Sequence diagrams scenarios

Normal operations

1. Manage Personal Profiles (CRUD Operations)

Purpose

This scenario demonstrates how a patient (user) creates, views, updates, and deletes personal profiles. Each profile can store basal rates, correction factors, insulin-to-carb ratios, and target BG values. Once created or updated, a profile can be activated so its settings guide insulin calculations.

Key Steps

1. **Create New Profile**: The user navigates through the UI to "Personal Profiles," taps **"+"**, and enters settings (e.g., basal rates, carb ratio, correction factor). The system checks if the maximum number of profiles is reached.
2. **Update Profile**: The user selects an existing profile, modifies fields, and saves. The pump validates ranges (e.g., basal rate between 0.05–15.0 U/hr).
3. **Activate Profile**: The user activates a profile, and the system loads those settings into the current configuration for real-time use.
4. **Delete Profile**: The user selects a profile to remove, and the system confirms before permanently deleting it.
5. **(Optional) Duplicate**: The user may duplicate an existing profile for quick creation of similar settings.

Why It Matters

- Profiles handle varying daily routines (sleep, exercise, etc.).
- Enforces correct insulin parameters, improving safety and usability.

2. Manual Bolus Delivery

Purpose

In this scenario, the user delivers a **mealtime or correction bolus**. They can choose a standard (immediate) bolus or an extended bolus (partial now, partial over time). The system also prevents multiple overlapping boluses, checks for low BG, and logs each delivery.

Key Steps

1. The user taps **"Bolus"** on the home screen.
2. If a bolus is **already** in progress, the system prevents starting another.
3. The user enters **blood glucose (BG)** (auto-populated by CGM or manual) and carbohydrate intake.

4. The system calculates a **suggested dose** using the active profile (carb ratio, correction factor, insulin on board). If BG is below safe thresholds, it warns the user.
5. The user confirms or adjusts the suggested dose.
6. For an **extended bolus**, the user sets how much insulin is delivered immediately vs. over time.
7. The **Insulin Delivery** mechanism starts the bolus, and the event is **logged**. If extended, the user can cancel the remaining portion mid-delivery.

Why It Matters

- Boluses handle **mealtime coverage** (carbs) and **correction** for high BG.
- Safety checks (one bolus at a time, low BG warnings) reduce risk of insulin stacking.

3. Basal Insulin Management with Control IQ

Purpose

Shows how **Control IQ** automatically manages basal insulin using CGM data. The pump forecasts BG 30 minutes ahead and selects one of five modes: suspended, decreased, normal, increased, or auto-correction bolus.

Key Steps

1. Every few minutes, the **CGM** sends a new reading to the **Pump Controller** (Control IQ).
2. A **Prediction Engine** estimates the BG in 30 minutes.
3. Control IQ decides on one of five basal states:
    a. **Suspend** if predicted BG < 3.9 mmol/L
    b. **Decrease** if ≤ 6.25 mmol/L
    c. **Normal** if 6.25–8.9 mmol/L
    d. **Increase** if 8.9–10 mmol/L
    e. **Auto-Correct** if ≥ 10 mmol/L (delivers a correction bolus).
4. The system logs each adjustment and updates the UI with a color-coded indicator (gray, orange, red, blue, or white droplet).
5. The user can **override** by manually setting a temporary basal.
6. **Profile switching** may also happen automatically (e.g., Day to Night profile).

Why It Matters

- Demonstrates how the pump **automatically** stabilizes BG within target range.
- Reflects the real t:slim X2 pump's Control IQ technology.

4. View Pump History & Data Visualization

Purpose

This scenario covers how the user reviews **historical data** for insulin deliveries (basal, bolus), CGM readings, and alerts. It also shows how the pump can display a **graph** of BG over time alongside insulin dosing events.

Key Steps

1. The user selects **"History"** or **"Data Review"** in the menu.
2. The pump queries its **Data Store** (or "Data Logger") for past events—bolus deliveries, basal changes, CGM logs, and any alerts.
3. The UI lists events chronologically, letting the user select a date/time range or event type (e.g., "only show bolus events").
4. The user can switch to a **graph view**, which displays BG trends on a chart over time, plus any bolus or basal suspension markers.
5. **Extended features** could include exporting data to a file, zooming in/out, or averaging BG in a timeframe.
6. Once done, the user navigates back to the Home screen.

Why It Matters

- Gives the user (and healthcare provider) insights into **patterns** and potential **improvements** (e.g., identifying frequent lows).
- Provides **visual feedback** on insulin usage, essential for refining therapy.

Safety operations

5. Pump Malfunction Handling

Purpose

Shows how the system detects and responds to **routine malfunctions** or alerts: low battery, low insulin, CGM disconnection, and occlusions. In some cases (like occlusion), insulin delivery is suspended to prevent unsafe dosing.

Key Steps

1. A **System Monitor** periodically checks battery level, cartridge volume, and CGM signal.
2. If an issue arises (e.g., battery < 20%), the **Alert Manager** displays a warning. For more serious events, it may suspend insulin.
3. The user **acknowledges** the alert and attempts to fix the issue (e.g., recharging, refilling insulin, reconnecting CGM).
4. If the issue is fixed, the system logs a **resolution** event.

5. If the user **ignores** or can't fix it, repeated alerts or an escalation may occur (e.g., "Contact Support").
6. The event is always **logged** for future reference.

Why It Matters

- Ensures real-time response to hardware or sensor issues.
- Minimizes risk to the patient by suspending insulin if critical problems persist.

6. Bolus Safety Measures

Purpose

Focuses on **safety logic** during bolus calculation and delivery, including low glucose warnings, maximum bolus caps, and mid-delivery cancellation. Complementary to the main "Manual Bolus Delivery" scenario, but with deeper focus on **safety checks**.

Key Steps

1. The user initiates a bolus. If BG is **below** target, the system suggests a **reduced** bolus or warns of hypoglycemia risk.
2. If the user attempts a dose above the **max bolus limit**, the system caps it and alerts the user.
3. Once a bolus is in progress, the user can **cancel** if it's an extended bolus (remaining portion). Standard boluses deliver immediately and cannot be undone.
4. All changes—reduced doses, overrides, cancellations—are logged with **safety flags**.

Why It Matters

- Protects the user from dangerously large or unnecessary boluses.
- Reinforces real-world pump constraints (e.g., max bolus size).

7. Control IQ Safety Operations

Purpose

Shows how **Control IQ** addresses **safety** situations, such as predicted severe hypoglycemia, CGM data loss, user overrides, and automatic basal resumption after a timed suspension.

Key Steps

1. If BG is predicted **below** 3.9 mmol/L, the system suspends basal insulin (logically distinct from a minor "decreased" rate).
2. If the CGM signal is lost, the system **reverts** to a default basal profile and repeatedly attempts to reconnect.

3. The user can do a **manual override** to stop insulin entirely.
4. After a preset time (e.g., 2 hours), the system **auto-resumes** insulin unless the user extends the suspension. All transitions are logged.

Why It Matters

- Reflects the real t:slim X2's approach to preventing severe lows (suspend on predicted hypo).
- Ensures the pump can handle sensor dropouts and revert to a safe baseline rate.

8. System Critical Errors

Purpose

Covers **catastrophic failures** beyond typical malfunctions: critically low battery (<5% → <2%), severe/persistent occlusions, or complete pump shutdown. The system tries to **safely suspend** insulin and either recover or remain disabled.

Key Steps

1. If the battery hits a **critical** threshold (e.g., 5%), the user sees a **urgent** alert. If it drops further (e.g., 2%) without intervention, the system initiates an **emergency shutdown** and suspends insulin.
2. In a **persistent occlusion**, the system repeatedly attempts to clear the issue. If it remains blocked, it instructs the user to replace infusion sets or contact support.
3. In a **complete pump failure** (system error), the pump tries to suspend insulin, logs the event, and attempts a **restart**. If the restart fails, the pump stays in a **disabled** state for user safety.
4. Any final messages direct the user to **contact support** or **switch to backup insulin** methods.

Why It Matters

- Ensures the pump halts insulin under life-threatening conditions.
- Provides a last-resort fallback if normal operation is impossible, protecting the user's safety.