Ambulatory Artificial Pancreas Platform (AAPP) User Manual

Welcome to the Artificial Pancreas User Manual. This manual is intended to teach you how to use the system in your clinical trial. If questions occur while using the system, please call your designated research coordinator or clinical advisor for the trial. He or she will help you understand how the system works and answer any questions you may have.

Introduction

The AAPP is a cell phone-based computational platform running on the Android operating system. The AAPP communicates with your continuous glucose sensor and insulin pump through a tablet that is wired to a communication device. Data from the sensor are transmitted to the AAPP, which then transmits insulin delivery commands to the insulin pump. The AAPP also includes a graphic user interface, a safety formula dedicated to the prevention of hypoglycemia, and a formula that suggests insulin corrections when needed. These two formulas are known as Control-to-Range because they minimize the risk for both hypo- and hyperglycemia and try to keep your blood sugar within a target range. For added safety, the AAPP transmits all data to a secure server, which enables remote monitoring and supervision by qualified personnel at all stages of the study.

It is important to emphasize that you will be using the AAPP only for the 18-hour duration of one clinical study of Control-to-Range, which will be carried in controlled outpatient conditions. The action of the AAPP will be monitored at all times by qualified personnel that will be readily available to intervene if communication, sensor, or pump failure occurs.

This study aims to see if this new technology that helps control blood sugar in people with type 1 diabetes mellitus on insulin pump therapy can be successfully used and monitored both in a hospital and in a non-hospital (hotel) setting. The principal elements of this technology, including the continuous glucose monitor (CGM) and the insulin pump, have been approved for use in people and are routinely used for the treatment of diabetes. The safety and the correction

formulas have been tested in extensive clinical trials. The new element of this study is the cell phone-based AAPP and its communication with the insulin pump and continuous glucose sensor. In previous studies, the Control-to-Range system was tested on a larger laptop computer. One of the main reasons for this study, then, is to see if the Control-to-Range computer programs can be used on the new equipment, namely the AAPP. Another goal of this study is to see whether the study team can monitor the equipment remotely.

System Start-Up

Your Artificial Pancreas interface has been pre-programmed to match your current pump settings by the clinicians performing the study. You will begin using the system after a training session with the research staff and will be given a copy of this manual to assist you in learning how to operate the AAPP. Your communication with the platform will be minimal. The start-up screen of the AAPP is presented below:

The Artificial Pancreas can operate in three modes: open loop, closed loop and stopped. When operating in open loop mode (), the system will deliver basal as programmed and will allow you to enter meal boluses. Open loop is the mode you will use in the trial until your CGM is calibrated. Please note that closed loop mode will not be an option on the home screen until after the CGM has been calibrated (). After your sensor is calibrated, closed loop mode () will become available on the home screen. As noted in the Introduction, closed loop mode uses Control-to-Range formulas which work to help prevent hypoglycemia and hyperglycemia. When closed loop mode is activated, the screen of the AAPP will change to the Home Screen

presented below. All communication with the principal interface of the AAPP is performed through the touch buttons on the Home Screen.

The Home Screen:

- The home screen reflects the current status of the device in the upper left-hand corner by stating CLOSED LOOP, OPEN LOOP, or stopped.
- The home screen has two traffic lights at either side to indicate hypoglycemia (left traffic light labeled “hypo”) or hyperglycemia (right traffic light labeled “hyper”).

- A battery indicator is at the top of the device to the right of center and displays the percentage of battery life left on the device. You will be encouraged to plug in and charge the device if the battery life declines below 25%. At 15% battery life, the device will need to be charged in order to keep operating.
- Next to the battery life are CGM and Pump indicators which appear in green when they are connected to the AAPP.
- In the upper area of the screen, the current blood sugar reading is displayed in mg/dl with an arrow indicating the latest blood sugar trend and the elapsed time in minutes since the last reading.
- The amount and time of the last bolus is displayed below the current blood sugar reading.
- Below that, there is a group of touch buttons that are described in the following pages.
- The current time is shown at the bottom center of the device.

Traffic Lights:

The system uses a pair of "traffic light" symbols to inform users of their risks for hypo- and hyperglycemia. In the Home Screen above, the hypoglycemia light is red, indicating high risk for hypoglycemia as described below. Under normal circumstances, however, both traffic lights would appear green indicating that blood glucose is currently stable.

Hypoglycemia Traffic Light:

- If the hypoglycemia traffic light is green, this means that, according to the CGM readings, you are currently not at risk for hypoglycemia. ***It is important to emphasize, however, that a risk for hypoglycemia may still exist***. For example, if the CGM readings are incorrect (i.e. sensor reading high), the system may underestimate the risk for hypoglycemia. Thus, you should always trust your experience and check your blood sugar independently if hypoglycemia is suspected.
- The yellow hypoglycemia light indicates that the system is detecting risk for hypoglycemia and is reducing insulin delivery to mitigate that risk.
- The red hypoglycemia light indicates that the system believes that hypoglycemia is imminent or already underway. An alarm will sound to notify you that you are either currently experiencing or predicted to experience hypoglycemia. ***When the red hypoglycemia light is illuminated or the alarm sounds, treat with your carbohydrate rescue choice immediately***.
- After treating your hypo, please press the Hypo-Rx button on the Home Screen to indicate that you have taken action to treat your low blood glucose (BG) and press the "Stop Alarm" button to acknowledge your response to the alarm message.

Hyperglycemia Traffic Light:

- If the hyperglycemia traffic light is green, this means that, according to the CGM readings, you are currently not at risk for hyperglycemia. ***It is important to emphasize, however, that a risk for hyperglycemia may still exist***. For example, if the CGM readings are incorrect (i.e. sensor reading low), the system may underestimate the risk for hyperglycemia. Thus, you should always trust your experience and check your blood sugar independently if hyperglycemia is suspected.
- When a yellow light appears under the hyperglycemia stoplight, the system may suggest a correction bolus to avoid hyperglycemia.
- A red hyperglycemia light may be a sign of pump occlusion. If you have been hyperglycemic for over three hours with no decrease in glucose, a pump change might be necessary. Please discuss this with the research staff to determine if this is necessary.

Correction Boluses:

The Control-to-Range may suggest correction boluses to avoid hyperglycemia. Any correction bolus that the system suggests will be announced via a dialog on the home screen which requests confirmation. **If the correction bolus is not confirmed or cancelled within 5 minutes, the system will automatically deliver the insulin to prevent hyperglycemia.**

 *The Meal Button - Giving a meal bolus:*

- Tap the meal icon when you are ready to eat. You will need to enter the following values when having a meal: meal size in grams of carbohydrates; BG; IOB; and additional correction bolus to be delivered.
- IOB stands for “Insulin on Board,” meaning the amount of insulin still active in your system as defined by the active insulin time per your current pump parameters.

- "Include IOB" will be automatically checked on the AAPP, but the box can be unchecked by touching the green checkbox.
- The total bolus will be calculated from the information that you entered. Press "INJECT" if you wish to deliver the bolus.
- The system has a bolus interceptor that will alert you to any bolus that is considered unsafe. If this occurs, the system will tell you the amount it recommends that you take instead. This recommendation can be overridden by entering a different amount that you wish the system to inject. If the bolus is intercepted you will have 60 seconds to adjust the bolus amount and inject. For added safety, if you do not respond within 60 seconds, the bolus will be cancelled.

Calibrating the System:

- The CGM sensor attached to the system will periodically need to be calibrated. Your research coordinator or clinical advisor will inform you when it is time to calibrate the sensor as part of the trial.
- Press the "Calibrate" (blood drop) icon on the main menu and follow the instructions given to enter your BG reading. Please use the glucometer the study team has given you to test your glucose.
- If the system requires more than one BG reading for calibration, you will be prompted to enter a second BG value.
- Please remember to wash your hands before any fingersticks to ensure accurate calibrations for the device.
- After the initial calibration you will need to calibrate the system approximately every twelve hours. You will only need to enter one fingerstick value for each calibration after the sensor has been initialized.

Exercise

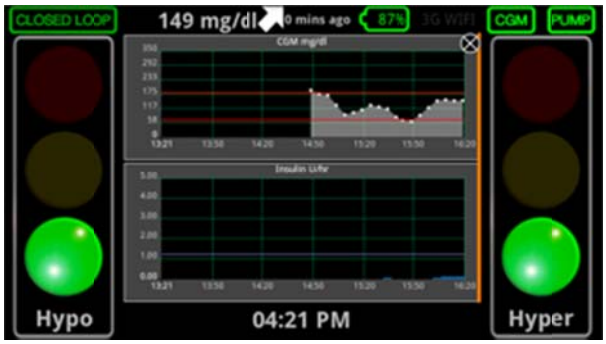
- When you begin an exercise session, please press the red “NOT EXERCISING.” The button will then turn green, and the status will change to “EXERCISING.”
- When you are ready to stop exercise, press the green “EXERCISING” button to confirm that you have stopped exercising. This will change the button back to its red “NOT EXERCISING” state.

Hypoglycemia Treatment - Hypo Rx:

- When you have treated yourself for hypoglycemia, press the pink Hypo-Rx button on the home screen. This will indicate to the system that you have treated your hypoglycemia. **Please be sure to treat your hypoglycemia before pressing the button.**

Continuous Glucose Monitor (CGM) Graph:

- Press the CGM button on the home screen to see your CGM and insulin delivery data.
- Once you open the CGM graph, a display showing your BG will appear. On the bottom of the screen, delivered insulin is displayed. Basal insulin in units/hour will be displayed in blue; bolus insulin will be displayed in green:



- There are arrows that indicate the direction of your glucose trend on the home screen directly after the glucose value is displayed.
- An arrow going straight up ↑ indicates that glucose is rapidly rising.
- An arrow going straight down ↓ indicates that glucose is rapidly dropping.
- An arrow traveling diagonally up ↗ indicates that glucose is gradually rising.
- An arrow traveling diagonally down ↘ indicates that glucose is gradually decreasing.
- A straight arrow → indicates that glucose is currently stable.

The Stop Sign:

- When you press the "STOP" button, the pump will stop delivering insulin. **Please consult the research team before pressing this button.**

Final thoughts:

- Please communicate any questions you have to the research team.
- Remember to wash and dry your hands before each BG calibration.
- Always treat hypoglycemia before taking time to push the Hypo-Rx treatment button on the device. **Your safety in this trial is our first priority.**