Nightscout Loader (PC Application)
V2.5

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NIGHTSCOUT
#WeAreNotWaiting

What is Nightscout Loader?

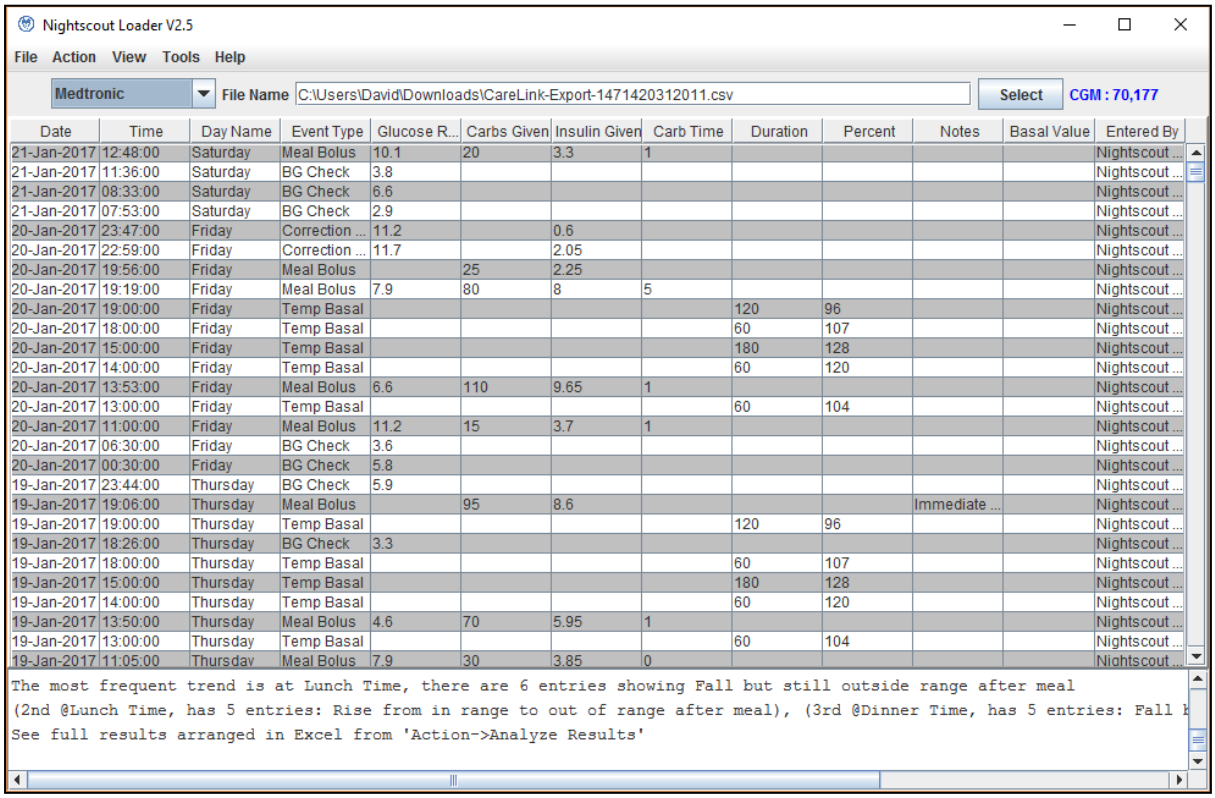


Figure 1 Screen shot of Nightscout Loader

Introduction

A PC desktop application with the following purposes in mind:

1. Synchronize data from meter/pump as treatments in Nightscout Care Portal.
   For two reasons:
   a. To release this 'locked' data and make it available for combination reports with sensor data in Nightscout
   b. To make this data available to answer questions like 'how did I handle this situation before and what impact did it have on my blood sugars?'
2. Quick way of allowing edits to the Notes field in treatment data.
   a. Adding information into the notes of a meal bolus for example or a BG can help locate days that particular things happened – pizza or feeling unwell for example. (This compliments objective 1.b above)
3. Analysis of BG Trends
   There is hidden information in the meter/pump data and it's possible to mine this for further

value such as a recommendations engine.

This area is evolving at the moment as ideas emerge, but the following features are included:

a. Result categorization – meal time, high, low etc.
b. Pre & post meal result grouping – breakfast to lunch, lunch to dinner, dinner to bed
c. Overnight result grouping
d. Trend analysis – Identifies patterns where grouped results show same characteristics such as rises, falls etc.
e. Skipped Meal identification – help identify fasting meal periods for tight basal tuning.
f. Results are all exported into a formatted Excel file – great for archiving the analysis and extending with your own data such as changes made etc.

4. Analysis of CGM Data

This is a new addition to V2.5. Note the blue reference to the number of CGM entries on the screen shot in Figure 1 Screen shot of Nightscout Loader.

The single analysis operation will analyze BG, Carb & Insulin results as before but now also include CGM analysis if data exists for the same date range.

CGM data is traditionally analyzed in a graphical format, perhaps overlaying several days' data onto a timeline or aggregating using AGP. For technical reasons, this tool can't generate graphs in Excel – the preferred method of output.

So instead, a **heat map** technique is used to show trends. The approach is as follows:

a. CGM results are placed into separate time buckets – either 1, 2 or 3 hour durations starting from midnight.
b. CGM results within this range are then categorized based on:
    i. Starting point (i.e. in range, low or high)
    ii. End point (rising, falling, flat)
    iii. Intermediate events (eg fall between start and end but also rising in between, hypo or hyper)
c. These results are then aggregated across days in the analysis range
d. Finally, the aggregate results are rendered on a heat map showing how many days CGM results exhibit the behaviour in the time range.

5. Additional Minor Features

a. Exports of Nightscout data
    i. The application can export all the treatment data into an Excel spreadsheet for further offline analysis
    ii. As a backup, the application can download all sensor data and treatments (Nightscout loaded data plus entries entered via Nightscout care portal) into a local text file.
b. Audit History of uploads

i. Each upload is stored in a new area. Advanced option flag unlocks the ability to delete uploads one at a time or all uploads
ii. Duplicate detection. Should Care Portal entries be manually entered that are also in the meter/pump, the application can detect this, mark the meter entries as duplicate and allow decision making – either confirm entry to be kept or remove it.

c. Pulse Checks on MongoDB
   i. While the application is running and either in a dormant state or performing other actions, it has a couple separate threads that sleep for 10 seconds, then wake and check for any activity on the MongoDB. If any extra data has been saved to the events (realtime BG data) or treatments (perhaps treatments stored from the Nightscout app), then it will highlight this in the panel.
d. Stand-Alone mode
   i. Users without CGM or the need for Nightscout can still benefit from the analytical features of the application. Data can be read from supported meters into memory for analysis without the need to connect to Mongo DB.
e. Treatment Data Search
   i. Treatment data can be searched by combinations of result type, Notes, Entered By, Glucose/Carbs/Insulin values as well as if the result is considered a duplicate.

Supported Meters/Pumps

The initial version has been tested against the following meter / pump products:

1. **Roche AccuChek Combo**
   a. Roche stores its meter and pump data in a SQL Server database. Nightscout Loader is able to access and query the host SQL Server database using configured parameters.
2. **Medtronic 640**
   a. I'm less familiar with Medtronic (since my daughter used Roche when development started and has since moved to OmniPod ☺) Test files supplied by Andy Sherwood have been analysed to code loaders. Consequently, Nightscout Loader can read a CSV file extract from the Medtronic software when informed of its location.
3. **Medtronic Veo**
   a. The Veo extract file is in the same format as 640 and hence works in the same way.
4. **Diasend**
   a. The recommendation from our Clinic has been to use Diasend for uploads rather than any local based application, so I've included support for Diasend and enhanced it.
   b. Users in Europe and United States have provided their slightly variant forms of Diasend files to ensure compatibility.

Nightscout Loader is designed for use internationally supporting both mmol/L and mg/dL BG unit readings.

Typical Uses

1. Regular Upload of Pump / Meter data as Treatments into Nightscout

   Typical use would be to load data on a regular basis from meter / pump into Nightscout. Having data there will allow access from mobile devices when using Nightscout. Because the application communicates directly with MongoDB it does not consume any of the Azure data allowance and hence will not increase the risk of any costs being incurred.

2. Updating Treatment Data Notes in Nightscout

   This use case would typically use the search features to locate entries of interest (result type, value etc) and then updating the Notes on the form.

3. Regular Analysis of BG Trend data and / or CGM data in Nightscout

   In addition, on a regular basis it's now possible to perform deep analysis of bg trends and store the output in Excel files that can be named with the date each time. Each time the application launches or new data is synchronized with Nightscout, the application silently runs an analysis over a two week period and summarises the top three trends in the notification area at the bottom of the main window. The most recent enhancement includes analysis of CGM data.

4. Analysis of BG Trend data without using Nightscout

   A recent enhancement allows use of the analytical features without the need for Nightscout. This opens the extends of the tool to meter/pump communities that have not yet benefitted from CGM in the Cloud with Nightscout.

Installation

In line with much of Nightscout, Nightscout Loader is Open Source and is accessible in GitHub, has been developed in a non-commercial way and hence does not have the same type of support tools to install you may be used to. Installation is manual but not too difficult. Please note that along with all other Nightscout software, use Nightscout Loader as a DIY tool as there is no warranty offered in any way.

The easiest way to obtain NightscoutLoader is from links on the dedicated Facebook Page.

Nightscout Loader comprises of the following components:

- Java application binary – "NightScoutLoader.jar"
- A file with SQL commands called "SQL_Query_For_Java.sql" (Required for Roche users only)

To install, follow these instructions:

1. Copy all of these items to a folder on your computer. For example, create a folder on your C:\ drive called "C:\Nightscout Loader" and copy all of these files and folders there.
2. Create a short cut on your desktop to the application "NightscoutLoader.jar"

3. To launch, double click the Nightscout Loader icon installed on the desktop after step 2 above.
4. If using Roche, then configure the SQL file to select the installed folder and reference the “SQL_Query_For_Java.sql” file

If installed correctly, the window should appear as shown in the screen shot in Figure 1 Screen shot of Nightscout Loader.

Nightscout Loader Menus

Nightscout Loader File Menu

On the main Nightscout Loader Window, the File menu contains the following options show below:

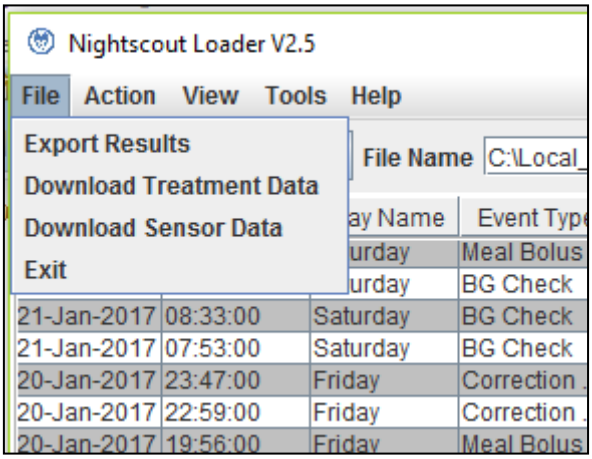


Figure 2 NightScout Loader – File Menu Options

Export Results menu

The Export Results menu will save the currently visible grid as an Excel 1997-2003 Work book. Select a file and results will be stored where selected. Once the file is stored, Excel will start immediately on the selected file for convenience.

Download Treatment Data menu

The Download Treatment Data menu will download all Care Portal treatment data from Nightscout and save it as a JSON file. This is a very convenient way of backing up the NIghtscout MongoDB contents. Should the need arise, MongoDB can be restored from the downloaded JSON file. Note that NIghtscout Loader does not have a facility to restore data to MongoDB.

Once the file downloads, Explorer launches at the save location for convenience.

Download Sensor Data menu

The Download Sensor Data menu will download all CGM sensor data from Nightscout and save it as a JSON file. This is a very convenient way of backing up the NIghtscout MongoDB contents. Should the need arise, MongoDB can be restored from the downloaded JSON file. Note that NIghtscout Loader does not have a facility to restore data to MongoDB.

Once the file downloads, Explorer launches at the save location for convenience.

Nightscout Loader Action Menu

On the main Nightscout Loader Window, the Action menu contains the following options show below:

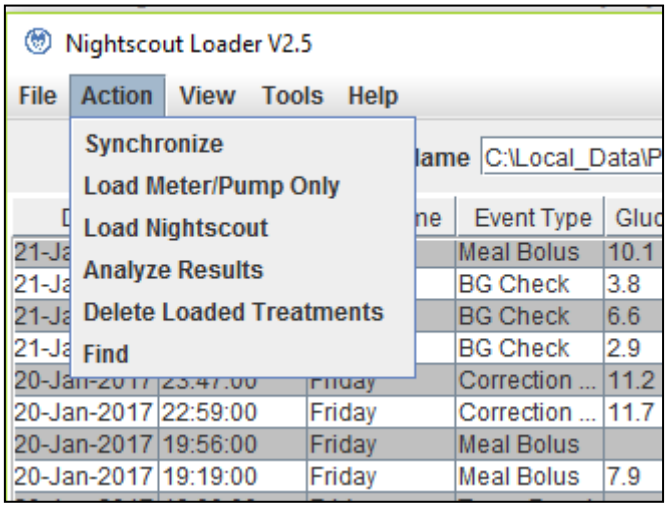


Figure 3 NightScout Loader – Action Menu Options

Synchronize Menu

The Synchronize menu will load additional meter/pump data and then merge into the existing Nightscout data set. This is explained in far more detail in the separate section called "Synchronizing Data" on page 22.

Load Meter/Pump Only Menu

When running in Stand Alone Mode, the Load Meter/Pump Only menu option will load data from the selected meter for display in the grid or for subsequent analysis. Stand alone mode will be enabled if the application does not have a connection to MongoDB. If the application is connected to MongoDB, selecting this option will flush the data set in memory and replace it with the contents of the selected meter.

Use "Synchronize" to load meter data **and** store it in Nightscout.

Load Nightscout Menu

The Load Nightscout Menu will retrieve all Care Portal results from Nightscout and then refresh the grid. If this is run straight after a Synchronization, then the green entries (that indicate newly entered results) will go light or dark grey based on ordering.

This only works with a successful MongoDB connection. If this is selected after Load Meter/Pump Only, then the application is refreshed with the full treatment data set in MongoDB.

Analyze Results Menu

The Analyze Results menu will launch the analysis. This is explained in far more detail in the separate section called "Analysis" on page 27.

Delete Loaded Treatments Menu

The Delete Loaded Treatments Menu will delete ALL entries stored by Nightscout Loader. This menu should be used with caution and is only enabled if the Advanced Options is set on the Options window.

Find Menu

The Find Menu will display the Find / Details window which is used as another way to navigate the treatment results grid.

The window that gets displayed is shown below and all the features are described here.

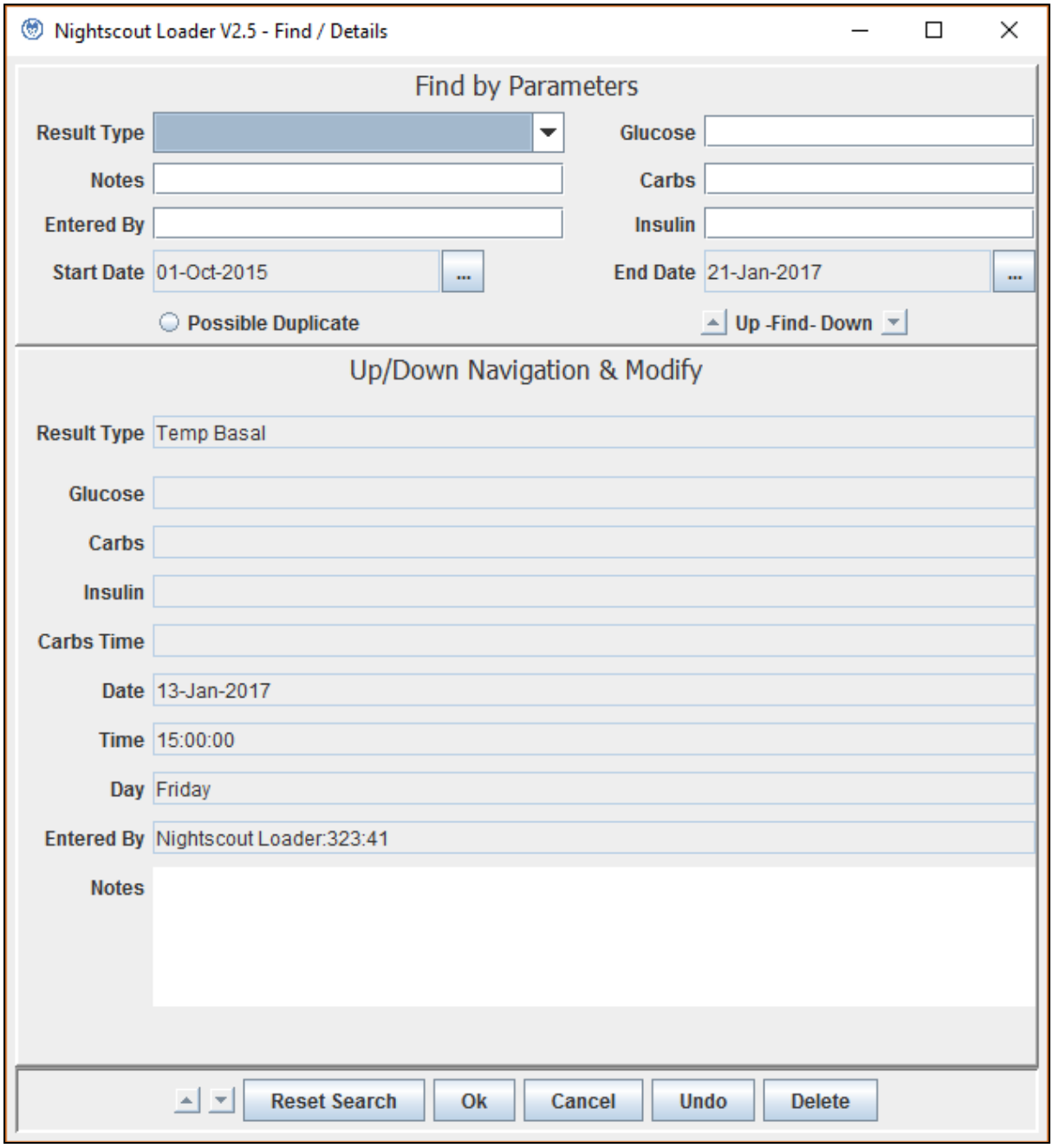


Figure 4 NightScout Loader – Find / Details window

Find by Parameters

The top panel includes various fields that can be used to search for data in the treatments grid either forwards or backwards in time. If just one field has values then just that is used in the search. Multiple fields mean "find the next result that has this value ***and*** this value ***and*** this value …".

Possible Duplicate will locate records that Nightscout Loader considers possible duplicates (in addition to any other selected parameter). The "Entered By" and "Notes" fields are not exact matches but will find records containing the text entered.

Start Date and End Date allow searching across a narrow date range. They are initialized to the dates of the earliest and latest treatments in Nightscout.

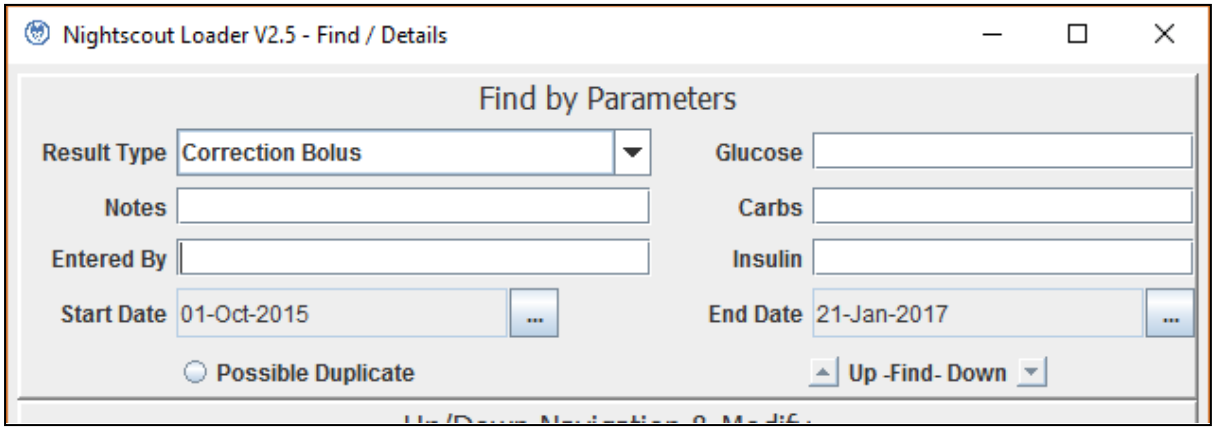


Figure 5 NightScout Loader – Find by Parameters Panel

The Reset Search button will reset all search parameters to empty values and reset the start and end dates to those of the earliest and latest treatments in Nightscout.

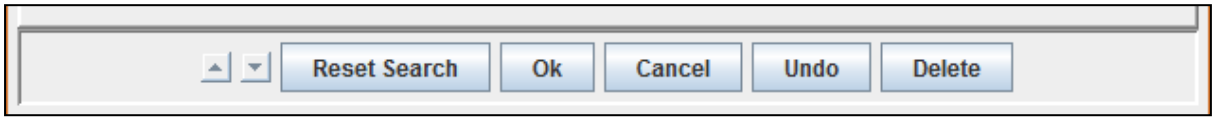


Figure 6 NightScout Loader – Find by Parameters Panel

To actually search for the record, hit the up or down arrow near bottom right of this panel.

The whole window will shake under various situations to highlight it's unable to complete the action:

1. A record can't be found. For example no records contain the entered notes text
2. No search parameters are entered.
3. The search has reached the top (or bottom) and no further results can be found in the search direction
4. The navigation has reached top (or bottom) and there is no next record in the direction being navigated. (Navigation is explained in the next section)

Once a record is located, the main grid will move to show that record within view and it will highlight it in yellow for easy identification.

Up/Down Navigation & Modify

The lower panel includes field names and values for the selected or the found record. All the fields are read-only except for Notes. Any existing text in Notes can be modified, deleted or entirely replaced from this screen.

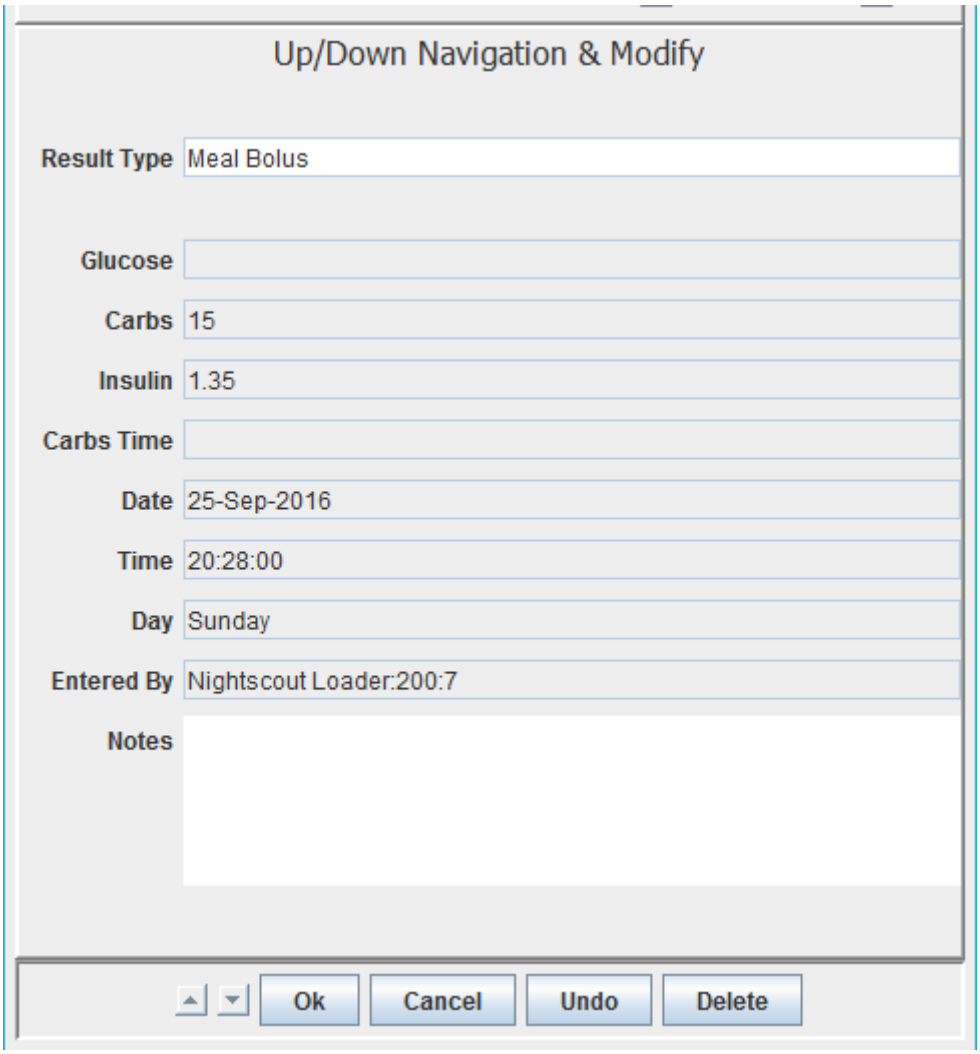


Figure 7 NightScout Loader – Up/Down Navigatin & Modify panel

The record is saved back with the "Ok" button.

In addition to the Find features, this window (through this panel) supports up / down navigation too. One can navigate up and down through the entire treatment result set using the up & down buttons to the left of Ok.

There is also a "Delete" button that will delete the selected treatment record ***whether it was loaded by Night scout Loader or not.***

Nightscout Loader View Menu

On the main Nightscout Loader Window, the View menu contains the following options show below:

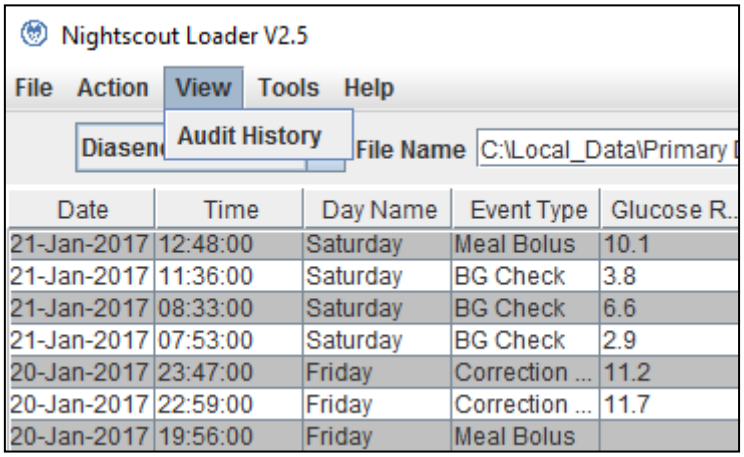


Figure 8 NightScout Loader – View Menu Options

Audit History Menu

The Audit History Menu displays the Audit History Window which shows a full trail of all Nightscout Loader Synchronizations against the configured MongoDB. This is explained in far more detail in the section called “Audit History” on page 39.

Nightscout Loader Tools Menu

On the main Nightscout Loader Window, the Tools menu contains the following options show below:

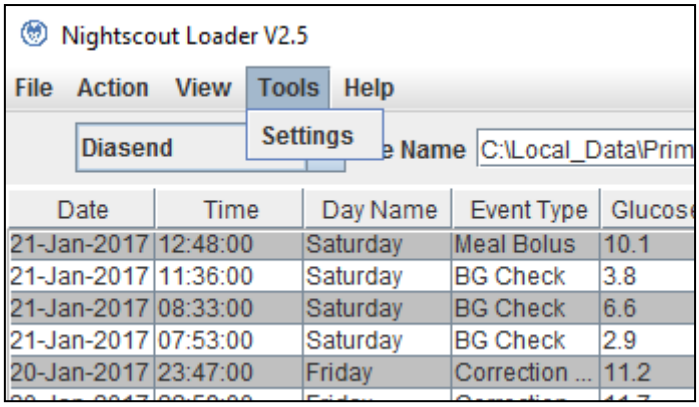


Figure 9 NightScout Loader – Tools Menu Options

Settings Menu

The Settings Menu displays the Options Window which allows configuration of the Nightscout Loader application. This is explained in far more detail in the section called “

Configuration” on page 19.

Nightscout Loader Help Menu

On the main Nightscout Loader Window, the Help menu contains the following options show below:

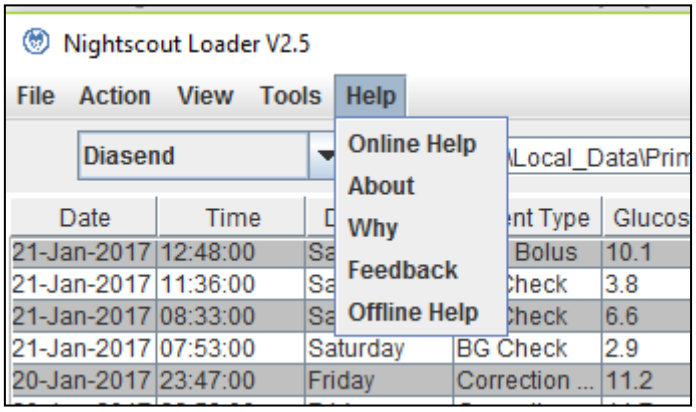


Figure 10 NightScout Loader – Help Menu Options

Online Help Menu

The Online Help Menu opens the default desktop browser this help document. This document is held on a Google Drive folder as a PDF.

About Menu

The About Menu will display a new window with details of the change log.

Why Menu

The Why Menu will display a new window with details of the reason behind this application.

Feedback Menu

The Feedback Menu will launch a new email addressed to the developer.

Offline Help Menu

The Online Help Menu will display a new window with this help document. This can be useful in cases where the application is used stand alone and there's no internet connection. It takes a few seconds to load as the application uses a custom library to read the PDF file before it can be displayed.

Major Features

Modify Data

Meter & Pump Treatment data in Nightscout groups BG, Carbs & insulin together. This application allows notes to be added or modified to any entry and saved back to MongoDB.

While not directly editable, a row on the main grid can be selected to modify data.

25-Sep-2...	19:00:00	Sunday	Temp Ba...					120	96			Nightsco...
25-Sep-2...	18:00:00	Sunday	Temp Ba...					60	107			Nightsco...
25-Sep-2...	17:08:00	Sunday	Meal Bolus	19.7	50	9.2	0					Nightsco...
25-Sep-2...	15:00:00	Sunday	Temp Ba...					180	128			Nightsco...
25-Sep-2...	14:00:00	Sunday	Temp Ba...					60	120			Nightsco...
25-Sep-2...	13:00:00	Sunday	Temp Ba...					60	104			Nightsco...
25-Sep-2...	12:38:00	Sunday	Meal Bolus	13.3	50	5.15	1					Nightsco...
25-Sep-2...	10:25:00	Sunday	Meal Bolus	9.1	40	4.9	1					Nightsco...
25-Sep-2...	08:33:00	Sunday	Correctio...	13.4		2.6						Nightsco...
24-Sep-2...	23:50:00	Saturday	Correctio...	9.2		1.1						Nightsco...
24-Sep-2...	22:30:00	Saturday	BG Check	7.7								Nightsco...
24-Sep-2...	20:34:00	Saturday	Meal Bolus	6.8	50	3.75	0					Nightsco...
24-Sep-2...	19:09:00	Saturday	Meal Bolus	9.3	30	3.9	1					Nightsco...
24-Sep-2...	19:00:00	Saturday	Temp Ba...					120	96			Nightsco...
24-Sep-2...	18:00:00	Saturday	Temp Ba...					60	107			Nightsco...
24-Sep-2...	15:22:00	Saturday	Meal Bolus		70	6.35						Nightsco...
24-Sep-2...	15:00:00	Saturday	Temp Ba...					180	128			Nightsco...
24-Sep-2...	14:33:00	Saturday	Meal Bolus	14.6	50	7.5	0					Nightsco...
24-Sep-2...	14:00:00	Saturday	Temp Ba...					60	120			Nightsco...
24-Sep-2...	13:00:00	Saturday	Temp Ba...					60	104			Nightsco...

Figure 11 NightScout Loader – Main Grid

Click a row on the main page grid and the detail window will appear as below:

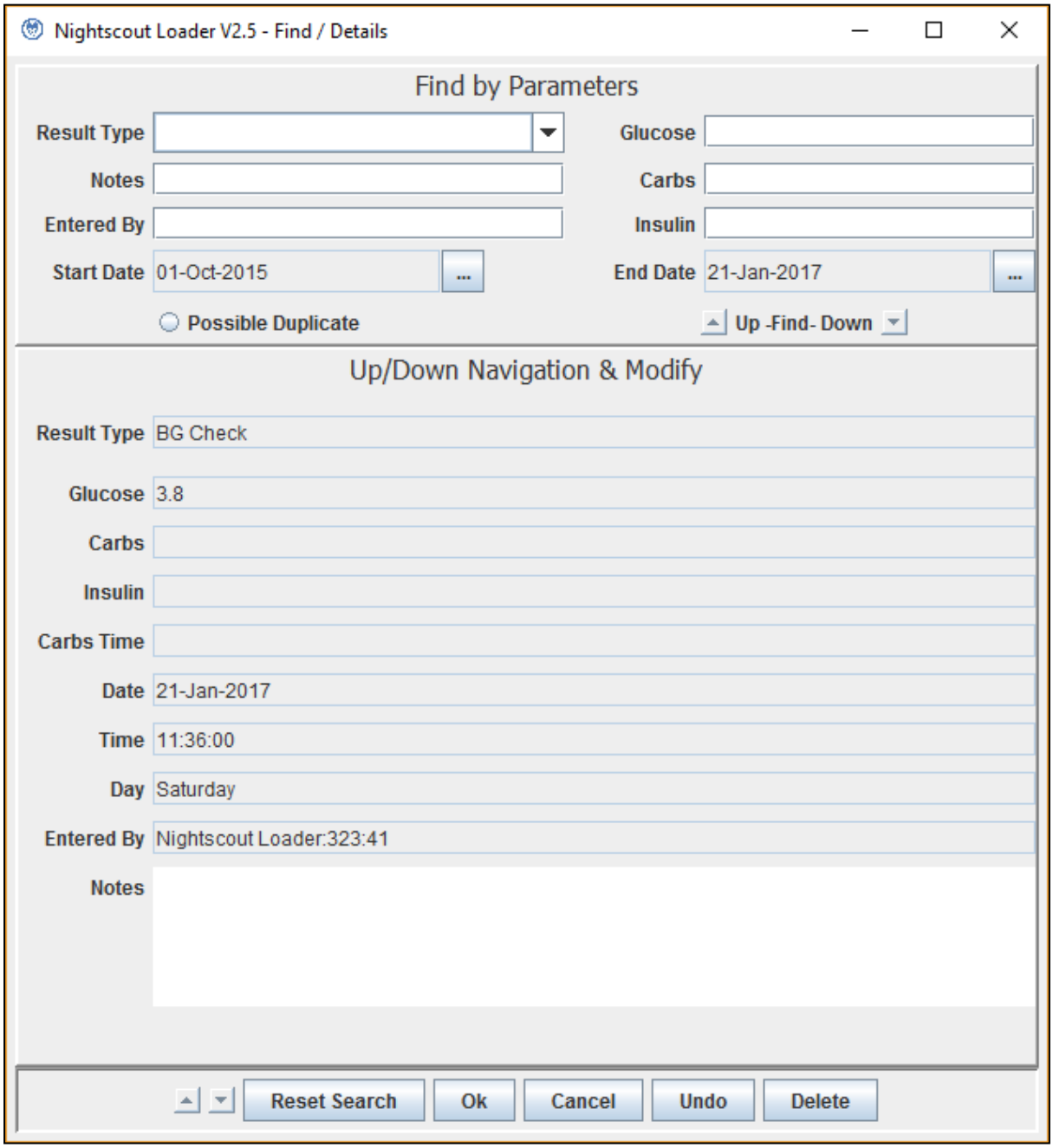


Figure 12 NightScout Loader – Find / Details Window

Enter text in the Notes panel and click OK to save it. The record on the main page will change colour to reflect the update that's just happened.

Note that although any entry can have notes modified, only entries added by Nightscout Loader are considered under its control and can be subsequently deleted. Manual Care Portal entries cannot be deleted by this application ***except when identified as duplicates.***

Configuration

The application holds key information in permanent stores that can be modified through a configuration screen as below:

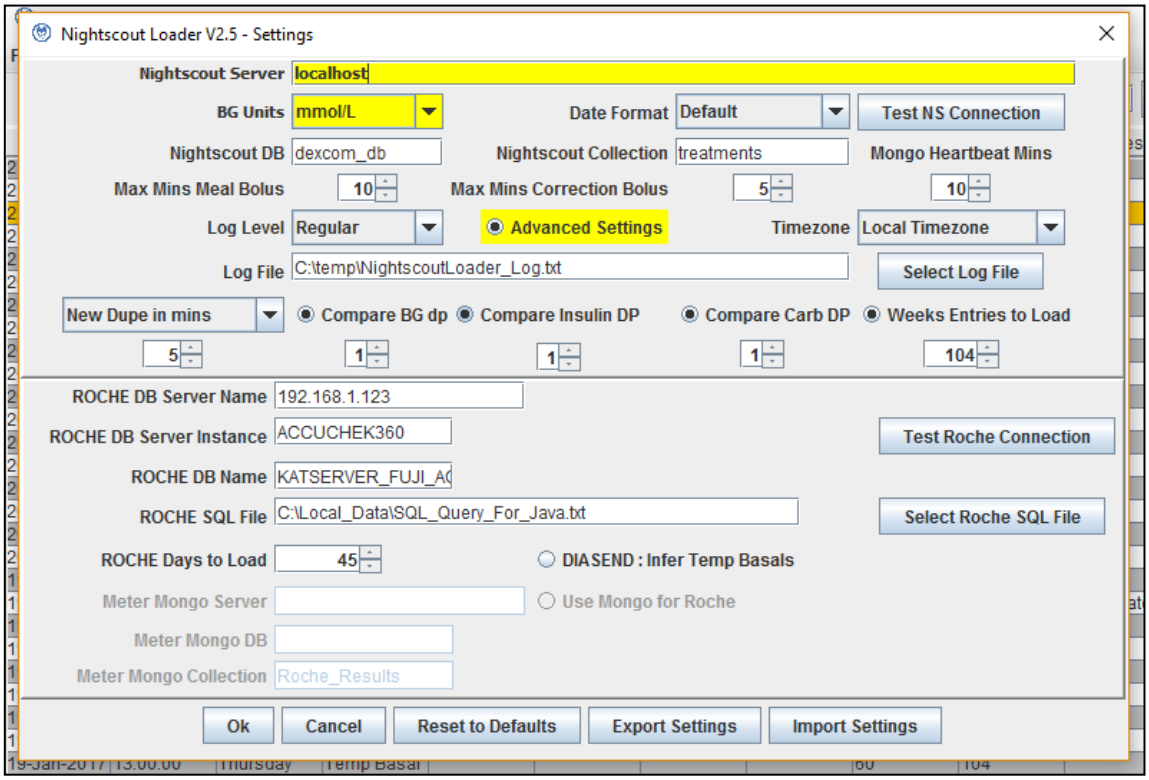


Figure 13 Nightscout Loader -- Options window (advanced view)

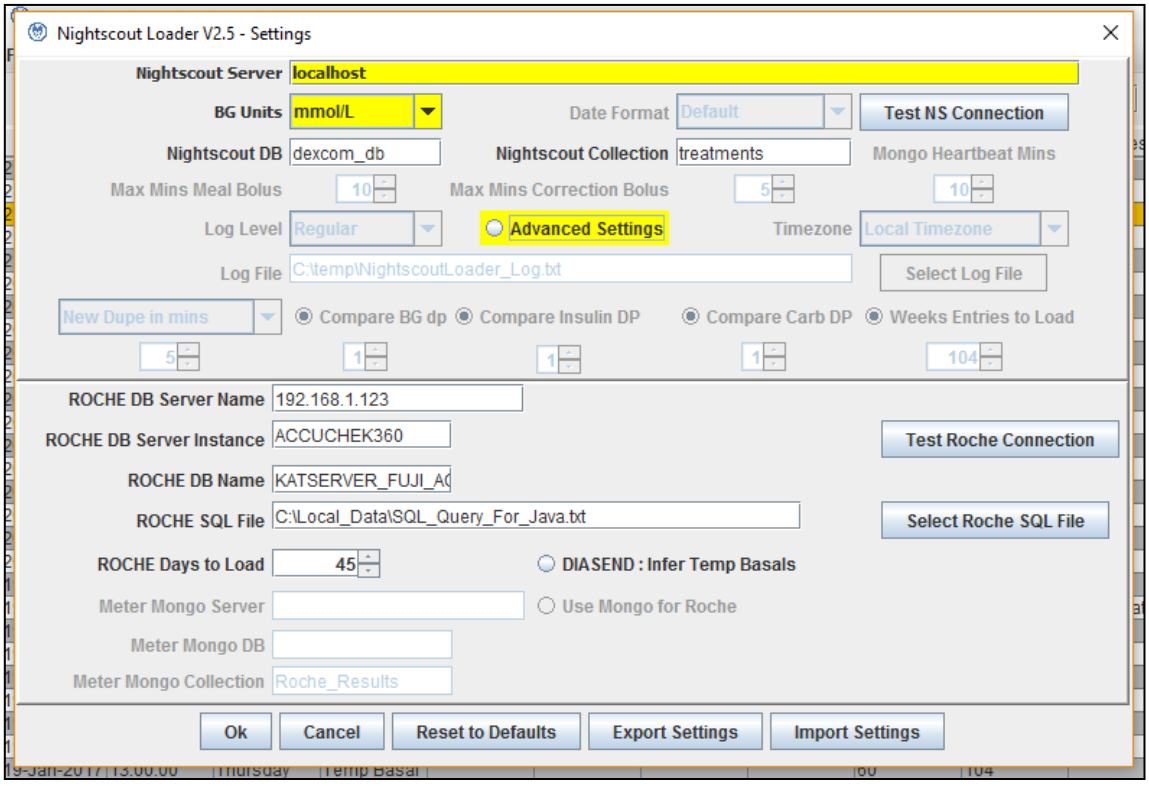


Figure 14 Nightscout Loader -- Options window (simple view)

Nightscout Settings

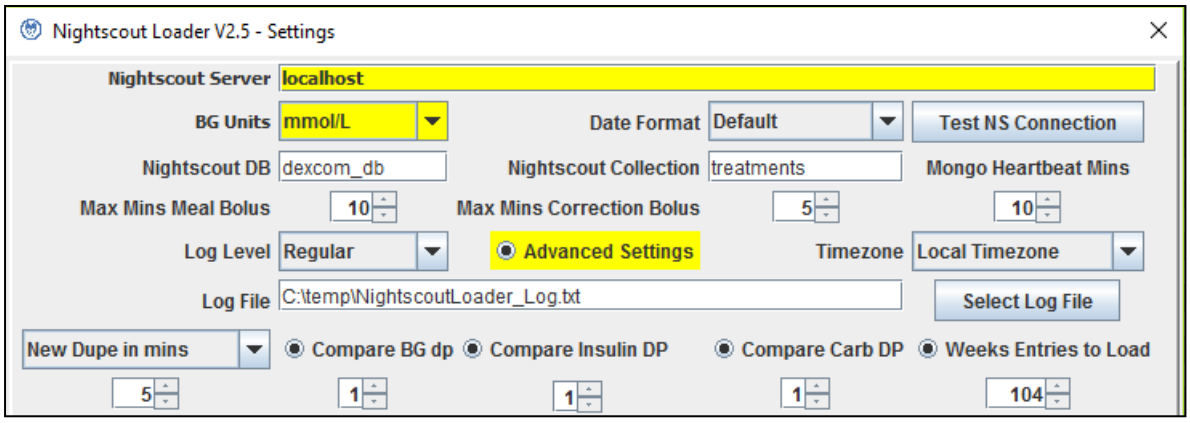


Figure 15 Nightscout Loader -- Options window (Nightscout Settings)

Ensure that the Nightscout Server name is defined from your Mongo DB set up as follows:

mongodb://(USER):(PASS)@ds(PORT).mongolab.com:(PORT)

The screenshot shows localhost since my development machine hosts a Mongo Database installation.

For example, if your user is my_mongo_user, password is my_mongo_pass, port is 123 and database is my_mongodb then the:

> **Nightscout Server** would be
> **mongodb://my_mongo_user:my_mongo_pass@ds123.mongolab.com:123**
>
> **Nightscout DB** would be **my_mongodb**

Nightscout Collection is always “treatments”

The Test NS Connection button will check connectivity to Nightscout to help ensure the right parameters are set.

The BG Units allows internationalization and will set up the comparison BG values (for example high, low) in either mmol/L or mg/dL.

The advanced view enables access to Timezone settings (useful if using a laptop connected to internet from in another country) to see times in home local timezone.

A Date format option is also available for use with Diasend since some users have reported alternate date formats in Excel exports. (For example MM/DD/YY hh:mm should be selected for US)

The max mins meal bolus and max mins correction bolus configure the combining algorithm. (See Combining Data on page 24 for more details).

Mongo Heartbeat Check is how many minutes between checks for updates on the Mongo DB Nightscout environment. While the application is running, if an uploader is sending CGM data, then the application will confirm this with a notification in the notification window.

Duplicate detection works in one of two ways. It will either consider new loadded entries to be duplicate (and therefore potential discards) or existing entries to be duplicate to be replaced by the new load. The first option selects which way duplicates are considered and the third option will turn duplicate detection off entirely.

Duplicate detection has a number of configurable parameters:

1. If enabled, the number under duplicate detection type (New or Existing) determines how many minutes away in time a manually created Care Portal entry can be away from a meter reading to be considered duplicate. For example, 30 minutes will match a meter reading made exactly at 12:03pm with a Care Portal entry made some time later at say 12:16 (based on type check and value check – see below)
2. Compare BG dp, Compare Carb dp & Compare Insulin dp
   These parameters determine whether BG, Carb and or Insulin values are compared for duplicate detection and the numbers below determine to how many decimal places. For example, if the majority of Care Portal entries made is BG amounts then enable Compare BG and disable the other options.

   Ultimately, regular use of Nightscout Loader should reduce/eliminate the need to enter details captured by meter/pump.

The Week Entries to Load selection parameter determines how many weeks CGM data is loaded into memory. An analysis can be performed on a subset date range but only on data loaded this far back in time.

Roche & Diasend Settings

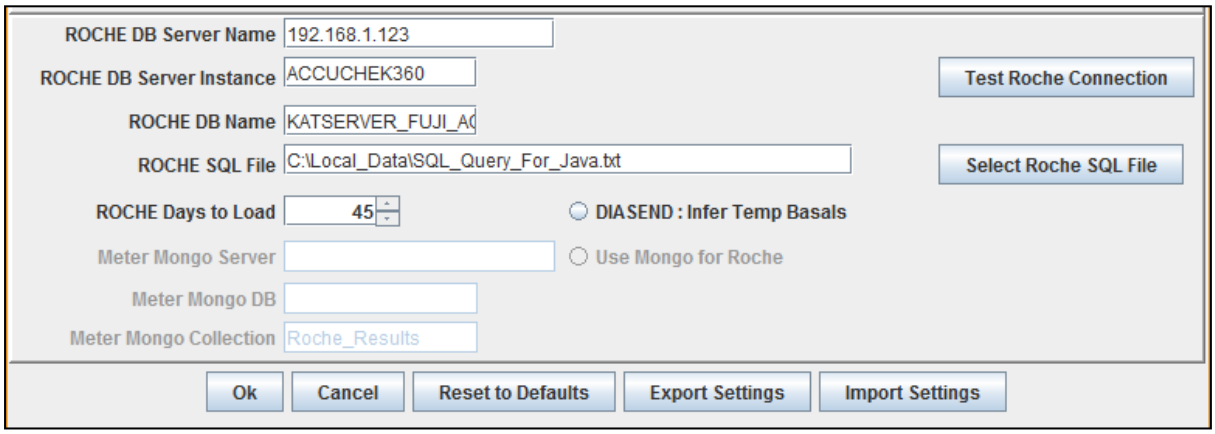


Figure 16 Nightscout Loader – Roche & Diasend Settings

If you have a Roche Combo meter and pump, then the data is held in a SQL Server database when uploaded to the computer.

If you can identify the **server**, the **instance** and the **database name** then meter & pump information can be extracted by the application. The application uses a complex query that's held in a file and the filename is the referenced as the **SQL File** parameter. If data is uploaded more frequently than every 45 days, then Days to Load can be left as it is. This simply defaults the date range when the application launches and the data range to load can be changed from the calendar selector easily.

The remaining 'Meter xxx' parameters & Use Mongo for Roche are for development testing only are disabled for general use.

The only Diasend option controls interpretation of Temporary Basals. Unfortunately, the Diasend output does not hold any temp basal information. Instead, it shows each time a basal rate changes – whether temporary or the set basal. The "Infer Temp Basals" setting will allow the tool to try and work out whether the basal rate change is temporary or not by comparing with the current "active" basal rate.

The way this works is as follows:

1. Iterate over all the basal rates loaded from the Diasend export
2. If the basal rate change happens on the hour (eg 1pm, 2pm etc), then assume it's a change that's part of the basal rate in use
3. If the basal rate change happens at another time off the hour (eg 1:13pm etc), then assume this is either the start or the end of a basal rate
4. We deduce the temporary amount by comparing the basal rate off the hour with the preceding one seen on the hour.

To refine the approach certain cases are ignored. For example, if a basal rate change sets the amount back to 0% then the tool will not assume that's the start of a basal rate.

This algorithm seems reasonably accurate with the sample set used to test it.

Synchronizing Data

The process of loading new data onto Nightscout is Synchronization (under "Action").

Data can be synchronized from Roche, Medtronic or Diasend data sources. See figures below to see how the window changes depending on the drop down selected:

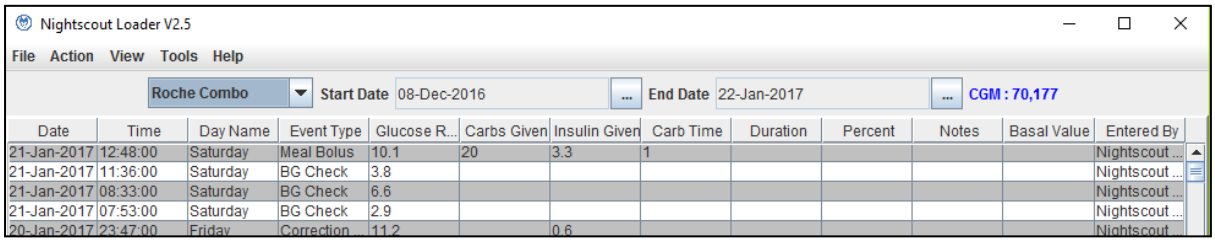


Figure 17 NightScout Loader - Roche Combo data load

For Roche, select the start and end dates from which results should be synchronized. If data has already been synchronized for the date range selected, the application will detect these duplicates and quietly ignore them. The tool has a default 'days to load' of 45 days and so will work out the start date based on this parameter. It can always be overridden in the date selector though.

Please note that straight after installation, the Settings will need updating to configure Nightscout Loader to know how to connect to the Roche SQL Server database.

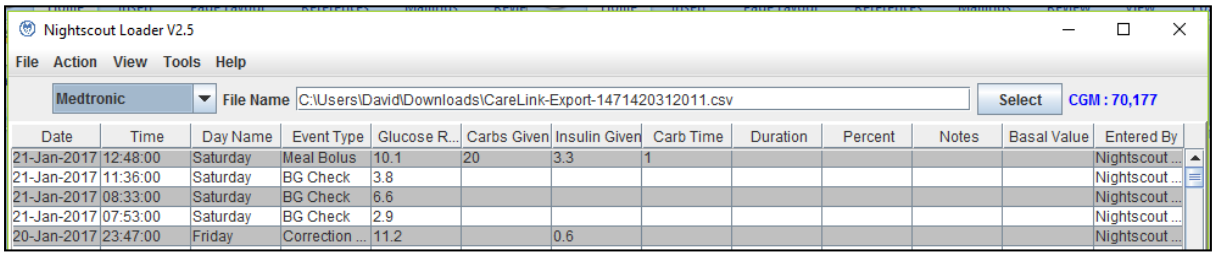


Figure 18 NightScout Loader - Medtronic Data Load

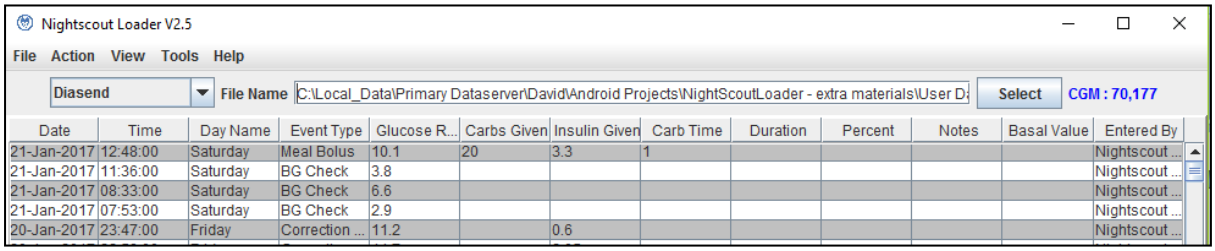


Figure 19 NightScout Loader - Diasend Data Load

For Medtronic and Diasend, data must first be extracted into Excel files from the Medtronic or Diasend systems. Once in these formats, navigate to the folder and select the file in the file selection panel at the top of the window before selecting Synchronize.

No configuration is necessary for either Medtronic or Diasend since data is in the form of an extract from other systems. Just the path to the file must be provided in the File Name panel.

Note that improved support for OmniPod is underway. Code is being written to read the binary file that OmniPod exposes during each data upload.

The data in Nightscout is shown in a grid and new data just loaded is coloured green so it can readily be seen. If the application is shutdown and relaunched, then the usual two tone colouring applies to these most recent results too.

When the application is re-launched, it remembers a lot of things from before including whether you loaded from Roche, Medtronic or Diasend and it assumes you will want to Synchronize from the same data source again. (For Medtronic and Diasend, remember to select a new export file to synchronize additional data and not just use the same file as before).

So that the tool can tell what it loaded into MongoDB, it uses a known value for the "Entered By" field on the treatments document. The string is made up of 3 parts as follows:

NightScoutLoader:<nn>:<ss>

Where "nn" is an incremental number and "ss" is the seconds part of the current time to ensure uniqueness should two instances be running at approximately the same time. (It's highly unlikely two instances would be running at same time and also saving at precisely the same moment in time)

Combining Data

Data from Diasend, Roche and Medtronic is typically one result. That could be a BG reading, a carb amount or insulin dose. Nightscout Loader combines these values.

Therefore the application internally groups results together. It's possible for example to do a BG at (say) 12:45pm, add Carbs & Insulin at say 13:05 pm. The application would consider this all the same result and create a meal bolus entry at 12:45. It will group results like this that are up to 30 minutes apart (configurable Options ➔ Max Mins Meal Bolus)

Also, the tool will group correction bolus together where the BG and the Insulin are up to 5 minutes apart.

A recent addition is duplicate detection. This is built into various areas:

1. the main application window (duplicates are permanently highlighted in orange until confirmed as not duplicate in the details data window)
2. the details data window
3. the Analyzer where duplicate counts appear on the day summary tab
4. the Audit Log where as well as a record of how many results were uploaded each time, the application keeps track of how many were considered duplicate.

See section "Duplicate Detection" for more details on duplicate detection.

Duplicate Detection

The application will try and detect readings coming in that have been manually stored. Essentially, it checks the type of reading and the time. The time is rounded up or down to the nearest point based on Duplicate Minutes in the configuration. For example, if this setting is 15 minutes, then the time is rounded up or down to on the hour, quarter past, half past and quarter to. This modified time is compared against similarly modified times already stored and if a match is found (correction, meal event etc based on options) then the new result is considered a duplicate.

Since two adjacent entries might span either side that splits this time (and hence be rounded up and round down, not matching), a second scan is made this time offsetting all times to ensure such adjacent entries are also caught.

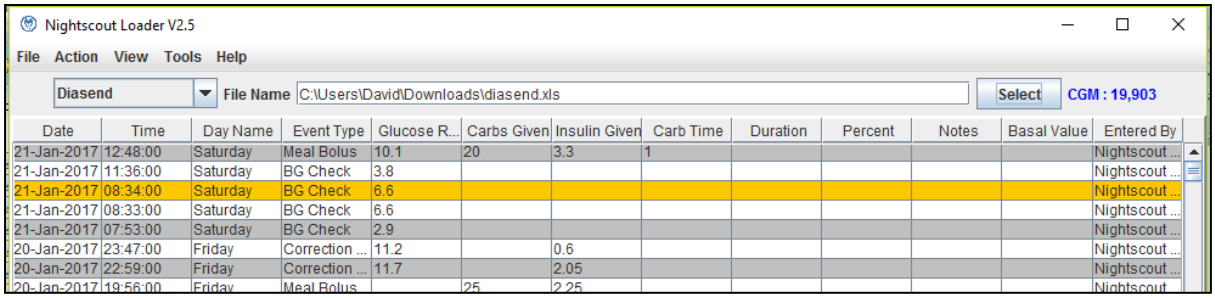


Figure 20 Nightscout Loader – Main view showing a duplicate record

There are two options for duplicate entries identified in this way. You may either agree with the tool and remove the duplicates or override the tool and confirm that they are not duplicate.

To accept the duplicate and remove the entry, go to the Audit History window (under View menu), select the top most record (if the duplicate came in with the last synchronization) and then choose Reverse Proximity Entries. This will remove the duplicates associated with this synchronization and leave all other results.

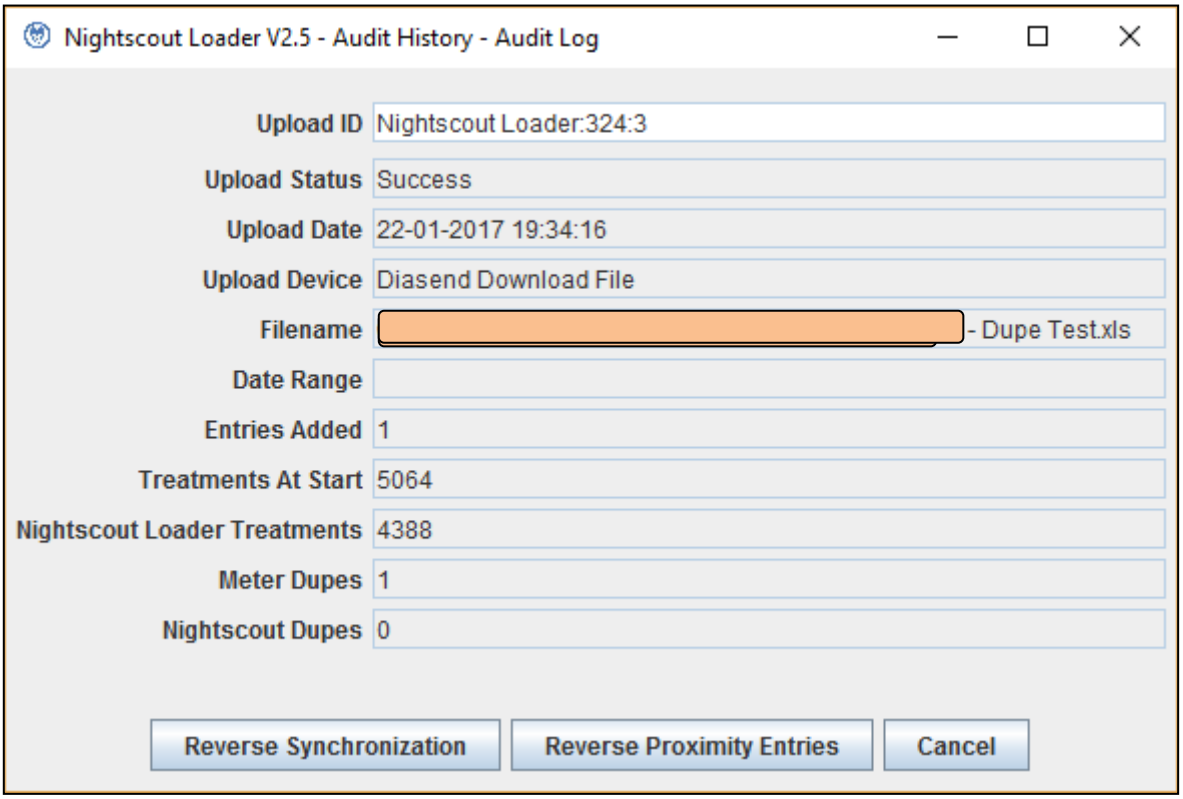


Figure 21 NightScout Loader - Details Window for Duplicate Entry

Conversely, to confirm that the entry is not a duplicate, clicking the duplicate entry in the main view will show the Details window

Figure 22 NightScout Loader - Details Window for Duplicate Entry below shows the same Details window for another record loaded from Diasend and made to appear as though it's a duplicate.

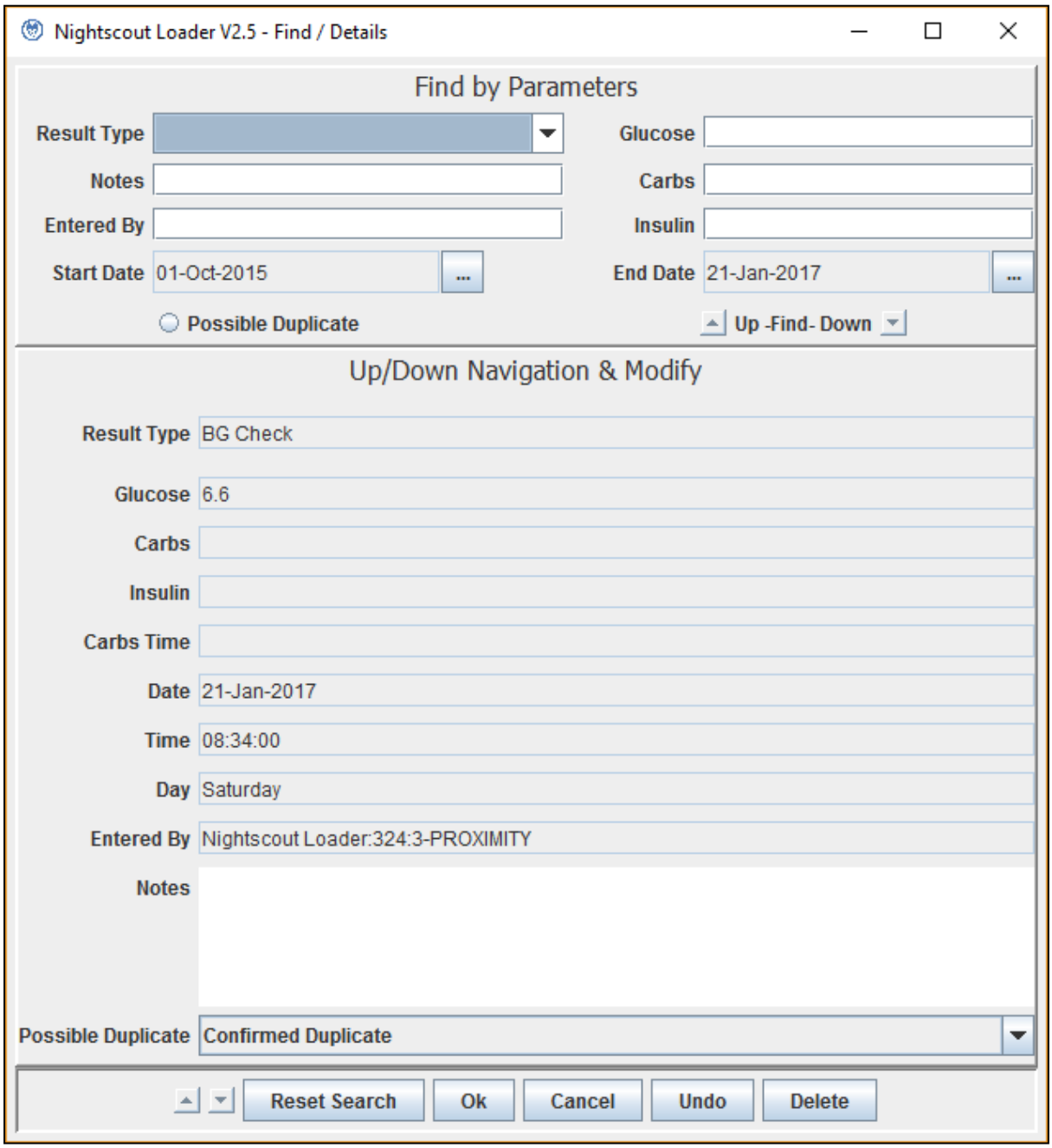


Figure 22 NightScout Loader - Details Window for Duplicate Entry

Records the application considers duplicate can be confirmed as not duplicate by selecting the drop down and clicking Ok

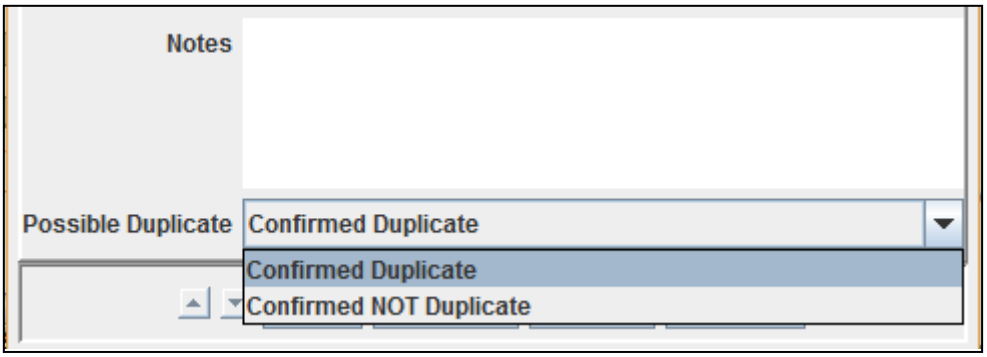


Figure 23 NightScout Loader - Details Window Confirmation entry is not duplicate

Analysis

The tool has been designed to perform trend analysis on available data between selected dates. This allows focus on a particular range of dates rather than always analysing all data.

The underlying principle is categorization, grouping and then counting to identify significant trends. Analysis can be performed on Nightscout Care Portal treatment data (BG factoring in aspects of Carbs and Insulin) and from version 2.5, analysis now also includes analyzing CGM data.

When an analysis is run, the tool will perform analysis on the selected date range and incorporate Care Portal analysis as well as CGM analysis if data is present. (If only Care Portal data exists in Nightscout then CGM analysis results are omitted. Conversely, if only CGM data exists then Care Portal analysis results are omitted.)

Care Portal Data Analysis

During the analysis of Care Portal treatment data, it creates “chains” of all BG readings within a selected date range (default 2 weeks if Advanced Options are not set and not changed) and then sets attributes for each of these trends such as starting time slot, if there’s associated meal and whether the first BG is lower, higher or flat compared to the second.

Trends are then grouped by time, type and direction to provide insight into repeating patterns of BG change that can be corrected.

The analysis automatically runs on the most recent fortnight data in the background at start up and also after synchronization from additional meter/pump data.

This background analysis gets summarised in the lower panel as below:

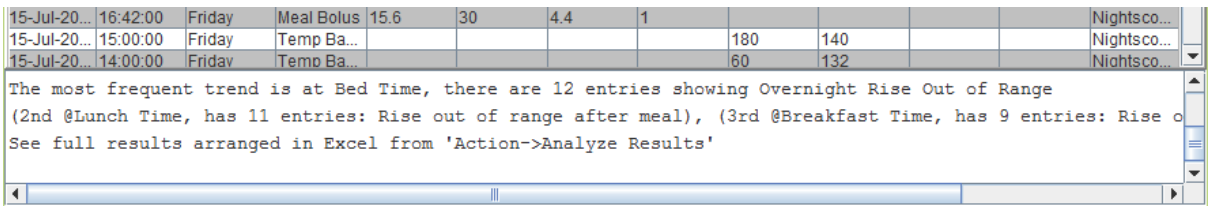


Figure 24 Nightscout Loader Background Analysis panel output

When run from the menu, the analysis is very detailed and the results are provided in Excel across a series of worksheets (tabs).

The Analysis can be invoked from the Action➔Analyze Results menu.

If the Advanced Options radio button is disabled, the analysis will run without displaying the control panel first.

If Advanced Options are enabled, then all the analysis controls are displayed before analysis runs. The worksheets for Recurring Trends, Trends, Skipped Meal Trends, Day Summaries, Single Results and Treatment Data Analyzed will each include extra 'ID' columns that help show how the data is linked. This is useful to confirm that the trend detection algorithm is working correctly but can be ignored in most cases.

Care Portal Data Analysis Approach

Data moves through four stages to provide a recommendations platform moving analysis from data to real insights.

1. Raw meter and pump data is read from the data source into the tool.
2. This is then grouped to form Care Portal entries ready for insertion into Nightscout.
3. Whereas most tools stop at the raw data and try to show statistical meaning from single values (percentage readings high or hypo), there's far more value in seeing the trends from pre and post meal results. This next stage then groups pairs of readings that form either side of a meal or either side of a night.
4. The trends are categorised such as a rise or fall, and then the number of such categories are counted for the same time of day. This is the recurring trend from which we get trend frequency and insight into recurring patterns that can be addressed for even better control.

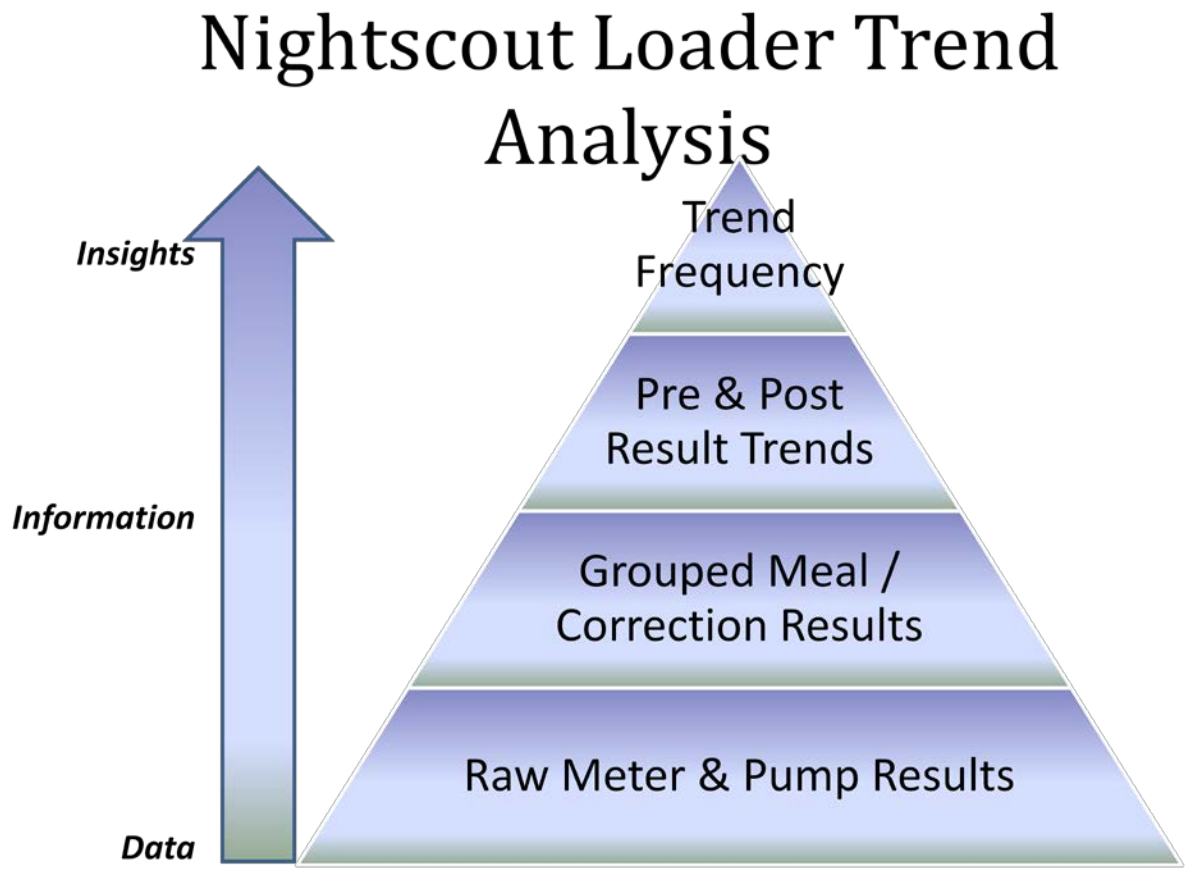


Figure 25 Nightscout Loader Care Portal Analysis Approach

The results from analysis are quite complex and for convenience are generated in the form of an Excel file that can be stored and archived as a snapshot of trends on a regular basis.

The data in Excel is tabular and arranged in worksheets. There's a control that determines the level of output generated – Full Details, Moderate Details and Minimal Details. More worksheets are included based on this selection.

CGM Data Analysis

Although Care Portal Data analysis runs in the background at start up as well as on demand from the menu, CGM analysis only runs from the Analyze Results menu.

CGM data is typically a BG result every five or so minutes. The tool creates one (two, or three) hourly intervals and then considers how CGM values have changed across that period. This interval is stamped based on its findings and then grouped with other days where a similar profile was observed.

Finally, the tool uses a heatmap format to show the hourly intervals horizontally and the hourly profile changes vertically. More intense colours show a higher concentration of the same event at the same time. This analysis provides yet another tool to assist in improved outcomes as it can highlight areas where attention is needed.

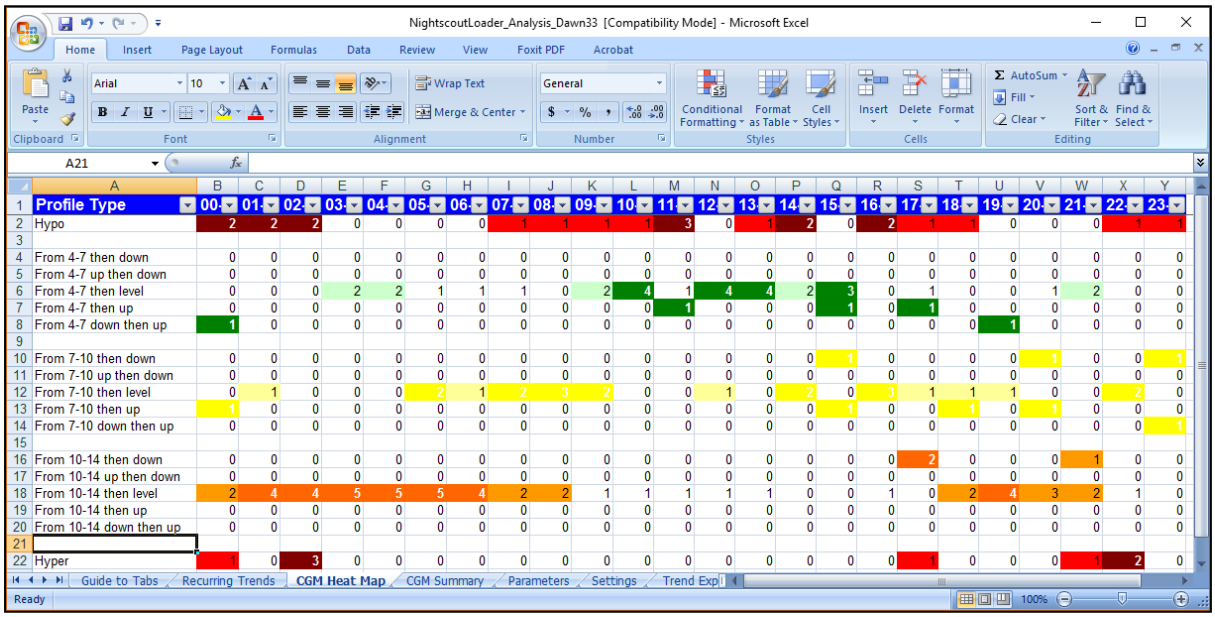


Figure 26 Nightscout Loader CGM Analysis Heatmap results

Analysis Window

In advanced mode, the analysis control panel is shown below:

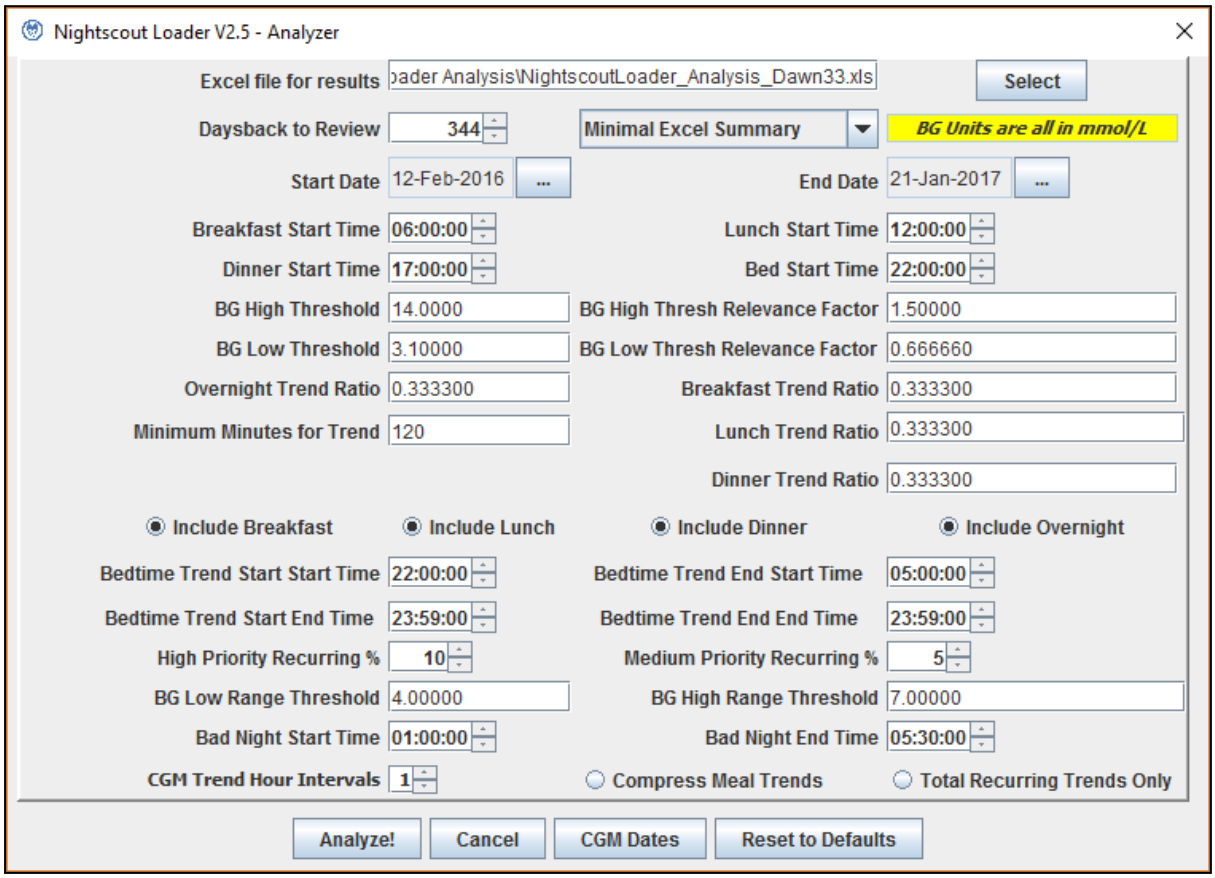


Figure 27 Nightscout Loader Analysis Window

The Analysis options are part of the underlying Configuration mechanism and have factory defaults that can be re-initialised with the “Reset to Defaults” button.

The fields that control how analysis works are summarized below.

Excel File for Results	Where results are stored		
Daysback to Review	Convenient control - how many days back from most recent result to analyze		
Minimal Excel Summary	Three options are offered here with more tabs showing the data the tool creates in memory as it works out trends		
BG Units are in ...	A highlighted indication of whether the tool is working in mmol/L or mg/dL		
Start Date	Start date of analysis – defaults daysback from end	**End Date**	End date of analysis – defaults at most recent result
Breakfast Start Time	Denotes start of breakfast results	**Lunch Start Time**	Denotes start of lunch results
Dinner Start Time	Denotes start of dinner results	**Bed Start Time**	Denotes start of bed results
Daysback to review	Analysis runs from most recent result back this number of days	**BG High Thresh Relevance Factor**	Used to set severity of high BG values from 1 to 10

BG High Threshold	Higher than this is HYPER	**BG Low Thresh Relevance Factor**	Used to set severity of low BG values from 1 to 10
BG Low Threshold	Lower than this is HYPO	**Breakfast Trend Ratio**	If difference of start & end BG / start BG >= this ratio, then severity = 10
Overnight Trend Ratio	If difference of start & end BG / start BG >= this ratio, then severity = 10	**Lunch Trend Ratio**	If difference of start & end BG / start BG >= this ratio, then severity = 10
Minimum Minutes for Trend	BG must be at least this many minutes apart	**Dinner Trend Ratio**	If difference of start & end BG / start BG >= this ratio, then severity = 10
Bed Trend Start Start Time	Overnight trends are between two time ranges. This marks start of start	**Bed Trend End Start Time**	Overnight trends are between two time ranges. This marks start of end
Bed Trend Start End Time	Overnight trends are between two time ranges. This marks end of start	**Bed Trend End End Time**	Overnight trends are between two time ranges. This marks end of end
High Priority Recurring %	Recurring trends / Total trends (recurring or overall based on last parameter) >= this ratio are coloured red	**Medium Priority Recurring %**	Recurring trends / Total trends (recurring or overall based on last parameter) >= this ratio are coloured orange If also < high %
BG Low Range Threshold	Lower than this is HYPO	**BG High Range Threshold**	Higher than this is HYPER
Bad Night Start Time	Bad nights involve intervention between this time and end time	**Bad Night End Time**	Bad nights involve intervention between start time and this time
CGM Trend Hour Intervals	Sets either one, two or three hourly intervals for the In Range CGM Trends heat map view		
Compress Meal Trends	Compresses rises or falls that may start in range or out of range.		
Total Recurring Trends Only	If set, then the percentages in the recurring tab will sum up to 100% since this tab omits any trends that occur once. If not set, then the percentages will not sum to 100% (since some single trends are not shown)		

Table 1 Analysis Option explanations

CGM Dates

The CGM Dates button on the main Analyzer window will display a popup with the range of CGM dates found in Nightscout. This list is inferred by traversing all the CGM entries data and where there is a date gap, then the assumption is that the current sensor has stopped and another has begun.

From this screen, double clicking a row or selecting one then OK will send the date details back to the main Analyzer window from where analysis can then be run. So this in effect provides a very convenient way of selecting analysis over date rages where a sensor was worn.

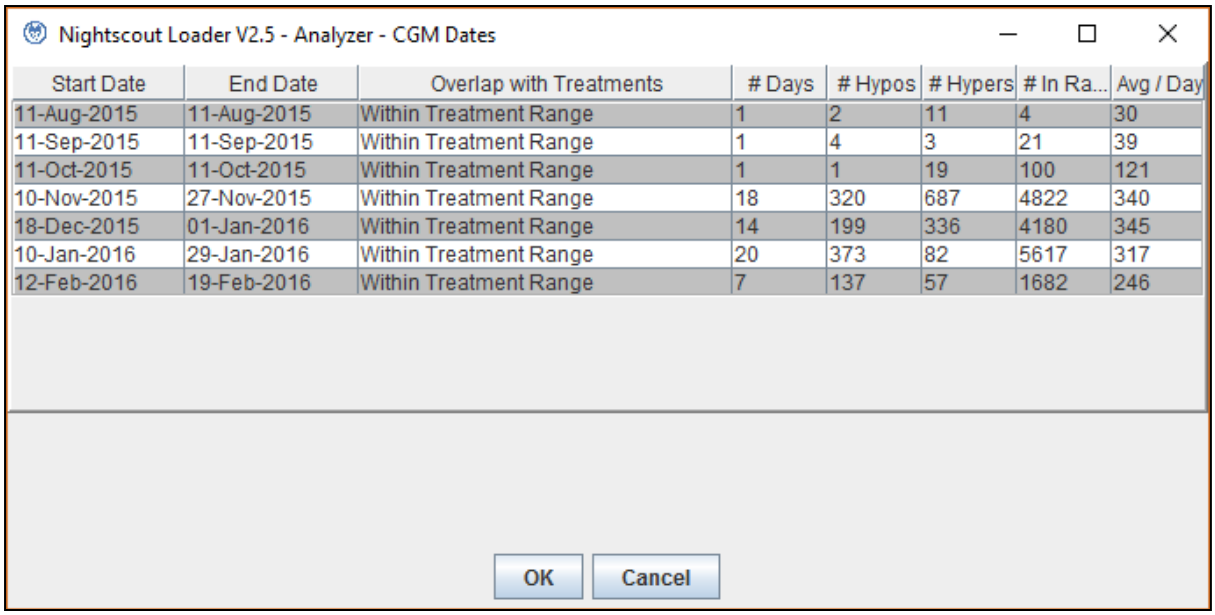


Figure 28 Nightscout Loader Analyzer CGM Dates Window

Care Portal Analysis Severity

The severity of a particular single reading ranges from 1 to 10. If the result is high, then a reading of (for example) 7.1 mmol/L would have lowest severity. A value of 10 is set as 14 mmol/L x BG High Thresh Relevance Factor or higher. If the threshold is 1, then severity ranges uniformly from 1 to 10 as the BG ranges from 7.1 through to 14. Results above 14 are treated as still 10. In this way, the severity can be 'tuned' according to what you consider a really bad reading is.

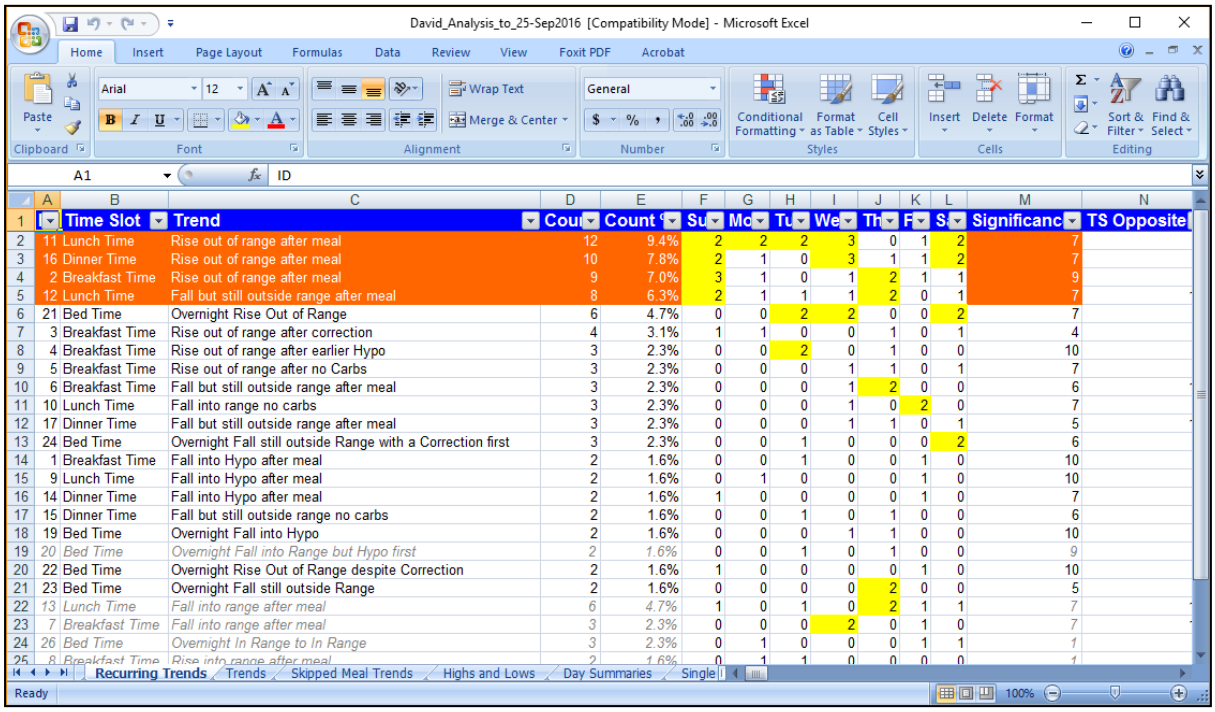
Conversely, the opposite happens for low readings. In this case, a reading of 3.8 mmol/L is too low but severity 1. The low value (3.8) is multiplied by BG Low Thresh Relevance Factor to determine what the floor value for severity 10 is. So readings below at or below this value are treated severity 10. Values between this and 3.8 uniformly range from 10 down to 1. Once again, the severity can be 'tuned' according to what you consider a really bad reading is.

Similarly, the severity of a trend also ranges from 1 to 10 and is based on the following formula:

(A – B) / A

Where A is the first BG reading and B is the second BG reading. The fractional change is compared against the ratio for the particular meal with values at the ratio and higher being 10 severity.

The severity of a recurring trend is simply the average of each trend severity grouped as a recurring collection.



David_Analysis_to_25-Sep2016 [Compatibility Mode] - Microsoft Excel

	Time Slot	Trend	Cou	Count %	Su	Mo	Tu	We	Th	Fr	Sa	Significanc	TS Opposite
2	11 Lunch Time	Rise out of range after meal	12	9.4%	2	2	2	3	0	1	2	7	
3	16 Dinner Time	Rise out of range after meal	10	7.8%	2	1	0	3	1	1	2	7	
4	2 Breakfast Time	Rise out of range after meal	9	7.0%	3	1	0	1	2	1	1	9	
5	12 Lunch Time	Fall but still outside range after meal	8	6.3%	2	1	1	1	2	0	1	7	
6	21 Bed Time	Overnight Rise Out of Range	6	4.7%	0	0	2	2	0	0	2	7	
7	3 Breakfast Time	Rise out of range after correction	4	3.1%	1	1	0	0	1	0	1	4	
8	4 Breakfast Time	Rise out of range after earlier Hypo	3	2.3%	0	0	2	0	1	0	0	10	
9	5 Breakfast Time	Rise out of range after no Carbs	3	2.3%	0	0	0	1	1	0	1	7	
10	6 Breakfast Time	Fall but still outside range after meal	3	2.3%	0	0	0	1	2	0	0	6	
11	10 Lunch Time	Fall into range no carbs	3	2.3%	0	0	0	1	0	2	0	7	
12	17 Dinner Time	Fall but still outside range after meal	3	2.3%	0	0	0	1	1	0	1	5	
13	24 Bed Time	Overnight Fall still outside Range with a Correction first	3	2.3%	0	0	1	0	0	0	2	6	
14	1 Breakfast Time	Fall into Hypo after meal	2	1.6%	0	0	1	0	0	1	0	10	
15	9 Lunch Time	Fall into Hypo after meal	2	1.6%	0	1	0	0	0	1	0	10	
16	14 Dinner Time	Fall into Hypo after meal	2	1.6%	1	0	0	0	0	1	0	7	
17	15 Dinner Time	Fall but still outside range no carbs	2	1.6%	0	0	1	0	1	0	0	6	
18	19 Bed Time	Overnight Fall into Hypo	2	1.6%	0	0	0	1	1	0	0	10	
19	20 Bed Time	Overnight Fall into Range but Hypo first	2	1.6%	0	0	1	0	1	0	0	9	
20	22 Bed Time	Overnight Rise Out of Range despite Correction	2	1.6%	1	0	0	0	0	1	0	10	
21	23 Bed Time	Overnight Fall still outside Range	2	1.6%	0	0	0	0	2	0	0	5	
22	13 Lunch Time	Fall into range after meal	6	4.7%	1	0	1	0	2	1	1	7	
23	7 Breakfast Time	Fall into range after meal	3	2.3%	0	0	0	2	0	1	0	7	
24	26 Bed Time	Overnight In Range to In Range	3	2.3%	0	1	0	0	0	1	1	1	
25	8 Breakfast Time	Rise into range after meal	2	1.6%	0	1	1	0	0	0	0	1	

Recurring Trends | Trends | Skipped Meal Trends | Highs and Lows | Day Summaries | Single

Ready

Figure 29 Example Care Portal Analysis Excel Output

Excel Analysis Output

The Analysis results are stored in an Excel file with separate tabs as explained in the following sections. The convenience in using Excel is that Analysis results can be archived and later viewed and that the results can be annotated with actual corrective actions that are taken.

Guide to Tabs

The Guide to Tabs tab provides a summary of all the tabs listed, a brief explanation of each and some observations on row counts of analytical output. For those unfamiliar with the Excel Analysis Output, it's a good first port of call.

Recurring Trends

The recurring trends tab is the most intelligent output from the analyzer. It essentially groups trends together based on type and then sorts in descending frequency order. If a trend is seen more frequently than **High Priority Recurring %** as a percentage of all trends (either all recurring trends or all trends overall), then it's coloured red (The example above shows amber trends since frequency exceeds 5% default but is less than 10%). The tab also shows the trends by day and colours any days where more than one is visible giving more insight. Finally, recommendations are offered for further investigation that may lead to changes in doses etc.

For a balanced view, the Recurring Trends tab also includes TS Opposite, TS Rises and TS Falls. These are counts of how many times during the analysis period an opposite trend was also seen for the same timeslot (eg rise after breakfast rather than fall), and also how many overall rises and falls were seen in the analyzer range for the same timeslot.

CGM Heat Map

The Heat Map shows day counts (in the main grid), colour coded based on frequency against time and type of profile.

The events list down the right side and start with Hypo, in range (4-7 mmol/L), outside range, further outside range and finally hyper.

To generate this view, the tool takes each CGM result and segments it by time. It then looks at the starting value to determine which profile it begins in (for example 4-7 mmol/L). It then looks at successive values to see whether the graph goes down, up, flat or a mixture of up and down to refine the profile type. If any result is hypo or hyper then the entire time block switches to that profile type. So for example, if a range of results start at 5.6 mmol/L and then go down to 3.3 then climb to 7, the entire hour block is considered hypo and not any of the From 4-7 profile types.

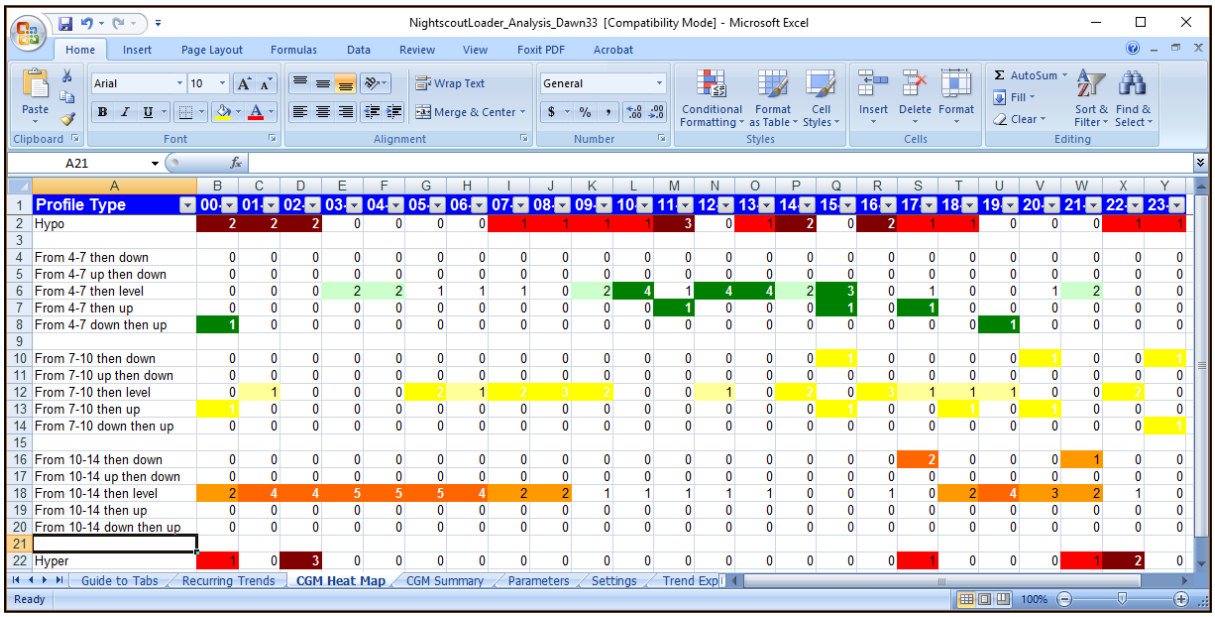


Figure 30 Example Care Portal Analysis Excel Output

The colour coding is intended to draw the eyes immediately to areas of high frequency and therefore times where change could be considered.

The CGM results included in the analysis results are those that fall within the Start Date and End Date selected.

If there are no CGM results during the date range of analysis, then this tab is not included.

Note that if the Settings option is for mg/dL, then the range names in the Profile Type change accordingly too.

CGM Summary

The CGM Summary tab includes a list of all the CGM dates inferred from CGM data loaded.

It's actually a permanent record of the contents shown in the CGM Dates window detailed on page 33.

As explained, the contents are inferred by traversing all the CGM entries data and where there is a date gap, then the assumption is that the current sensor has stopped and another has begun. Note that the tool does not load ***ALL*** CGM data into memory, only data that falls within the configured number of weeks back.

Trends

The trends tab has all the underlying trends that make up the recurring trends tab. Data is shown in reverse chronological order – most recent data at the top and earliest data at the bottom. It's possible to pivot this tab to create the Recurring Trends tab. Details in this tab along with the remaining data tabs are all in reverse chronological order.

A trend is two BG events separated in time from which a 'trend' can be inferred. That is, have the BGs gone up, come down or stayed level. Repeated trends are of interest and identified in the Recurring Trends tab.

Trends can be separated by several minutes like a pre & post prandial test (before a meal and up to 2 hours after). Trends can also be hypo events so the second result would typically be around 15 minutes later. Finally trends can be overnight starting between 10pm and midnight and finishing early morning.

All three types of trends have their own characteristics that the tool works hard to extract meaning from and then display in the Excel sheet for interpretation and decision making.

Skipped Meals

Those trends that span a meal but have no carbs recorded are replicated in the Skipped Meals tab for convenience. It allows an easy way to focus in on days & times where fasting may well have taken place. The tab format is therefore the same as Trends tab in reverse chronological order. Note that there will be gaps in the day sequence as not all days will be shown since there will be days where no meals are skipped.

BGs Outside Range

The highs and lows are single results (not trends) that are outside the normal range, again sorted in reverse chronological order.

Day Summaries

Day Summaries tab includes details for particular days in reverse chronological order that are unusual. This includes days where any of the following occur:

- A possible duplicate record is present
- A meal BG was missed
- A meal Carb was missed
- How many hypos occurred
- Interventions at "Very Late times" – small hours of the morning:
    - How many BGs during this time
    - How many Corrections during this time
    - How many Hypos during this time

The Day Summary is built up from a very low level analysis of each individual result. Since trends must span a minimum time period, it's possible that some results are not included in trend analysis.

Single Results

Single results are a composite BG, insulin and possibly Carbs based on treatment data. A Trend consists of a start single result and an end single result. The BGs are compared to determine the trend. If the start BG is higher than the end, then the trend is a fall. Conversely, if the start BG is lower than the end then the trend is a rise. This is a reverse chronological view of all single results in the analyzer date range. It is quite detailed and probably only rarely consulted. For verification that the trend detection engine is working correctly, the last column includes details of selection decisions made for each single result during the trend creation phase.

Treatment Data Analyzed

Treatment Data is an extract that looks very much as it's held in Nightscout. Again, this is in reverse chronological order and includes results for the analyzer date range only.

In Range CGM Trend Result Entries

If the date range overlaps with a time period for which CGM data is loaded, and if Full Details are requested for output, then this worksheet will be included in the Excel analytical file.

CGM Trend Results are the second stepping stone toward the heat map representation for CGM trends.

Essentially, CGM Entry Intervals are grouped by Profile Type and start and end hour. Thus results with the same profile type at the same time across different dates are aggregated together. This is the information that then feed the heat map representation.

In Range CGM Entry Intervals

If the date range overlaps with a time period for which CGM data is loaded, and if Full Details are requested for output, then this worksheet will be included in the Excel analytical file.

CGM Entry Intervals are the first stepping stone towards the heat map representation for CGM trends.

The CGM results are partitioned based on the CGM Trend Hour Intervals into 1, 2 or 3 hour intervals.

If CGM Trend Hour Intervals is 1, then there will be 24 CGM Entry Intervals each day that has CGM results.

The first CGM result that falls within a particular interval is checked along with the last result within the interval and each intervening result. The tool then categorizes that interval based on the starting result (eg in range, hypo etc), the last result and whether any result in between shows a turbulent profile (up and down), goes hypo or hyper or if all results remain flat. The interval is thus categorized into a profile type. Each interval will then have a number of CGM entries. Since there is typically one CGM entry every hour, there will be around 12 if the Trend Hour Intervals is 1.

In Range CGM Results

If the date range overlaps with a time period for which CGM data is loaded, and if Full Details are requested for output, then this worksheet will be included in the Excel analytical file.

CGM Results are the raw CGM data that comes back from Nightscout.

This is the data that's analyzed to make CGM Entry Intervals and then CGM Result Trends.

Full History Trends

As previously mentioned, when the application launches, after a Nightscout Load and after each Synchronization a thread launches and performs a full analysis on all the NIghtscout data. This serves as a reference for comparison when running an explicit analysis. The Full History Trends tab is the same as the Trends tab but shows results across the full data set.

Comparison to Full History

This tab provides a stripped down view like the Recurring Trends view, but on the full data set. Extra columns show how the full data set recurring trends compare with the date range being analyzed. It provides a convenient way of seeing how the more recent trends compare with long term averages.

Parameters

The parameters tab gives a summary of all the parameters – even if the Advanced Options is disabled and the window doesn't show.

From this it's possible to see all in one sheet the following:

- When the analysis ran
- What BG units the analysis has assumed for high/low values
- If Advanced Options is enabled
- Exactly what date range the analysis is over
- What parameter values each of the Analysis window options has

Settings

This tab includes a reference summary of the application itself and all the options and their values set at the time of analysis. Since options can be reset to default, it provides a convenient way of seeing any previous customizations used.

Trend Explanations

This tab summarises all the categories that the application can identify trends for. The full table is reproduced on page 45 in the Analyzer Trend Categories section.

Record Data IDs and References

When Advanced Options are set, a number of tabs include primary key and foreign key references. The ID column in the Treatment Data tab is the MongoDB ID value for each result. The Single Results tab has this (as DB Result ID and then introduces its own ID column). The Trends tab has Start ID and End ID which refer to Single Result Ids. Finally, internally each Recurring Trend has a list of Trend Ids but this is not shown on the Excel output.

Audit History

Each result stored in Nightscout by Nightscout Loader has an “Entered By” set as explained below.

So that the tool can tell what it loaded into MongoDB, it uses a known value for the “Entered By” field on the treatments document. The string is made up of 3 parts as follows:

NightScoutLoader:<nn>:<s>

Where “nn” is an incremental number and “s” is the number of seconds of the current time. This pretty much guarantees uniqueness for each load onto MongoDB.

The Audit History panel shows each time that Nightscout Loader synchronized results with the MongoDB.

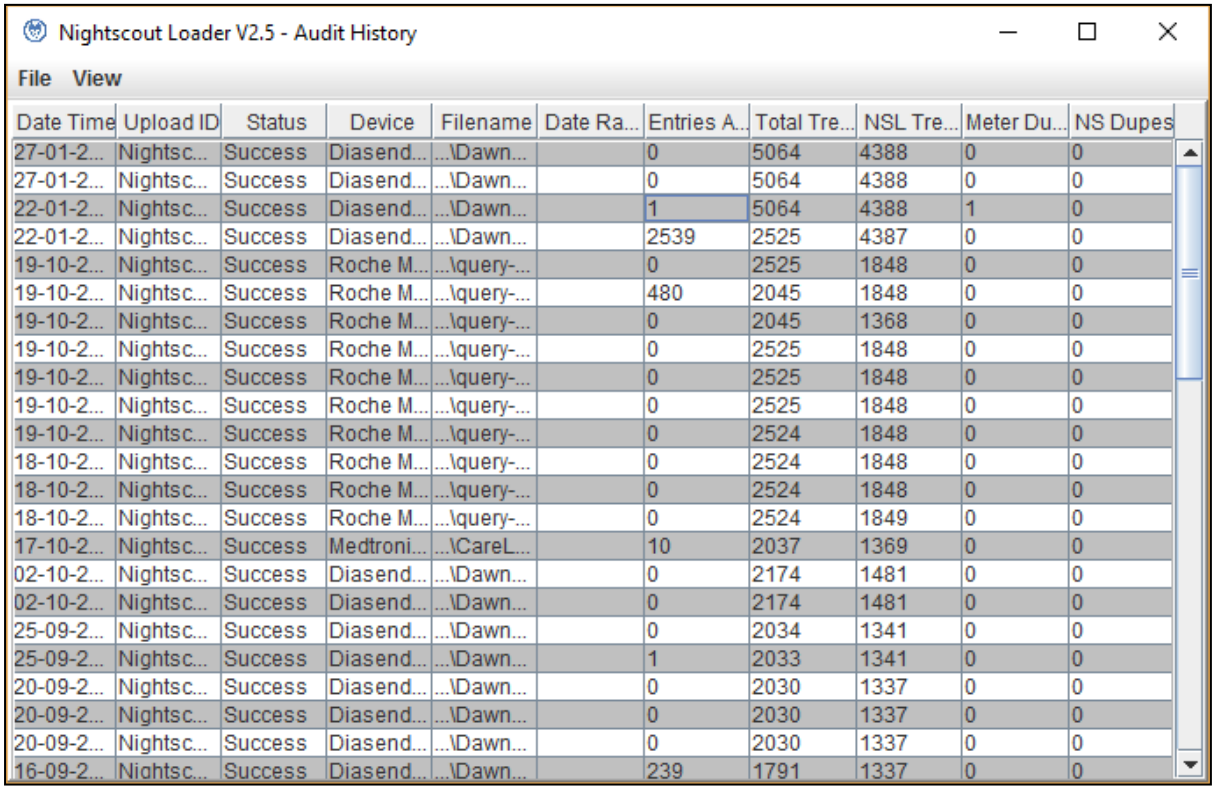


Figure 31 Nightscout Loader Audit Window

The View menu allows a toggling between Active Only and All records. Active only (as above) shows currently active uploads. A specific upload or all previous uploads can be reversed out and when this happens the original load becomes inactive.

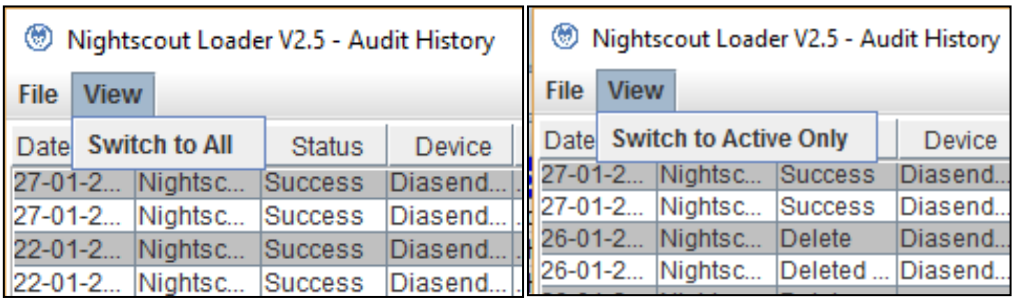


Figure 32 Nightscout Loader Audit Window View Menu Options

Clicking one result displays the Audit Log Window:

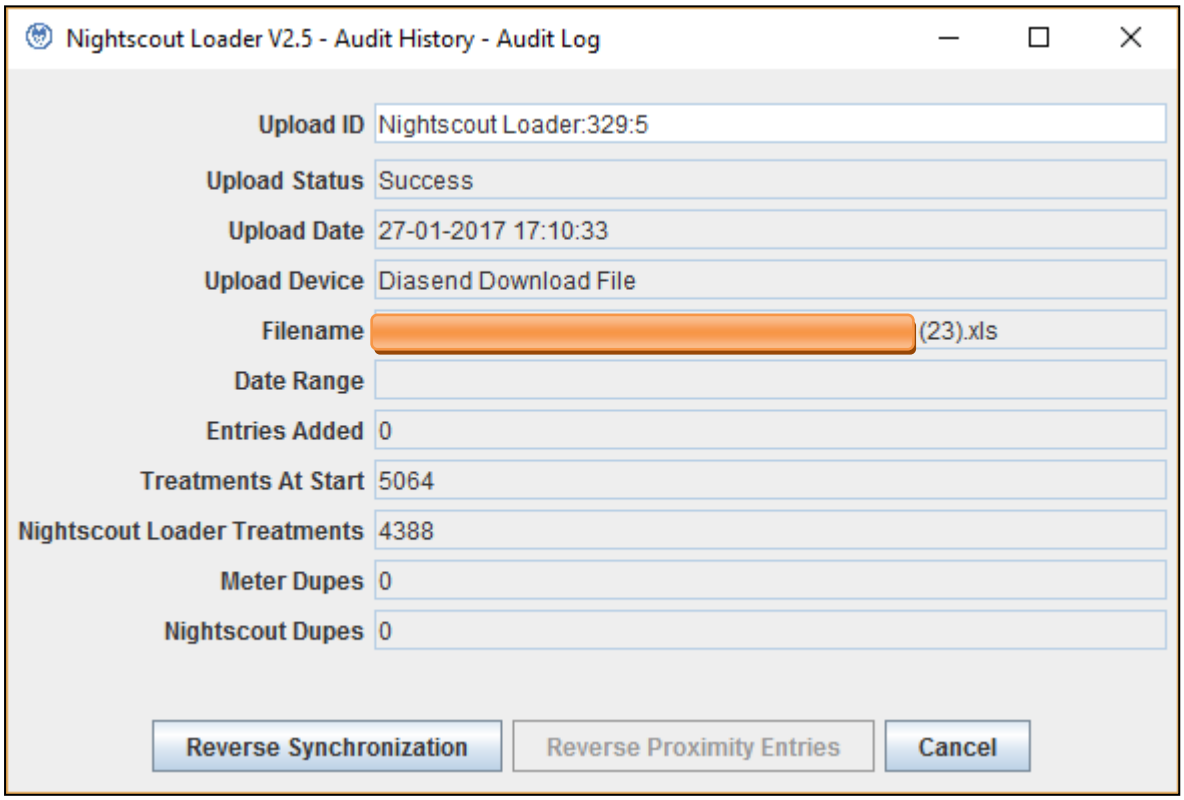


Figure 33 Nightscout Loader - Audit Log

This screen allows the reversal of a synchronization – that is, all the results uploaded on this date and time can be reversed out or deleted. See page 24 and section “Duplicate Detection” for details on Proximity or possible duplicate entries.

Should the need arise, the Action menu has a quick way of deleting all Nightscout loaded data as long as Advanced Options are set.

Miscellaneous

Roche Query

The application has been developed against version 1 of Accuchek 360. It can be made to work with the later version of this application but it will require a change to a supplied SQL script. Also, it may work with Roche Insight – again, this will need to be tested out with willing volunteers.

Testing Completed

I’ve done a lot of testing using a copy of Nightscout on a local laptop. I’ve also uploaded 4 years’ worth of Roche data to Dawn’s Nightscout and it’s all behaving fine.

I’m indebted to a number of beta testers who have provided feedback and also provided support for Apple platforms

- Andy Sherwood
- Sarah Davies
- Melanie Clegg
- Paul Cooper

In case there are any issues, please email me the log file.

nightscoutloader@gmail.com

Facebook

There's a dedicated Facebook page for the software for instructions and downloading the sotware.

The page is here: https://www.facebook.com/NightscoutLoader/

Github

https://github.com/gh-davidr/NightscoutLoader

Future

Other Meters/Pumps

If there are devices not supported currently and a wish to include, please drop a comment on Facebook.

Other Platforms

The application is developed and originally intended for use on PCs. It's written in Java which is highly portable and some users have reported success in running on Apple.

Future Features

- I like the analysis to Excel output and feel that it could be leveraged even further to include sensor graphs. With the CGM analytical features incorporated into version 2.5, I looked into including graphs. However the current POI & XOI libraries don't support this.
- The analytics capability is currently based purely on BG results. What's there could be extended with extra information from meters/pumps to make even more informed recommendations.
- I'd like to vet the trend categorization with a Diabetes Consultant – this is my own work based on how I view trends and look at data. If I'm way off, then it would be great to correct this. Please feedback any suggestions on the FB page.
- I trialled an even higher perspective recommendations tab looking at the recurring trends but decided the time being spent was better used finishing the application in current state. This is something that could be expanded on.
- The analytics could be extended to correlate with sensor data.
- Finally, more advanced correlations could be deduced from other factors or even a big data set of several users' data. Whether this could yield meaningful insights is yet to be confirmed but could be a research project for some students.

History

The concept for the application was conceived a few years ago and I attempted some more detailed analysis using SQL Server queries.

After discovering NightScout in October 2015, it was a small step to decide to dust off my coding skills and learn Java from around Christmas. All the development has been done with very limited spare time during commutes from Hertfordshire to Canary Wharf by train since January to date.

Change Log

Version	Date	Changes
V1.1	March 2016	Early version sent to early adopters for testing (around March 2016)
V2.0	13 June 2016	Add audit log features to track & back out data uploaded Add sophisticated meal and overnight trend analysis stored as Excel Initial version launched 14th June 2016
V2.1	14 June 2016	Fix to Medtronic load. All previous trial data was January 2016 which masked an issue in date handling.
V2.11	20 June 2016	Fix to storage of UTC dates in Mongo. Since tested in GMT region, time zone effect was also masked. Tested with different local time zones now.
V2.2	24 June 2016	Included options to allow explicit control of Timezone and date formats for input files. Made version more prominent across all screens (except Mongo & Roche test panels). Added Options tab to Excel output. Fixed a bug not spotted before where modifying a recently loaded record raised an exception. Now if a recent loaded record is selected, it reloads from Nightscout before allowing changes.

Version	Date	Changes
V2.3	31 July 2016 (David's Birthday)	1. Fixed the Temporary Basal record in Nightscout. 2. Trends now include BG results that span a meal with no carbs – useful for identifying fasting tests. There's an additional Skipped Meal Trends tab for this purpose too. 3. Enhanced Trend Detection Engine. Previously would discard a starting BG result if one was found shortly after, settling on the later one as a starting point. Instead, it will keep the original BG and then hold the second as an intervening result thereby ensuring that a wider range is included for analysis. Also, previously a single result could not be in two trends. This has been changed now so the end result can also be the beginning of the next trend – a more natural way of looking at results. 4. If advanced options are set then various records will expose an internal ID field and more commentary if discarded. This is useful for checking the Trend Detection Engine is working correctly and was added as part of enhancement 2 above. 5. Added a 'Guide to Tabs' tab at the start that summarises analytical results and provides some commentary/help on usage. 6. Made the date controls on analytics page much more robust. Also changed the format here and on the main Roche date selector to use the UK format. Fixed an issue with file selection after pressing analyze button 7. Introduced stand-alone mode through more careful checks on accessibility of MongoDB server. If configuration string for server is blank, the tool assumes offline mode and will not attempt a connection. As this option changes, the tool will detect need to try again. Stand alone mode allows load of meter/pump data into memory and then subsequent use of analytics – open up new communities of users. 8. To publicise the analytic features, the previous primitive analysis on start-up has been replaced with a full analysis and a report on top 3 trends. This runs on startup, on load from nightscout and also on synchronizations
V2.3.1	August 2016	1. Introduced a Full History Load for Analyzer comparisons. Played around with use of this and how best to show results compared to Recurring Trends in current Analyzer 2.

Version	Date	Changes
V2.4	02 October 2016	1. Introduced Duplicate Detection (Proximity Checking). Enhanced the main window, Audit History and Details form to allow control over duplicates. 2. Changed Recurring Trend to use Percentage rather than counts as driver for colour coding. Introduced a parameter that means 100% is either all recurring trends only or all trends. (Note the recurring trends tab only shows trends that occur twice or more during the analyzer period) 3. Made sure that when advanced options are not set, IDs do not appear in any of the tabs. (IDs are intended for showing referential integrity in the links between data types)
V2.5	Late January 2017	1. Introduced Roche SQL File extract for installations that are having issues connecting to SQL Server for Roche meters 2. Minor enhancements to proximity/duplicate checking. Specifically, Nightscout Loader for the first time can now identify existing manually entered Treatment Entries that match meter/pump data. For the first time, Nightscout Loader now offers the possibility of deleting ***manually loaded data***, and not just data that's under its responsibility (data from meter/pump). This is based on a request from a user that manually loads data in Care Portal but wants the data from meter/pump to supersede it. 3. A refined merge algorithm based on seeing more data sets. Less chance some results are overlooked. 4. Enhanced the Treatment Details screen to include up down navigation and also a Find feature. 5. On request, included the option of disabling certain meal times from analysis. 6. Inclusion of CGM Loading 7. Inclusion of CGM Analysis result tabs to Excel analysis output 8. Option of variable level of detail in Excel results workbook 9. Disabling incomplete features – Diasend temporary basals and OmniPod binary file reader 10. Having added a feature to disable Diasend temp basals, introduced a much better algorithm to infer them more accurately ☺ 11. Fix to issue where last value read from file is duplicated 12. Reference to Online help – link to PDF on Google Drive

Analyzer Trend Categories

The table below summarises all the categories that trends can take ordered by increasing importance rank with names and the recommendations that can also appear. It also includes the recent enhancement of showing 'opposite' trends and whether the trend is a rise or fall. These extra attributes now feature on the Recurring Trends tab.

Category Name	Importance Rank	Opposite Name	Rise, Fall or Flat	Recommendations
Still Hypo after earlier Hypo	10	Rise into range after earlier Hypo	Flat	Presumed Carb correction and following result still hypo. Should repeat & give 15g carbs.
Fall into Hypo no carbs	60	Rise into range after no Carbs	Fall	fall after no carbs into hypo. Is Basal rate too high?
Fall into Hypo after meal	20	Rise into range after meal	Fall	fall after meal bolus into hypo. Was insulin correction too great? Is Carb/Insulin Ratio too low?
Fall into Hypo after correction	30	Rise into range after correction	Fall	fall after correction bolus into hypo. Was correction too much?
Overnight Fall into Hypo with earlier Hypo	70	Overnight Rise Out of Range but Hypo first	Fall	fall overnight into hypo and other hypos too. Definitely check Basal rate as insulin may be too high.
Overnight Fall into Hypo	80	Overnight Rise Out of Range	Fall	fall overnight into hypo no intervention. Check Basal rate
Overnight Fall into Hypo with a Correction first	90	Overnight Rise Out of Range despite Correction	Fall	fall overnight into hypo but higher before and correction first. Was correction too much?
Overnight Rise Out of Range but Hypo first	100	Overnight Fall still outside Range but surpsingly Hypo firt	Rise	rise overnight but hypo first. Was too much correction given? Is overnight basal right?
Overnight Rise into Range but Hypo first	110	Overnight Fall into Range but Hypo first	Rise	fall overnight into hypo no intervention. Check Basal rate
Overnight Fall still outside Range but surpsingly Hypo firt	120	Overnight Rise Out of Range but Hypo first	Fall	fall overnight into hypo and other hypos too. Definitely check Basal rate as insulin may be too high.
Overnight Fall into Range but Hypo first	130	Overnight Rise into Range but Hypo first	Fall	fall overnight into ideal target range but hypo first. Check Basal rate to avoid needing carb correction.
Overnight In Range to In Range but Hypo first	140	Overnight In Range to In Range with a Correction first	Flat	overnight start in range and end in range, but hypo first. Check basal rates for early night or Dinner ratio.
Rise out of range after no Carbs	200	Fall but still outside range no carbs	Rise	rise from out of range to higher value after no carbs. Is Basal rate too low?
Rise out of range after meal	150	Fall but still outside range after meal	Rise	rise after meal bolus. Outside target range, so was too little insulin given for carbs? Is Carb/Insulin Ratio too high?
Rise from in range to out of range after no Carbs	210	Fall into range no carbs	Rise	rise from in range to out of range after no carbs. Is Basal rate too low?
Rise from in range to out of range after meal	160	Fall into range after meal	Rise	rise from in range to out of range after meal bolus. Outside target range, so was too little insulin given for carbs? Is Carb/Insulin Ratio too high?
Rise out of range after correction	170	Fall but still outside range after correction	Rise	rise after correction bolus. Possible Canula failure/absorption issue.
Rise from in range to out of range after correction	180	Fall into range after correction	Rise	rise from in range to out of range after correction bolus. Unusual to bolus with no carbs like this. Possible Canula failure/absorption issue.
Rise out of range after earlier Hypo	190	Still Hypo after earlier Hypo	Rise	rise after possible Carb correction. Outside target range, so were too many carbs given to treat hypo?
Overnight Rise Out of Range	220	Overnight Fall still outside Range	Rise	rise overnight with no intervention. Check Basal rate for overnight.
Overnight Rise Out of Range despite Correction	230	Overnight Fall still outside Range with a Correction first	Rise	rise overnight despite insulin given. Check Basal overnight but also possible Canula failure/absorption issue?
Fall but still outside range no carbs	50	Rise out of range after no Carbs	Fall	fall after no carbs but still out of range. Was there an earlier insufficient correction? Is Basal rate too high?
Fall but still outside range after meal	240	Rise out of range after meal	Fall	fall after meal bolus. Outside target range still, so was correction sufficient?
Fall but still outside range after correction	250	Rise out of range after correction	Fall	fall after correction bolus. Outside target range still, so was correction sufficient?
Overnight Fall still outside Range	260	Overnight Rise Out of Range	Fall	fall overnight into hypo no intervention. Check Basal rate
Overnight Fall still	270	Overnight Rise Out of	Fall	fall overnight into hypo but higher before and correction

Category Name	Importance Rank	Opposite Name	Rise, Fall or Flat	Recommendations
outside Range with a Correction first		Range despite Correction		first. Was correction too much?
In Range to In Range	280	In Range to In Range	Flat	BG held nicely in target range
Overnight In Range to In Range	290	Overnight In Range to In Range	Flat	overnight start in range and end in range. Perfect overnight result.
Overnight In Range to In Range with a Correction first	300	Overnight In Range to In Range but Hypo first	Flat	overnight start in range and end in range, but higher before and correction first. Check basal rates for early night or Dinner ratio.
Overnight Rise into Range	310	Overnight Fall into Range	Rise	rise overnight into ideal target range. Basal rate may be just about right.
Overnight Rise into Range with Correction	320	Overnight Fall into Range with a Correction first	Rise	fall overnight into hypo no intervention. Check Basal rate
Overnight Fall into Range	330	Overnight Rise into Range	Fall	fall overnight into ideal target range no intervention. Basal rate may be just about right.
Overnight Fall into Range with a Correction first	340	Overnight Rise into Range with Correction	Fall	fall overnight into ideal target range but higher before and correction first. Check Basal rate to avoid needing carb correction.
Fall into range no carbs	40	Rise into range after no Carbs	Fall	fall after no carbs into ideal target range. Was there an earlier correction? Is Basal rate too high?
Fall into range after meal	350	Rise out of range after meal	Fall	fall after meal bolus into ideal target range. Carb Ratio and Sensitivity look about right.
Fall into range after correction	360	Rise out of range after correction	Fall	fall after correction bolus into ideal target range. Sensitivity look about right.
Rise into range after no Carbs	190	Fall into range no carbs	Rise	rise from hypo to in range after no carbs. Is Basal rate too low?
Rise into range after meal	370	Fall into Hypo after meal	Rise	rise after meal bolus into ideal target range. Carb Ratio looks about right.
Rise into range after correction	380	Fall into Hypo after correction	Rise	rise after correction bolus into ideal target range.
Rise into range after earlier Hypo	390	Still Hypo after earlier Hypo	Rise	rise after possible Carb correction into ideal target range. Carb treatment was just about right.

Keyword Index

(Note that this is quite incomplete and was an experimental trial of the feature in Word)