Understanding Automated Insulin Delivery (AID) Systems

WHAT IS AID?

AID systems contain 3 components: A continuous glucose monitor (CGM), an insulin pump, and an algorithm, that makes automatic adjustments to the pump's insulin delivery in response to the CGM value and trend. These systems are frequently referred to as hybrid or advanced hybrid closed-loop insulin pumps because they are not fully automated and still require input from the user to manually deliver insulin doses when carbohydrate is consumed. (7, 10)

WHY AID?

People with diabetes (PWD) who utilize intensive insulin therapy still struggle with elevated A1c, hypoglycemia and glucose variability because there are countless factors that impact glucose values. AID systems are designed to help users achieve increased time in range while minimizing hypoglycemia and reducing the burden of diabetes.

PROVIDER PERSPECTIVES:

WHAT ARE THE LONG-TERM ADVANTAGES OF AID SYSTEMS?

- Fewer and less severe episodes of hypoglycemia and hyperglycemia

- Less worry by reducing the risk of hypoglycemia

- Increased confidence due to more time in target range

- Potential for improved A1C

- Stable overnight glucose and increasing the potential for fasting glucose to remain within target

- Improved sleep due to more stable glucose readings overnight

- Reductions in diabetes distress - allowing the individual to not have to THINK about their diabetes self-management ALL the time

- Allows for more "forgiveness" surrounding meals – if someone cannot count carbs precisely, the pump can compensate by increasing the insulin (basal and/or bolus) based on the glucose readings (11)

- The ability to match basal needs more physiologically instead of presuming someone's basal requirements are the same day after day

- Reduces the daily tasks required to manage glucose readings

1

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WHAT ARE CONSIDERATIONS FOR USE OF AID SYSTEMS?

With any technology, it's important to manage expectations and the realities of using it initially and on a continual basis to individualize and match to the user's needs. Here are some common considerations to discuss prior to initiating an AID system to set realistic expectations.

- Two devices must be worn – the insulin pump and CGM

- Insurance coverage may vary

- There may be additional alarms/alerts

- Basal and bolus settings must be assessed prior to initiating

- Requires a back-up plan in the event of a pump failure

- User must still pre-bolus for food and adjust for exercise, stress, or illness

- Time must be allowed for the system to adjust to the user's needs to get desired results

- Requires user to troubleshoot when readings are unexpected or out of range

- Requires trust by allowing the system to make the necessary adjustments without inputting fictitious information

HOW CAN AID HELP THE USER IMPROVE THEIR SELF-MANAGEMENT?

Below is a summary of learnings and best practices related to use of AID systems and diabetes self-management activities.

TREATING HYPOGLYCEMIA AND HYPERGLYCEMIA

HOW AID SYSTEM FUNCTIONS	USER RESPONSIBILITIES	TIPS AND BEST PRACTICES
Reduces and/or suspends insulin delivery when the glucose is predicted to go below a certain value within a certain period of time.	It is not advisable to wait for the system to correct hypoglycemia; initiate treatment immediately.	Revisit treatment of hypoglycemia. Since the AID system is designed to reduce automated insulin delivery before and during hypoglycemia, it may take fewer carbs than usual to treat hypoglycemia.
Increases basal insulin delivery or administers a small bolus when the glucose is predicted to go above a certain level within a certain period of time.	Utilize bolus calculator to correct hyperglycemia as necessary.	Correction boluses may be smaller than expected due to additional insulin on board/active insulin taken into account from AID. Amount should not be overridden as this can lead to stacking and hypoglycemia.

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COVERING MEALS AND SNACKS

HOW AID SYSTEM FUNCTIONS	USER RESPONSIBILITIES	TIPS AND BEST PRACTICES
Reduces and/or suspends insulin delivery if glucose is trending down or below target, resulting in less Active insulin/Insulin-On-Board (IOB) leading up to mealtimes.	Evaluate bolus timing.	Pay attention to bolus timing, ideally 15-20 mins before eating. In the event a bolus is missed it may be necessary to omit that bolus or bolus for half the carbs eaten to reduce risk of stacking.
Calculates a bolus for meals/snacks based on carbohydrate and glucose values entered into the bolus calculator.	Due to the insulin pharmacodynamics and limited insulin on board before meals, bolus calculator setting adjustments may be needed.	Utilize the system's bolus calculator. Overriding suggested bolus doses can result in hypo/hyperglycemia. Consider stronger insulin-to-carb-ratio (10-20%) if postprandial hyperglycemia occurs.

REVERTING TO OPEN LOOP/MANUAL MODE

HOW AID SYSTEM FUNCTIONS	USER RESPONSIBILITIES	TIPS AND BEST PRACTICES
Automated insulin delivery may not be able to respond quickly enough to rapid increases in insulin resistance that occurs during illness, stress, steroid use.	Guidelines should be in place for managing insulin during illness, stress and medications that raise glucose.	Consider switching to manual mode during increased insulin needs such as illness, stress, or steroid use.
Generates alerts.	Respond to AID and CGM alerts. Use blood glucose meter when symptoms don't match CGM reading.	Ensure users understand when and how to use a back-up plan.

MANAGING PHYSICAL ACTIVITY

HOW AID SYSTEM FUNCTIONS	USER RESPONSIBILITIES	TIPS AND BEST PRACTICES
Makes automated adjustments but may not match with the intensity or amount of physical activity to handle the rapid glucose drop that occurs during exercise.	Consider making manual adjustments in anticipation of exercise.	Plan ahead. Temporary "override" features need to be set 1-2 hours or more before planned exercise. In the event that the temporary features don't manage the situation, consider adjustments to the pre-exercise bolus or supplementing with carbs.

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SYSTEM OPTIONS

Below is a comparison of AID systems and some of their key features. For more information on all the specifications, refer to the manufacturers' user guides (links below).

	OMNIPOD® 5	TANDEM CONTROL IQ™ TECHNOLOGY	MEDTRONIC MINIMED™ 770G SYSTEM
TYPE OF ALGORITHM	Model Predictive Control (MPC).	Model Predictive Control (MPC).	Proportional Integrative Derivative (PID).
HOW ALGORITHM WORKS	*SmartAdjust*™ technology predicts glucose 60 minutes ahead and adjusts insulin delivery every 5 minutes based on current and predicted values when above or below chosen Target Glucose. Always pauses if <60 mg/dl.	*Control-IQ*™ adjusts basal if glucose is predicted to be above 160 or below 112.5 mg/dl in the next 30 minutes. Delivers correction bolus if >180 mg/dl. Stops basal if <70 mg/dl.	*SmartGuard*™ *Auto Mode* automatically controls basal insulin delivery to regulate glucose levels to a target sensor glucose setting of 120 mg/dl based on sensor glucose values received from the CGM.
DAILY BASAL PATTERN USED AS BASELINE	Adaptive basal rate based on insulin delivery history that updates with each Pod change.	User's choice (rates may vary by time of day).	Flat rate based on prior 6 days' data.
GLUCOSE TARGET	Choose 110 through 150 mg/dl (in 10 mg/dl increments– up to 8 segments per 24 hour period).	112.5-160 mg/dl pre-set range.	120 mg/dl.
HYPERGLYCEMIA RESPONSE	■ No automated correction boluses, rather basal insulin is increased every 5 minutes to reduce glucose toward chosen Target Glucose. ■ Manual corrections based on user settings.	■ Automatic correction bolus *(set once per hour)* if predicted to be >180 mg/dl 30 minutes in the future: calculates using the Personal Profile settings, a target of 110 mg/dl and delivers 60% of that value; will not be delivered within 60 minutes of the start, cancellation, or completion of an automatic or manual bolus. ■ Manual corrections based on user settings and any manual correction bolus that is given resets the 60-minute timer for an Automatic Correction Bolus.	Determined by algorithm, cannot be adjusted by user. Targets 150 mg/dl when making corrections. No automated correction boluses.
EXTENDED BOLUS OPTION	No (manual mode only).	Yes (up to 2 hours).	No.

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	OMNIPOD® 5	TANDEM CONTROL IQ™ TECHNOLOGY	MEDTRONIC MINIMED™ 770G SYSTEM
CGM TREND USED IN BOLUS CALCULATOR	Yes, in percentages – Adds up to 30% more to the bolus when trending up and subtracts up to 100% when trending down.	No.	No.
INSULIN ACTION TIME	Adjustable by user from 2-6 hours (0.5-hour increments)- user initiated boluses are the only insulin dosages affected by insulin action time.	Preset at 5 hours.	Adjustable by user from 2-8 hours (15-minute increments.
TEMPORARY OVERRIDE OPTIONS	Activity feature sets target to 150 mg/dl, reduces automated insulin delivery – can be set for 1-24 hours in 1 hour increments.	Exercise activity feature sets target to 140-160 mg/dl – must turn on and off manually; Sleep activity feature reduces target to 112.5-120 mg/dl with no automated correction boluses – can customize days and duration of time of use.	Temp Target feature sets target glucose to 150 mg/dl – can be set for 2-12 hours.
CONTROLLER	Controller or app on personal compatible smartphone (full control of all pump functions). Do not need to be next to Controller/App for auto-mation to occur.	Pump itself or bolus via phone app.	Pump itself.
CGM COMPATIBILITY AND CALIBRATIONS REQUIRED	Dexcom G6 No calibrations.	Dexcom G6 No calibrations.	Medtronic Guardian 3; calibrate 2 hours after warm up; at 6 hours after warm up and every 12 hours – to maintain auto mode status, calibrating 3-4 times per day can optimize sensor performance.
TUBELESS	Yes.	No.	No.
AUTOMATIC DATA UPLOAD CAPABILITY	Automatic upload to Glooko hourly via Wi-Fi or cell data using built-in SIM card.	T-connect mobile app must be installed on phone, paired to pump and open at least every 2-3 days to maintain up-to-date information on T-connect.	App must be installed on phone, Sync to CareLink must be turned on and the phone must be within 20 feet of pump.

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