides access to the menu screen, which displays the Guardian Connect system status information and allows the user to set up the sensor, define alert settings, view the logbook, and access CareLink personal settings.

System Status Icons	• Transmitter Battery: Indicates the charge level of the transmitter battery • Sensor Life: Indicates the number of days remaining in the life of the current sensor • Transmitter communication: Indicates if the transmitter is active and connected to the app • Notification: Indicates if alerts may be missed because the audio override feature is turned off
Continuous Sensor Glucose Readings and Trend Graphs	Indicates the latest sensor glucose readings. Values below the low glucose limit appear in red and values above the high glucose limit appear in orange. Trend graphs also display the sensor glucose values over preset intervals in graph format.
Sensor Glucose Trend Indicators	Indicates the direction and rate of change for sensor glucose values.
Event Entry	Subject may enter additional information, such as exercise, blood glucose readings, meals, or insulin. Blood glucose readings entered here may also be used for sensor calibration.
Sensor Status Message	Displays the latest active status notification. If a current sensor glucose reading is not available, the sensor status message will appear instead of displaying sensor glucose information.
High Sensor Glucose Alert	Displays a line showing the high sensor glucose limits on the sensor graph. The orange line indicates the sensor glucose high limit. High sensor glucose alert limit is the value on which the high settings are based. The high limit can be set from 100 mg/dL to 400 mg/dL.
Low Sensor Glucose Alert Limits	Displays a line showing the low sensor glucose limits on the sensor graph. The red line indicates sensor glucose low limit. Low sensor glucose alert limit is the value on which the low settings are based. The low limit can be set from 60 mg/dL to 90 mg/dL.

High Glucose Alerts	This setting defines when the user will be notified if the sensor glucose is approaching (predictive) or has reached the high limit (threshold). This limit and the time before high is set by the user. The following high alerts are available if switched on: Alert on High: The system displays a high sensor glucose alert when the sensor glucose value reaches or exceeds the set high limit. Alert before high: The user gets a high predicted alert any time the sensor glucose is predicted to reach the high limit. This makes users aware of potential high glucose levels before they occur.
Low Glucose alerts	Low glucose alert: This setting defines when the user will be notified if the sensor glucose is approaching (predictive) or has reached the low limit (threshold). This limit and the time before low is set by the user. The following low alerts are available if switched on: Alert on low: The system displays a low sensor glucose alert when the sensor glucose value reaches or falls below the set low limit. Alert before low: The user gets a low predicted alert any time the sensor glucose is predicted to reach the low limit. This makes users aware of potential low glucose levels before they occur.
Urgent Low Sensor Glucose Alert	This alerts the user to a threshold sensor glucose at or below 55 mg/dL, using 100% of the iOS device built-in speaker volume. The visual and vibratory notifications are also available subject to user settings. With proper application setup, this alert is always provided since independent to what the user settings on the device are (silenced phone, 'Do Not Disturb' activated, etc.).
Rate Alerts (Rise and Fall)	This defines when the user will be notified if the sensor glucose is rising or falling at a specified rate. One arrow signals a 1-2 mg/dL change; two arrows signal a 2-3 mg/dL change; and three arrows signal a greater than 3 mg/dL change.
Calibration Reminder	Displays the calibration screen where you enter a blood glucose meter reading for sensor calibration.
Snooze Time	The snooze feature lets the user set a snooze time for alerts. This setting is used to remind the user that the alert condition still exists after the snooze time is set by the user.

Mobile Device Low Battery Alert	This alerts the user to a low battery condition for the iOS mobile device. The alert sounds when the user's iOS device is at 20% remaining battery.
Audio Override	This ensures that an audible alert is delivered to the user at all times by using a "Media" volume source and bypassing the iOS notification management features (i.e., hardware "Mute" switch, "Do Not Disturb", "Ringer and Alerts" volume settings and/or "volume Control" buttons). This is the default alert notification mode for all existing and new alerts to ensure users receive all alerts. By turning the default Audio Override mode off, it switches back to iOS-based notification mode for 'System Alerts' and 'User Configurable Alerts' per typical mobile device settings. If the phone is set to silent or 'Do Not Disturb', the user will not receive audible alerts if the Audio Override feature is turned off. **Note**: Audio Override cannot be disabled for Urgent Low Sensor Glucose Alerts where sensor glucose levels are at or below 55 mg/dL. Therefore, with proper application setup, users will always receive an alert if glucose level fall below 55 mg/dL.
Lost Communication Alert	When the Guardian Connect app runs on an older model iPhone or iPod Touch with less than 512 MB memory, and the user is running a memory-intensive app (such as a game), the iOS may terminate other apps suspended in the background in order to free up memory for the gaming app in the foreground. The Lost Communication Alert ensures that if a data packet from the transmitter has not been received by the app within 30 minutes, a Lost Communication Alert is generated. The Lost Communication Alert will be repeated every 15 minutes for 1 hour if the user does not respond to the initial Lost Communication Alert and the app remains closed. A Lost Communication Alert will also be displayed on the app if the mobile device is out of range, there is radio frequency interference from other devices, the senor is disconnected from the transmitter, or the sensor is pulled out of the skin.
Calibration	Displays the calibration screen where you enter a blood glucose (BG) meter reading for sensor calibration. The icon is color coded to indicate the status and the approximate time left until the next sensor calibration is due.

In addition to the features above, the Guardian mobile application also has the following features:

- Provide alerts for calibration, sensor change, and transmitter battery life and error.
- Allows the user to send information to a personal CareLink Personal website. The CareLink Personal website hosts the CareLink Personal Diabetes Therapy Management Software that receives and stores routine uploads of sensor glucose data for retrospective analyses and the CareLink Connect Module that facilities remote monitoring of sensor glucose values by care partners. The user can authorize others to view this information.

Training for the Guardian Connect system is provided to users in an one-on-one training session with a certified product trainer (CPT) which includes training on CGM basics, inserting and calibrating the sensor, set up of the Guardian Connect app for use with the mobile device, and review of the key features of the Guardian Connect app including how to manage alerts, use of the audio override feature, and connectivity for wireless communication. Training is also provided to users through an onboarding program in the first 180 days that includes proactive outreach by the sponsor to provide information on the use of the system.

VI. ALTERNATIVE PRACTICES AND PROCEDURES

Control of diabetes can be achieved through a combination of various behaviors and methods.

Self-behaviors include healthy eating, taking the clinically indicated medications, and being active. Persons with diabetes may also administer insulin by injection or using other insulin infusion pumps as prescribed by their physician. An insulin pump is an alternative to multiple daily insulin injections (via insulin syringe or an insulin pen). Periodic self-glucose monitoring using home use blood glucose meters provides information regarding variations in glucose levels.

Methods of monitoring glycemic control include periodic measurement of Hemoglobin A1c (HbA1c) which reflects blood glucose control over a three month period. Self-monitoring of blood glucose using glucose meters and test strips provides quantitative measurements of blood glucose at a single point in time for users and their healthcare providers. This helps to monitor the effectiveness of glycemic control, as well as make more immediate treatment modifications.

Each alternative has its own advantages and disadvantages. A patient should fully discuss these alternatives with his/her physician to select the method that best meets expectations and lifestyle.

VII. MARKETING HISTORY

The Guardian Connect system has not been marketed in the United States or any foreign country.

The Guardian Sensor (3) used with the Guardian Connect system is the same as the Guardian Sensor (3) used with the MiniMed 670G System (P160017) and the MiniMed 630G System (P150001/S008), which were approved for marketing in the United States in September 2016 and June 2017, respectively.

VIII. PROBABLE ADVERSE EFFECTS OF THE DEVICE ON HEALTH

Below is a list of potential adverse effects (e.g. complications) associated with the use of the device. Potential device-related, non-serious events related to CGM use include:

- Local infection
- Skin inflammation
- Pain or discomfort
- Bleeding
- Bruising
- Itching
- Scarring or skin discoloration
- Allergic reactions to adhesives
- Sensor or needle fracture during insertion, wear or removal

A minor risk of this device is that users may need to perform unnecessary fingersticks to evaluate their blood glucose when the CGM gives false positive hypoglycemic and hyperglycemic readings or alerts. Inaccurate calculation of the rate of change of glucose could also lead to unnecessary additional blood glucose tests or inappropriate measures to stop a trend of increasing or decreasing glucose level which could result in hyperglycemia or hypoglycemia. There is a minor risk of skin irritation, inflammation, or infection due to either the sensor needle or the adhesive.

There is a risk of sensor breakage leaving a sensor fragment under the skin. This event was reported infrequently with previously approved sensors. No sensor breakage was documented in the clinical study reviewed. Reported sensor breakage rate with similar devices has been very low, however, and this study was not powered or designed to assess the rate of breakage, though all sensors were inspected for fracture after removal. Based on postmarket experience with similar devices and the results observed in these clinical studies, the occurrence and severity of these events is low.

There are risks due to missed alerts and false negative hypoglycemia and hyperglycemic readings related to patients not being alerted to the need to perform a fingerstick to detect hypoglycemia or hyperglycemia, particularly since users of this device may rely on these alerts in certain situations to guide their self-treatment strategy (e.g., to alert them to potential nighttime hypoglycemia). There is a risk to false alerts and false positive hypoglycemia and hyperglycemia readings related to the need to perform unnecessary fingersticks to confirm an erroneous low or high reading. Inaccurate calculation of the rate of change of glucose by the CGM could prevent a patient from performing additional blood glucose tests or taking measures to stop a trend of increasing or decreasing glucose

levels which could lead to serious hypoglycemia or hyperglycemia if no action is taken to stop these glucose trends. Inaccurate calculation of the rate of change of glucose could also lead to unnecessary additional blood glucose tests or inappropriate measures to stop a trend of increasing or decreasing glucose level which could result in hyperglycemia or hypoglycemia.

There is a risk related to off label non-adjunctive use of the device if patients make decisions on diabetes management based on inaccurate sensor readings alone without confirmation by blood glucose testing.

There are risks relating to the use of the mobile application, the sole display for this device. This device utilizes a mobile application as its sole display, instead of a dedicated receiver, which differs from earlier versions of this device from this manufacturer. There is no alternate or dedicated display specific to only this device. The level of information necessary to understand the safety aspects of the user interface, and how it supports the user and reduces the potential for use error was provided by the sponsor, and found to be adequate. There may be an additional risk that the display, or alerts or alarms related to the CGM device may not be able to override other applications or functions (phone, camera, SMS) within the mobile device. This risk could potentially result in missed alerts or alarms, or temporary loss of access to the display. Missed alerts, alarms, or inability to access the display could result in missed opportunities to detect or prevent hypoglycemia or hyperglycemia, and are discussed above. Human factors studies conducted assessed the safety of the user interface of the mobile app (sole display) for this device. The human factors study sufficiently assessed the potential for user error associated with comprehension of the impact of mobile device and app settings on notifications and Bluetooth communications, as well as use of the audio override feature.

IX. SUMMARY OF NONCLINICAL STUDIES

A. Laboratory Studies

Please refer to the SSED for P160017 for descriptions of the pre-clinical testing of the Guardian Sensor (3). Completed sensor functional and environmental testing are presented in Table 5 on page 16, completed biocompatibility testing is presented in Table 7 on page 19, and completed sterility testing is presented on page 20 of the P160017 SSED. Other system components (Guardian Connect transmitter, One-Press Serter and the Guardian Connect app) are provided non-sterile.

Pre-clinical testing of the One-Press Serter was reviewed and approved under P120010/S070.

Functional and environmental Tests for the Guardian Connect transmitter were conducted to ensure that the transmitter will continue to function normally as a part of the Guardian Connect system when exposed to extreme environmental conditions.

Table 1. Guardian Connect Transmitter Functional and Environmental Tests

Test Name	Test Parameter	Acceptance Criteria
Chemical Compatibility	Demonstrate the ability of the transmitter to withstand exposure to chemicals used in the cleaning procedure	No cracks, crazing, dissolving, or discoloration of the transmitter surface
Drop Test per EN 60601-2-24	Demonstrate safe operation after three repeated 1 meter drops onto 50 mm thick hardwood	Each unit must pass visual inspection, accuracy test, RF test, and leak test
Random Vibration Test per EN 60601-2-24	Transmitters demonstrate reliable operation after exposure to 10-100 Hz @ (1 m/s2)2/Hz, 100-200 Hz @ -3dB/octave, and 200-2000 Hz @ 0.5 (m/s2)2/Hz for 30 minutes in each axis	Each unit must pass visual inspection, accuracy test, and RF test
Mechanical Shock per IEC 60601-1-11	Demonstrate reliable transmitter operation after exposure to 150 m/s2 (15g) acceleration, with three shocks per axis in each direction (±X, Y, Z) for a total of 18 shocks	Each unit must pass visual inspection, accuracy test, and RF test
Push Test per EN 60601-2-24	Demonstrate that transmitters do not pose an unacceptable risk after exposure to applied force	Transmitter does not pose an unacceptable risk to user
Impact Test per IEC 60601-1	Demonstrate ability of transmitter to withstand an impact from a 500g steel ball with approximate diameter of 50mm dropped from a height of 1.3m	Transmitter does not pose an unacceptable risk to user
Mold Stress Relief per EN 60601-1	Demonstrate that after release of any internal stresses due to the plastic molding process, the transmitter maintains basic safety	Transmitter does not pose an unacceptable risk to user
Environmental storage conditions	Transmitters withstand -20 to 55ºC, up to 95% relative humidity	Each unit must pass visual inspection, accuracy test, and RF test

Temperature Shock Test	Transmitters demonstrate reliable performance after cycling from 0 to 45 ºC with 5 minute ramp time and 2 hour dwell time at each plateau	Each unit must pass accuracy test and RF test
Operating Environmental Conditions	Transmitters demonstrate the ability to operate with temperature of 0-45 ºC, 10-95% relative humidity, 8.4-15.4 psiA	Each unit must pass visual inspection, accuracy test, and RF test
Connection insertion force	Demonstrate force required to connect battery charger to transmitter is less than 3 pounds	Charger insertion force is less than 3 pounds
Connector retention force	Demonstrate force required to retain battery charger to transmitter is greater than 0.5 pounds and less than 3 pounds	Charger retention force is greater than 0.5 pounds and less than 3 pounds
Connector cycling	Demonstrate that the transmitter can withstand 180 insertion/removal cycles (60 with sensor, 60 with charger, 60 with tester)	Each unit must pass accuracy test and RF test. Each unit must be able to be charged, detect a sensor, and detect a tester following all connection cycles.
Fluid ingress per IPX8 (International Protection)	Demonstrate reliable operation of the transmitter after submerged to a depth of 8ft for 30 minutes	Each unit must pass visual inspection, accuracy test, and RF test. All device weights must vary by less than 0.001g before and after test.
Protection against solid foreign objects per IP4X (International Protection)	Demonstrate that the full diameter of 1.0mm spherical probe cannot pass through any opening of the transmitter	The full diameter of a 1.0mm spherical probe cannot pass through any opening of the transmitter.

The Guardian Connect system was also subjected to Electromagnetic Compatibility (EMC) testing to confirm that the devices will function properly in the presence of electromagnetic signals that may be encountered in the intended use environment:

Table 2. Guardian Connect System Functional and Environmental Tests

Test Name	**Test Parameter**	**Acceptance Criteria**
EMC/EMI Testing per	Demonstrate ability of the system to operate in environments with	No unrecoverable observations and no latent

EN 60601-1-2:2007	EMI which meet the standard of EN 60601-1-2:2007	effects resulting from exposure – transmitter must pass accuracy test
Wireless Coexistence	Demonstrate ability of system to withstand expected levels of wireless transmission from other sources	No observations at the applied levels and no latent effects resulting from exposure – transmitter must pass accuracy test
FCC and Avionics	Demonstrate compatibility with FCC regulation	Emitted levels must be per FCC CFR 47 Part 15.247.
X-ray Immunity	Demonstrate reliable operation when exposed to x-ray – 100kV, 100 uA exposure for 2 minutes	No observations at the applied levels and no latent effects resulting from exposure – transmitter must pass accuracy test
RF Performance	Demonstrate reliable system operation when multiple systems are operating within close proximity	No observations at the applied levels and no latent effects resulting from exposure – transmitter must pass accuracy test. Data only exchanged between paired devices.
Electronic article surveillance immunity	Demonstrate that the system operates reliably when exposed to EMI from electronic article surveillance equipment	No observations at the applied levels and no latent effects resulting from exposure – transmitter must pass accuracy test
Cell phone and cordless phone immunity	Demonstrate that the system operates reliably when exposed to EMI specifically in common cell phone spectra (800-960 MHz and 1700-2200 MHz @ 1MHz steps) using WCDMA, WCDMA/3GPP, GSM/EDGE, DECT, IS95, PHS, NADC, PDC, and cordless phone spectra (2400 and 900 MHz)	No observations at the applied levels and no latent effects resulting from exposure – transmitter must pass accuracy test

All protocols, test reports and acceptance criteria have been reviewed and found to be acceptable. All devices met all pre-determined acceptance criteria during testing.

Shelf-Life

Shelf-life of the Guardian Sensor (3) was previous established in P160017 for one year (365 days) at a storage temperature of 36ºF to 80ºF (2 to 27 °C).

The non-sterile Guardian Connect transmitter shelf-life is limited by the shelf-life of its battery. Testing was submitted that supports a Guardian Connect transmitter shelf-life of 6 months. The transmitter should be stored at temperatures of -4ºF to 131ºF (-20 to 55 °C) and up to 95% humidity with no condensation.

Packaging/Ship Testing

The primary packaging is a Guardian Connect system kit, which consists of a Guardian Connect transmitter, Charger, two Testers, and the One-Press Serter. Guardian Sensor (3) devices are shipped separately in either single packs or 5-packs. Testing was performed in accordance with ASTM D4169, *Standard Practice for Performance Testing of Shipping Containers and Systems.*

Packages representative of the Guardian Connect system kit and the Guardian Sensor (3) packages were subjected to environmental conditions and simulated shipping conditions under ASTM D169 (e.g., vibrational testing, pressure testing, impact testing, etc.), before being subjected to functional performance requirements. Testing for all devices passed, demonstrating that the system packaging meets all applicable specifications.

Software

The software verification and validation were carried out in accordance with the FDA Guidance Document, "*General Principles of Software Validation: Final Guidance for Industry and FDA Staff.*" Software development activities included establishing detailed software requirements, linking requirements with associate verification tests, software code reviews, unit testing, system level testing and defect tracking and dispositioning to ensure the software conforms to user needs and intended uses.

Software validation was provided for the Guardian Connect transmitter and Guardian Connect app.

B. Animal Studies

Animal testing was performed using the Guardian Sensor (3) to determine the sensor's performance in a pre-clinical setting. Approximately 288 Guardian Sensor (3) were tested in canines to provide preliminary information regarding mechanical integrity and sensor accuracy. The results of the animal testing indicated that the Guardian Sensor (3) performed satisfactorily in the study.

C. Additional Studies

Human Factors/Usability

A human factors study was conducted to confirm that users can safely and effectively use the Guardian Connect system which includes the use of the Guardian Connect app as the primary display device for receiving glucose sensor information.

Human factors testing of the system was performed in accordance with the FDA Guidance: *Applying Human Factors and Usability Engineering to Optimize Medical Device Design* (February 3, 2016). The study took into account the different types of users, the use environment, user interfaces, and critical tasks associated with the Guardian Connect system.

The human factors study evaluated adult and pediatric users with a variety of smartphone experience and an approximately equal distribution of iPhone and Android users. The initial human factors study evaluated usability tasks such as performing initial setup and pairing, setting alerts, calibrating sensor, and responding to alerts. A supplemental human factors study evaluated critical use-related tasks for the Guardian Connect app such as notification setup, operation of the audio override feature, the use of headphones, user guide comprehension, and alert notifications including the lost communication alert and the mobile device battery low alert. Three participants (out of 30) did not fully understand the audio override feature. The participants thought the audio override when defaulted to ON would always allow the user to hear alerts and when turned OFF, the user would not hear alerts. While these three participants did not demonstrate a complete understanding of the audio override feature, none of the users committed a use error that would have caused increased risk since the audio override defaults to ON and the participants kept the audio override feature ON to hear all alerts. The participants did not fully understand the audio override feature in that when the audio override feature is turned OFF, alerts are received using the audio settings for the mobile device and therefore, if the ringer volume is ON, the alerts are received at the same level as the mobile device's ringer volume even if the audio override is OFF.

The human factors validation evaluation and testing demonstrates that the device can be used by the intended users without serious use errors or problems, for the intended uses and under the expected use conditions. Although the human factors study identified use difficulties with the understanding of the audio override, these use difficulties did not represent serious use errors since although the user did not fully understand that alerts could be received with the audio override turned OFF (for example, if the mobile device's settings were at full volume, alerts would be received since the volume settings of the mobile device are used for alerts when the audio override is turned OFF), the users understood that to always receive all alerts, the audio override feature should be turned ON and the audio override feature defaults to ON. Therefore, results from the human factors study demonstrates users can safely and effectively use the Guardian Connect System including the Guardian Connect app. Potential risks associated with incomplete understanding of the audio override feature being turned OFF are further mitigated by training that is provided to users in a one-on-one setting

and includes how to use the audio override feature. Additional user assistance is also provided to all new users for 180 days through an onboarding program to provide additional follow-up and assistance that can include additional training on the audio override feature.

X. SUMMARY OF PRIMARY CLINICAL STUDY

Medtronic performed a clinical study to evaluate the performance of the Guardian Sensor (3) to support 7 days of use. This study included evaluation of sensors inserted into both the abdomen and the upper arm. This study was previously performed to support approval of the sensor within the Medtronic MiniMed 670G System. Please refer to the SSED for P160017/S017, Section X, for a detailed description and the results of the pivotal sensor accuracy study for the Guardian Sensor (3).

All subjects wore two CGMs in the abdomen and one CGM in the upper arm. One abdomen CGM consisted of a Guardian Sensor (3) connected to the Guardian Link (3) transmitter, which transmitted glucose information to the insulin pump (for display purposes only). The other abdomen CGM used the Guardian Sensor (3) connected to the Guardian Connect transmitter, which transmitted glucose information to the Guardian Connect app. The Guardian Connect transmitter possesses the same real-time glucose measurement algorithm as the Guardian Link (3) transmitter; however, the app calculations for the Guardian Connect low predictive alerts is different from the alert calculations for the MiniMed 670G System. As such, the safety and effectiveness results of the Guardian Sensor (3) in the MiniMed 670G System (P160017/S017) is reflective of the performance of the Guardian Connect system, except for Alert Performance. Alert performance of the Guardian Connect system is presented below in Section X.D.

A. Study Design

Please refer to the SSED for P160017/S017 for information on the study design.

B. Accountability of PMA Cohort

Please refer to the SSED of P160017/S017 for information on subject accountability.

C. Study Population Demographics and Baseline Parameters

Please refer to the SSED of P160017/S017 for information on participant demographics and baseline parameters.

D. Safety and Effectiveness Results

1. Safety Results
   Please refer to the SSED of P160017/S017 for safety results of the primary clinical study.

2. Effectiveness Results
   Please refer to the SSED of P160017/S017 for the accuracy and precision performance of the Guardian Sensor (3).

Alert performance

Alert performance was evaluated using the Guardian Connect app to generate 'true alert' and 'false alert' rates, and 'correctly detected' and 'missed alert' rates. The descriptions and tables below describe the alert rate performance of the device within the clinical study.

Due to differences in how predictive low glucose alerts are calculated by the Guardian Connect app and the MiniMed 670G System (P160017/S017), the predictive low glucose alert performance for the Guardian Connect system is generally comparable to the MiniMed 670G System (P160017/S017) but not identical. Furthermore, the Guardian Connect system has a mandatory low glucose threshold alert at 55 mg/dL, which is not present in the MiniMed 670G System (P160017/S017) or the MiniMed 630G System (P150001/S021). Unlike the MiniMed 630G/670G Systems, the Guardian Connect system does not have predictive or threshold alert at 50 mg/dL. The alert performance otherwise is identical to the alert performance presented in P160017/S017.

True alert rates

The true alert rate is the rate at which the blood glucose value confirmed that the continuous glucose monitor (CGM) alert was triggered correctly. For example:

- True Threshold Hypoglycemic alert rate indicates the alarm alerted when the continuous glucose monitor read that the user was below the low threshold and the user's blood glucose was actually below that low threshold (within +/- 15 or 30 minutes of the alert).

- True Threshold Hyperglycemic alert rate indicates the alarm alerted when the continuous glucose monitor read that the user was above the high threshold and the user's blood glucose was actually above that high threshold (within +/- 15 or 30 minutes of the alert).

- True Predictive Hypoglycemic alert rate indicates the alarm alerted when the continuous glucose monitor predicted that the user would reach below the low threshold and the user's blood glucose was actually below that low threshold within 15 or 30 minutes following the alert.

- True Predictive Hyperglycemic alert rate indicates the alarm alerted when the continuous glucose monitor predicted that the user would reach above the high threshold and the user's blood glucose was actually above that high threshold within 15 or 30 minutes following the alert.

Table 3: Glucose TRUE Alert Performance Using Every 12 hours

	Threshold Only			Predictive Only			Threshold & Predictive		
	mg/dL	**30 min**	**15 min**	**mg/dL**	**30 min**	**15 min**	**mg/dL**	**30 min**	**15 min**
Glucose True Alert Rate: Low glucose Alerts, Abdomen	**55**	38.8%	38.8%	**55**	N/A*	N/A*	**55**	N/A*	N/A*
	60	53.5%	51.9%	**60**	27.6%	26.9%	**60**	35.6%	34.6%
	70	66.9%	66.9%	**70**	38.4%	35.9%	**70**	47.4%	45.7%
	80	69.3%	69.3%	**80**	44.5%	40.8%	**80**	52.9%	50.5%
	90	75.1%	74.4%	**90**	48.9%	45.9%	**90**	57.9%	55.6%
Glucose True Alert Rate: High glucose Alerts, Abdomen	**300**	81.3%	81.3%	**300**	57.8%	54.0%	**300**	65.4%	62.7%
	250	90.2%	90.2%	**250**	64.0%	60.1%	**250**	72.5%	69.8%
	220	91.9%	91.9%	**220**	68.9%	66.3%	**220**	76.6%	74.8%
	180	93.7%	92.8%	**180**	70.5%	66.9%	**180**	78.0%	75.4%
Glucose True Alert Rate: Low glucose Alerts, Arm	**55**	58.7%	58.7%	**55**	N/A*	N/A*	**55**	N/A*	N/A*
	60	69%	67.8%	**60**	29.1%	27.2%	**60**	38.9%	37.2%
	70	77.4%	75.3%	**70**	40.4%	35%	**70**	51.7%	47.3%
	80	77.5%	76.4%	**80**	43.3%	39.2%	**80**	54.2%	51%
	90	74.9%	74.9%	**90**	53.3%	48.7%	**90**	60.9%	57.9%
Glucose True Alert Rate: High glucose Alerts, Arm	**300**	81.9%	80.6%	**300**	51.7%	49.7%	**300**	61.2%	59.3%
	250	91.4%	91.4%	**250**	62%	59.8%	**250**	71.1%	69.6%
	220	92.2%	92.2%	**220**	65.7%	62.2%	**220**	74.5%	72.2%
	180	92.9%	92.9%	**180**	68%	63.2%	**180**	76.5%	73.7%

**The Guardian Connect system only issues threshold alerts at the mandatory low glucose threshold setting of 55 mg/dL.*

False Alert Rates

The glucose false alert rate is the rate at which the blood glucose value did not confirm that the continuous glucose monitor alert was triggered correctly. For example:

- False Threshold Hypoglycemic alert rate is the alarm alerted when the continuous glucose monitor read that the user was below the low threshold but the users blood glucose was actually above that low threshold (within ± 15 or 30 minutes of the alert); or
- False Threshold Hyperglycemic alert rate is the alarm alerted when the continuous glucose monitor read that the user was above the high threshold but the user's blood glucose was actually below that high threshold (within ± 15 or 30 minutes of the alert); or
- False Predictive Hypoglycemic alert rate is the alarm alerted when the continuous glucose monitor predicted that the user would be below the low threshold but the user's blood glucose was actually above that low threshold within 15 or 30 minutes following the alert.
- False Predictive Hyperglycemic alert rate is the alarm alerted when the continuous glucose monitor predicted that the user

would be above the high threshold but the user's blood glucose was actually below the high threshold within 15 or 30 minutes following the alert.

Table 4: Glucose FALSE Alert Performance Calibrating Every 12 hours

	Threshold Only			Predictive Only			Threshold & Predictive		
	mg/dL	**30 min**	**15 min**	**mg/dL**	**30 min**	**15 min**	**mg/dL**	**30 min**	**15 min**
Glucose False Alert Rate: Low Glucose Alerts, Abdomen	**55**	61.2%	61.2%	**55**	N/A*	N/A*	**55**	N/A*	N/A*
	60	46.5%	48.1%	**60**	72.4	73.1%	**60**	64.4%	65.4%
	70	33.1%	33.1%	**70**	61.6	64.1%	**70**	52.6%	54.3%
	80	30.7%	30.7%	**80**	55.5	59.2%	**80**	47.1%	49.5%
	90	24.9%	25.6%	**90**	51.1	54.1%	**90**	42.1%	44.4%
Glucose False Alert Rate: High Glucose Alerts, Abdomen	**300**	18.8%	18.8%	**300**	42.2%	46.0%	**300**	34.6%	37.3%
	250	9.80%	9.80%	**250**	36.0%	39.9%	**250**	27.5%	30.2%
	220	8.10%	8.10%	**220**	31.1%	33.7%	**220**	23.4%	25.2%
	180	6.30%	7.20%	**180**	29.5%	33.1%	**180**	22.0%	24.6%
Glucose False Alert Rate: Low Glucose Alerts, Arm	**55**	41.3%	41.3%	**55**	N/A*	N/A*	**55**	N/A*	N/A*
	60	31%	32.2%	**60**	70.9%	72.8%	**60**	61.1%	62.8%
	70	22.6%	24.7%	**70**	59.6%	65%	**70**	48.3%	52.7%
	80	22.5%	23.6%	**80**	56.7%	60.8%	**80**	45.8%	49%
	90	25.1%	25.1%	**90**	46.7%	51.3%	**90**	39.1%	42.1%
False Alert Rate: High Glucose Alerts, Arm	**300**	18.1%	19.4%	**300**	48.3%	50.3%	**300**	38.8%	40.7%
	250	8.6%	8.6%	**250**	38%	40.2%	**250**	28.9%	30.4%
	220	7.8%	7.8%	**220**	34.3%	37.8%	**220**	25.5%	27.8%
	180	7.1%	7.1%	**180**	32%	36.8%	**180**	23.5%	26.3%

**The Guardian Connect system only issues threshold alerts at the mandatory low glucose threshold setting of 55 mg/dL.*

Correct Detection Rates

Glucose Correct Detection Rate is the rate that the device alerted when it should have alerted. For example, the blood glucose was below the hypoglycemic threshold, or above the hyperglycemic threshold, and the device sounded an alert (within +/- 15 or 30 minutes for the threshold alerts, and within 15 or 30 minutes following predictive alerts).

Table 5: Glucose Correct Detection Alert Performance Calibrating Every 12 hours

	Threshold Only			Predictive Only			Threshold & Predictive		
	mg/dL	**30 min**	**15 min**	**mg/dL**	**30 min**	**15 min**	**mg/dL**	**30 min**	**15 min**
Glucose Correct Detection Rate: Low Glucose	**55**	73.6%	73.6%	**55**	N/A*	N/A*	**55**	N/A*	N/A*
	60	83.3%	82.1%	**60**	96.4%	95.2%	**60**	96.4%	96.4%
	70	90.5%	90.5%	**70**	98.5%	95.6%	**70**	98.5%	95.6%
	80	87.2%	87.2%	**80**	95.2%	92%	**80**	95.7%	93.6%

Alerts, Abdomen	**90**	91.1%	88.7%	**90**	97.3%	93.4%	**90**	98.1%	94.6%
Glucose Correct Detection Rate: High Glucose Alerts, Abdomen	**300**	75.3%	75.3%	**300**	95.3%	92.9%	**300**	95.3%	94.1%
	250	81.5%	80.9%	**250**	96.5%	91.3%	**250**	96.5%	93.6%
	220	90.1%	89.2%	**220**	94.8%	93.5%	**220**	95.3%	94.4%
	180	93.1%	91.4%	**180**	96.6%	93.4%	**180**	96.9%	95.4%
Glucose Correct Detection Rate: Low Glucose Alerts, Arm	**55**	78.7%	78.7%	**55**	N/A*	N/A*	**55**	N/A*	N/A*
	60	86.3%	83.6%	**60**	100%	97.3%	**60**	100%	100%
	70	90.2%	88.6%	**70**	96.7%	91.9%	**70**	96.7%	93.5%
	80	89%	88.4%	**80**	97.1%	91.3%	**80**	97.7%	96.5%
	90	91.7%	90.4%	**90**	98.7%	96.5%	**90**	98.7%	97.8%
Glucose Correct Detection Rate: High Glucose Alerts, Arm	**300**	74.4%	71.8%	**300**	93.6%	89.7%	**300**	93.6%	89.7%
	250	80.9%	79.6%	**250**	96.7%	90.8%	**250**	96.7%	91.4%
	220	90.1%	89.2%	**220**	96.1%	93.6%	**220**	96.1%	95.6%
	180	93.2%	92.2%	**180**	98.1%	94.2%	**180**	98.7%	96.4%

**The Guardian Connect system only issues threshold alerts at the mandatory low glucose threshold setting of 55 mg/dL.*

Missed Detection Rates

The Missed Detection Rate is the rate that the device did not alert when it should have (within +/- 15 or 30 minutes for the threshold alerts, and within 15 or 30 minutes following predictive alerts). For example, the blood glucose was below the hypoglycemic threshold, or above the hyperglycemic threshold, and the device did not sound a threshold or predictive alert.

Table 6: Glucose Missed Detection Alert Performance Calibrating Every 12 hours

	Threshold Only			**Predictive Only**			**Threshold & Predictive**		
	mg/dL	**30 min**	**15 min**	**mg/dL**	**30 min**	**15 min**	**mg/dL**	**30 min**	**15 min**
Glucose Missed Detection Rate: Low Glucose Alerts, Abdomen	**55**	26.4%	26.4%	**55**	N/A*	N/A*	**55**	N/A*	N/A*
	60	16.7%	17.9%	**60**	3.6%	4.8%	**60**	3.6%	3.6%
	70	9.5%	9.5%	**70**	1.5%	4.4%	**70**	1.5%	4.4%
	80	12.8%	12.8%	**80**	4.8%	8%	**80**	4.3%	6.4%
	90	8.9%	11.3%	**90**	2.7%	6.6%	**90**	1.9%	5.4%
Glucose Missed Detection Rate: High Glucose Alerts, Abdomen	**300**	24.7%	24.7%	**300**	4.7%	7.1%	**300**	4.7%	5.9%
	250	18.5%	19.1%	**250**	3.5%	8.7%	**250**	3.5%	6.4%
	220	9.9%	10.8%	**220**	5.2%	6.5%	**220**	4.7%	5.6%
	180	6.9%	8.6%	**180**	3.4%	6.6%	**180**	3.1%	4.6%
Glucose Missed Detection Rate: Low Glucose Alerts, Arm	**55**	21.3%	21.3%	**55**	N/A*	N/A*	**55**	N/A*	N/A*
	60	13.7%	16.4%	**60**	0%	2.7%	**60**	0%	0%
	70	9.8%	11.4%	**70**	3.3%	8.1%	**70**	3.3%	6.5%
	80	11%	11.6%	**80**	2.9%	8.7%	**80**	2.3%	3.5%
	90	8.3%	9.6%	**90**	1.3%	3.5%	**90**	1.3%	2.2%
Glucose Missed Detection	**300**	25.6%	28.2%	**300**	6.4%	10.3%	**300**	6.4%	10.3%
	250	19.1%	20.4%	**250**	3.3%	9.2%	**250**	3.3%	8.6%

Rate: High Glucose Alerts, Arm	**220**	9.9%	10.8%	**220**	3.9%	6.4%	**220**	3.9%	4.4%
	180	6.8%	7.8%	**180**	1.9%	5.8%	**180**	1.3%	3.6%

**The Guardian Connect system only issues threshold alerts at the mandatory low glucose threshold setting of 55 mg/dL.*

3. Subgroup Analyses
   Please refer to the SSED of P160017/S017 for subgroup analyses.

4. Pediatric Extrapolation
   The sponsor provided clinical data in pediatric subjects aged 14 and up. In this premarket application, existing clinical data was not leveraged to support approval of a pediatric patient population younger than 14 years old. This device is approved for use in persons aged 14 and older.

E. Financial Disclosure

The Financial Disclosure by Clinical Investigators regulation (21 CFR 54) requires applicants who submit a marketing application to include certain information concerning the compensation to, and financial interests and arrangement of, any clinical investigator conducting clinical studies covered by the regulation. The pivotal clinical study included 6 investigators. None of the clinical investigators had disclosable financial interests/arrangements as defined in sections 54.2(a), (b), (c), and (f). The information provided does not raise any questions about the reliability of the data.

XI. SUMMARY OF SUPPLEMENTAL CLINICAL INFORMATION

Please refer to the SSED of P160017 and P160017/S017 for descriptions of the supplemental clinical information relevant to the Guardian Sensor (3).

XII. PANEL MEETING RECOMMENDATION AND FDA'S POST-PANEL ACTION

This PMA was not reviewed by an advisory panel because FDA has the experience and breadth of knowledge to evaluate safety and effectiveness.

XIII. CONCLUSIONS DRAWN FROM PRECLINICAL AND CLINICAL STUDIES

A. Effectiveness Conclusions

The effectiveness of the sensor was based on the performanceevaluation of the Guardian Sensor (3) compared to blood glucose values measured by the comparator method during in-clinic sessions spanning the wear period of the sensor (7 days). The performance data presented in the SSED for P160007/S017 established the sensor performance across the claimed measuring range (40 to 400 mg/dL glucose), the precision, and the calibration frequency (calibrate minimally every 12 hours or 3-4 times a day) of the 7-day wear period for the Guardian Sensor (3) in the abdomen and the arm.

The performance data presented above established the performance of the alarms and alerts of the Guardian Sensor (3) and Guardian Connect transmitter using the Guardian Connect app. The human factors testing presented above confirms that users can effectively use the Guardian Connect system which includes the mobile application as the primary device display.

The results of the nonclinical and clinical studies performed to support approval establish a reasonable assurance that the Guardian Connect system is effective for its intended use for continuous or periodic monitoring of glucose levels in the interstitial fluid under the skin, in patients (14 to 75 years of age) with diabetes mellitus using a mobile application as the primary device display.

B. Safety Conclusions

The risks of the device are based on non-clinical studies, human factors testing, and data collected in a clinical study conducted to support PMA approval as described above.

The following events are possible adverse device effects of inserting a sensor into your skin: local infection, inflammation, pain or discomfort, bleeding at the glucose sensor insertion site, bruising, itching, scarring or skin discoloration, hematoma, tape irritation, sensor or needle fracture during insertion, wear or removal.
Potential device related non-serious events include:

- Skin irritation or redness
- Infection
- Pain or discomfort
- Bruising
- Edema
- Rash
- Bleeding
- Induration of skin
- Allergic reaction to adhesives

Risks of CGM devices are discussed above and below. The risks associated with this CGM are similar to previously approved CGM devices. Additional risks for this device are those associated with use of a mobile application as the primary device display, described above in Section VIII and below in Section XIII.C

Data from human factors testing to evaluate use-related risks of the device with an emphasis on application setup including the audio override feature and system connectivity, comprehension of warning statements, and alert handling, s safe use of the device.

C. Benefit-Risk Determination

Summary of Benefits:
This device is intended to supplement self-monitoring of blood glucose to track and trend interstitial glucose levels as estimates of blood glucose excursions. The adjustable threshold and predictive glucose alerts are intended to warn the patients that they need to test their blood sugar to see if they need to take action to treat or prevent a hypoglycemic or hyperglycemic event.

Further, CGM measurements, which are performed every 5 minutes for 7 days via an indwelling sensor, do not require repeated performance of fingersticks with a lancet for each measurement as is required for each individual blood glucose measurement with a traditional glucose meter.

These functions are not feasible using traditional blood glucose monitoring as blood glucose meters only provide information about discrete, intermittent blood glucose levels and therefore are unable to provide information regarding patterns of glycemic excursions throughout the day and night when patients may be unable to test their blood glucose. The CGM includes a software package to aid in the evaluation of glucose trends over several days to detect patterns which may indicate a need to adjust therapy, but might be missed with infrequent, intermittent blood glucose monitoring.

This device presents an additional potential benefit of convenience compared to the previous version of the device (Enlite Sensor) from the same manufacturer, in that the device utilizes a mobile device application as its display. Use of a mobile device as the primary display is beneficial to patients, as it offers convenience in terms of decreasing the number of devises required to be with the patient to utilize this CGM device.

Furthermore, real time knowledge of whether blood glucose is increasing or decreasing adds information unavailable by traditional discrete monitoring. This information regarding direction and rate of change can alert users that they need to take action to prevent hypoglycemia or hyperglycemia. The alert functions can notify users that they need to test their blood sugar to see if they need to take action to treat asymptomatic hypoglycemia or hyperglycemia before their blood glucose concentration reaches a dangerous level. This is especially helpful for individuals with hypoglycemia unawareness (these individuals may develop severe hypoglycemia with loss of consciousness, seizures, or rarely death without the normal warning symptoms), or during the night when subjects may have prolonged hypoglycemia that does not waken them which could proceed to severe hypoglycemia if not treated in time. Traditional blood glucose monitoring is not able to capture these potentially dangerous episodes of asymptomatic hypoglycemia. Therefore, this device provides significant benefit to users not possible with traditional blood glucose monitoring. For these reasons, the above endpoints are accepted in lieu of explicit demonstration of clinical benefit.

Summary of Risks:
There are risks due to missed alerts and false negative hypoglycemia and hyperglycemic readings related to patients not being alerted to the need to perform a fingerstick to detect hypoglycemia or hyperglycemia, particularly since users of this device may rely on these alerts in certain situations to guide their self-treatment strategy (e.g., to alert them to potential nighttime hypoglycemia). There is a risk to false alerts and false positive hypoglycemia and hyperglycemia readings related to the need to perform unnecessary fingersticks to confirm an erroneous low or high reading.

There are risks related to potentially inaccurate glucose readings from the device. Inaccurate calculation of the rate of change of glucose by the CGM could prevent a patient from performing additional blood glucose tests or taking measures to stop a trend of increasing or decreasing glucose levels which could lead to serious hypoglycemia or hyperglycemia if no action is taken to stop these glucose trends. Inaccurate calculation of the rate of change of glucose could also lead to unnecessary additional blood glucose tests or inappropriate measures to stop a trend of increasing or decreasing glucose level which could result in hyperglycemia or hypoglycemia. A minor risk of this device is that users may need to perform unnecessary fingersticks to evaluate their blood glucose when the CGM gives false positive hypoglycemic and hyperglycemic readings or alerts. The reported alert performance overall is comparable to other currently available CGM devices for adjunctive use. Potential risks relating to missed alerts and false negative alerts are not expected to be greater for this device than other CGM devices with a similar adjunctive indication for use.

The risk of inaccurate results related to the use of this device should not be greater than the risk of managing diabetes with a blood glucose meter alone, unless patients omit a blood glucose test that they would have otherwise performed if they were not using the sensor or the sensor was not reading within their target glucose range.

There is a risk related to off label non-adjunctive use of the device if patients make decisions on diabetes management based on inaccurate sensor readings alone without confirmation by blood glucose testing.

There is a minor risk of skin irritation, inflammation, or infection due to either the sensor needle or the adhesive. There is a risk of sensor breakage leaving a sensor fragment under the skin. This event was reported infrequently with previously approved sensors. No sensor breakage was documented in the clinical study reviewed. Reported sensor breakage rate with similar devices has been very low, however, and this study was not powered or designed to assess the rate of breakage, though all sensors were inspected for fracture after removal.

There are risks relating to the use of the mobile application, the sole display for this device. Risks of the use of a mobile application as the sole device display include delayed or missed alerts due to loss of mobile application connectivity or operation, improper application setup, lack of comprehension of the audio override feature, and

lack of comprehension of alert features that may result in an increased risk of hypoglycemia or hyperglycemia. There is no alternate or dedicated display specific to only this device. Three participants (out of 30) did not fully understand the audio override feature. The participants thought when defaulted to ON, the audio override would allow the user to always hear alerts and when turned OFF, they would not hear alerts. The participants did not fully understand the audio override feature in that when the audio override feature is turned OFF, alerts are received using the audio settings for the mobile device and therefore, if the ringer volume is ON, the alerts are received at the same level as the mobile device's ringer volume even if the audio override is OFF. While these three participants did not demonstrate a complete understanding of the audio override feature being turned OFF, none committed a use error that would have caused increased risk since the participants kept the audio override feature ON to hear all alerts and the audio override defaults to ON. This potential risk is further mitigated by training offered by the sponsor, as described above.

Human factors studies assessed the safety of the user interface of the mobile app (sole display) for this device. The level of information necessary to understand the safety aspects of the user interface, and how it supports the user and reduces the potential for use error was provided by the sponsor, and found to be adequate. Further, the human factors study sufficiently assessed the potential for user error associated with comprehension of the impact of phone and app settings on notifications and Bluetooth communications, as well as use of the audio override feature.

Patient Perspectives
Patient perspectives considered during the review included information provided directly to the Agency by patients in written statements and also obtained through discussion with patients at public forums regarding their experience with continuous glucose monitoring system devices in general.

In conclusion, given the available information above, the data support that for continuous or periodic monitoring of glucose levels in the interstitial fluid under the skin, in patients (14 to 75 years of age) with diabetes mellitus, the probable benefits outweigh the probable risks.

D. Overall Conclusions

The data in this application support the reasonable assurance of safety and effectiveness of this device when used in accordance with the indications for use. The benefits of using the Guardian Connect system outweigh the risks, as discussed above.

XIV. CDRH DECISION

CDRH issued an approval order on March 8, 2018.

The applicant's manufacturing facilities have been inspected and found to be in compliance with the device Quality System (QS) regulation (21 CFR 820).

XV. APPROVAL SPECIFICATIONS

Directions for use: See device labeling.

Hazards to Health from Use of the Device: See Indications, Contraindications, Warnings, Precautions, and Adverse Events in the device labeling.

Post-approval Requirements and Restrictions: See approval order.

XVI. REFERENCES

None.