AcqKnowledge Impedance Scoring Manual

Updated 2014/01/18

1. Setup for scoring

1.1.Download the AcqKnowledge datafile (e.g., "SAL001.acq") that you want to score onto your computer

1.2.Open the datafile in AcqKnowledge

1.2.1.Windows 7 prompt

1.2.1.1.Windows 7 may ask you if you want to allow AcqKnowledge to make "changes to the computer"

1.2.1.2.Say "Yes"

1.2.2.AcqKnowledge Hardware Prompt

1.2.2.1.If a dialogue box appears that says, "Choose MP150"

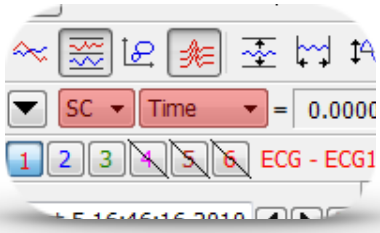
1.2.2.1.1.Ensure that "No hardware" is selected in the pull-down menu next to "Work with:"

1.2.2.1.2.Click "OK"

1.2.2.1.3.You may want to check the checkbox next to "Do not ask me again"

1.2.3.You will only need the ECG, Z0, and dZ/dT channels, so you can hide the extraneous channels (i.e., channels containing PPG, Skin Temp, GSR)

1.2.3.1.While holding down the "alt" key, click on the number of the channel you want to hide, and it should look like the picture to the right



1.3.Set the time units used by AcqKnowledge

(Note: you only have to do this once per computer on which you use AcqKnowledge)

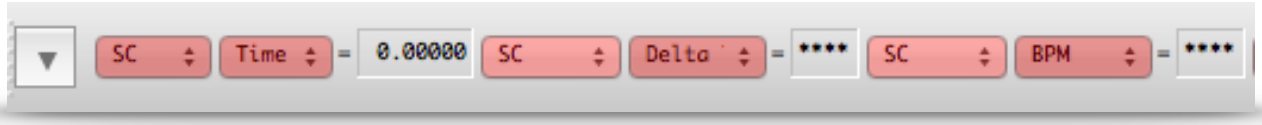
1.3.1.Go to "Display" -> "Preferences"

1.3.2.Under "Measurements," find the pull-down menu for time units

1.3.3.Select "milliseconds" from the "Time Units" pull-down menu

1.4.Setup the "Measurements" bar to calculate relevant numbers

1.4.1.Along the top "measurements" pane, set the first three measurements to **Time**, **Delta T** (change in time), and **BPM**, as shown in the image below



2. Run the Impedance (ZCG) Analysis

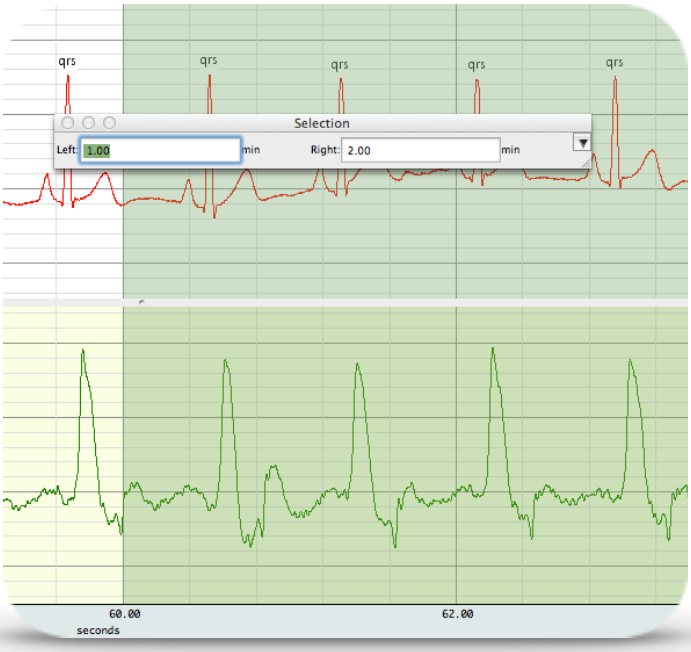
2.1.Prepare for Impedance ("ZCG") Analysis

2.1.1.Split the datafile into 1-minute files

2.1.1.1.Starting with your ECG-scored datafile …

2.1.1.2.Select each 1-minute interval and export it as a new data file

2.1.1.2.1.Go to "Display" -> "Show" -> "Selection Palette"



2.1.1.2.2.For each minute of the data file:

2.1.1.2.2.1.In the Selection Palette, enter the beginning and end of the minute you want to select, like the picture to the left (e.g., to export minute 2, you want to enter "1" in the "Left" text box and "2" in the Right text box)

2.1.1.2.3.Export the selected segment of data by going to "File" -> "Save Selection As"

2.1.1.2.4.Change the filename by:

2.1.1.2.4.1.Adding a number that corresponds to the minute of the datafile that you are exporting plus a hyphen in front of the original file name

2.1.1.2.4.2.Change the analysis identifier in the file name to "ZCG"

2.1.1.2.4.3.*Note: For example, if the file was originally named "SAL001-ECG-EP-G.acq" then the new file for minute 2 should be named "2-SAL001-ZCG-EP-G.acq" and the new file for minute 3 should be named "3-SAL001-ZCG-EP-G.acq"*

2.1.1.2.4.4.Note: I recommend creating a new folder to store all the 1-minute data files, just to store the time-split data files

2.1.1.3.Repeat this process for all minutes in your file (e.g., a 25-minute file should yield 25, 1-minute files)

2.1.2.Create your ZCG Data Spreadsheet

2.1.2.1.Open a new spreadsheet in any spreadsheet program (e.g., Excel)

2.1.2.2.Name the file the same name as your overall impedance AcqKnowledge file (e.g., "*SAL001-ZCG-EP-G.xlsx*")

2.1.2.3.In the first row, create headings for three columns:

2.1.2.3.1."Minute"

2.1.2.3.2."HR"

2.1.2.3.3."PEP"

2.1.2.3.4."LVET"

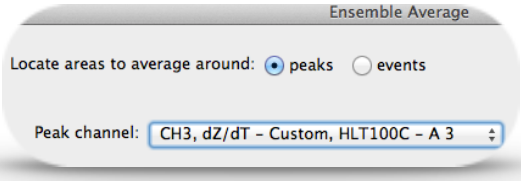
2.2.Conduct the ICG analysis by repeating the following steps for EVERY 1-minute file

2.2.1.Open the 1-minute data file that you want to score

2.2.2.Ensemble the "average" dZ/dt waveform

2.2.2.1.Go to "Analysis" -> "Ensemble Average"

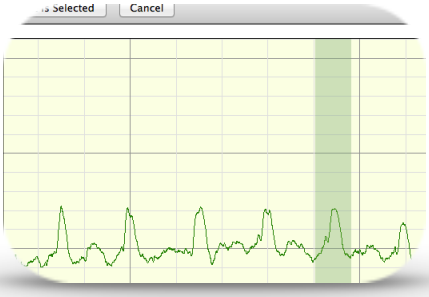
2.2.2.2.A dialogue box will appear, like the one to the right



2.2.2.3.Ensure that you select "peaks" for the areas to locate averages

2.2.2.4.Set the "peak channel" to the dZ/dt channel

2.2.2.5.You will be prompted to highlight a single peak and select "Peak is Selected"



2.2.2.5.1.On the graph, click and drag to select a dZ/dt peak

2.2.2.5.1.1.Note: Select the best dZ/dt peak and ensure that you include B and X. This waveform will be used as the template, so try to find a nice-looking peak

2.2.2.5.2.When you are satisfied with your selection, click the "Peak is Selected" button that will appear directly above the graph on the left-hand side

2.2.2.5.3.You will be asked whether the peak you selected points up or down

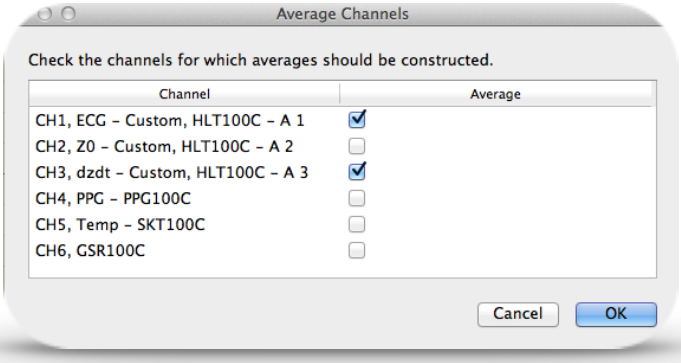
2.2.2.5.3.1.Choose "up"

2.2.2.5.3.2.Click "OK"

2.2.2.6.You will be asked which channels should be included in the averaging

2.2.2.6.1.Make sure to select ECG and dZ/dt as shown below

2.2.2.6.2.Click OK



2.2.2.7.You will be asked to select the area around each peak to be included in the averaging

2.2.2.7.1.Note: Be sure to select enough of an area to include Q on the ECG waveform an X on the dZ/dT waveform

2.2.2.7.2.Additional Note: You must select an area that surrounds the peak you selected in step 2.2.2.5.1, or you will receive an error message. You can identify the peak that you selected in 2.2.2.5.1, because it will have a downward arrow directly above the peak

2.2.2.7.3.Click "Do Average"

2.2.2.7.4.Wait for the ensembling …

2.2.2.8.A new window will appear with a new, ensembled data

2.2.2.8.1.Save this new datafile as "Ensembled–[Filename].acq"

2.2.3.Conduct the ICG Analysis for that minute

2.2.3.1.Mark B and X on the ensembled dZ/dt waveform (and sometimes "Q" on the ensembled ECG waveform)

2.2.3.1.1.Select the correct "event tool" type by clicking and holding the mouse over the event tool

2.2.3.1.2.The points that you must place well are:

2.2.3.1.2.1.Q-point: "Hemodynamic" -> "ECG Complexes" -> "QRS Onset"

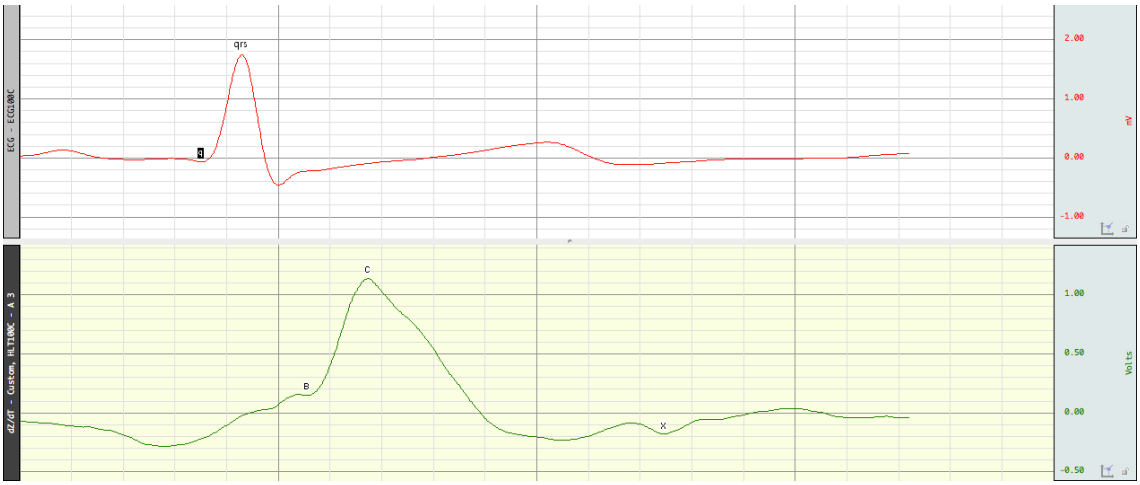
2.2.3.1.2.2.B-point: "Hemodynamic" -> "Impedance" -> "B-point"

2.2.3.1.2.2.1.Note: The B-point is usually at the last local minimum before the dZ/dt peak on the dZ/dt waveform

2.2.3.1.2.3.X-point: "Hemodynamic" -> "Impedance" -> "X-point"

2.2.3.1.2.3.1.Note: The X-point is usually the second local minimum after the dZ/dt peak on the dZ/dt waveform and is also usually the lowest voltage point of the whole dZ/dt cycle (although note this last feature is not always true)

2.2.3.1.3.The resulting placements should look a lot like this:



2.2.4.Calculate that minute's values for PEP and LVET

2.2.4.1.Calculate Pre-Ejection Period (PEP) for that minute

2.2.4.1.1.Click on the bar cursor to select it

2.2.4.1.2.Position the cursor at the beginning of the file

2.2.4.1.3.Go to "Analysis" -> "Find Cycle"

2.2.4.1.4.Under the "Cycles/Peaks" Tab:

2.2.4.1.4.1.Select "Locate Cycle From" "Events"

2.2.4.1.4.2.For all minutes except the first minute, a dialogue box will appear asking you if you want to keep your "non-zero offsets"
2.2.4.1.4.3.Click the "Reset Offsets to Zero" button
2.2.4.1.5.Choose "Hemodynamics" -> "ECG Complexes" -> "QRS Onset" for the "Start Event"
2.2.4.1.6.Choose "Hemodynamics" -> "Impedance" -> "B-point" for the "End Event"
2.2.4.1.7.Under the "Selection" Tab:
2.2.4.1.7.1.Set the "Left Edge":
2.2.4.1.7.1.1.The "Time of" should be set to "Starting Event"
2.2.4.1.7.1.2.Change the "+" field to be 0 seconds
2.2.4.1.7.2.Set the "Right Edge":
2.2.4.1.7.2.1.The "Time of" should be set to "Ending Event"
2.2.4.1.7.2.2.Change the "+" field to be 0 seconds
2.2.4.1.8.Under the "Output" Tab:
2.2.4.1.8.1.In the "Measurements" sub-tab: Check the "Save measurements into Excel spreadsheet file" option
2.2.4.1.8.2.In the "Averaging" sub-tab: Ensure that "Construct an Average from …" is <u>not</u> checked
2.2.4.1.9.Click "OK"
2.2.4.1.10.An Excel File will open
2.2.4.1.11.Copy the value in the "Delta T" column
2.2.4.1.12.In the ZCG Data Spreadsheet (c.f., step 2.1.2):
2.2.4.1.12.1.Enter the current minute in the next empty row of the "Minute" column
2.2.4.1.12.2.Paste the value of the Delta T column that you copied in step 2.3.2.1.11 in the corresponding row of the "PEP" column
2.2.4.1.12.3.Transform this PEP value by multiplying it by -1

2.2.4.2.Calculate Left Ventricular Ejection Time (LVET) for that minute

2.2.4.2.1.Re-position the bar cursor at the beginning of the ensembled file
2.2.4.2.2.Go to "Analysis" -> "Find Cycle"
2.2.4.2.3.Select "Locate Cycle From Events"
2.2.4.2.4.Choose "Hemodynamics" -> "Impedance" -> "B-point" for the "Start Event"
2.2.4.2.5.Choose "Hemodynamics" -> "Impedance" -> "X-point" for the "End Event"
2.2.4.2.6.Click "OK"
2.2.4.2.7.An Excel file will open
2.2.4.2.8.Copy the value in the "Delta T" column
2.2.4.2.9.In the ZCG Data Spreadsheet (c.f., step 2.1.2):

2.2.4.2.9.1.Paste the value of the Delta T column that you copied in step 2.3.2.2.8 in the corresponding row of the "LVET" column

2.2.4.2.9.2.Transform that LVET value by multiplying it by -1

2.2.4.3.Record the Heart Rate (HR) for that minute

2.2.4.3.1.Above the QRS Peak of the ECG waveform, you will see a label that indicates how many cycles were ensembled in that minute; this is the participant's HR for that minute

2.2.4.3.2.In the ZCG Data Spreadsheet (c.f., step 2.1.2), record the participant's HR under the "HR" column

2.2.5.ENSURE THAT YOUR VALUES FOR PEP AND LVET ARE PHYSIOLOGICALLY PLAUSIBLE

2.2.5.1.The gold standard for checking your scoring is by ensuring the values you are generating could come from a human. That is, the numbers must be "physiologically plausible." Plausibility is evaluated by taking Heart Rate (HR), Pre-Ejection Period (PEP), and Left Ventricular Ejection Time (LVET) into account. If there is any beat for which PEP or LVET fall outside the plausible range for HR, then you must change the placement of the relevant points

***2.2.5.2.*Physiological Plausibility Table**

2.2.5.2.1.For every row of the output datafile, ensure that the values are physiologically plausible, according to this table:

Heart Rate	PEP	LVET
40-60	140.8-81.2	364.8-291.2
60-80	132.8-73.2	330.8-257.2
80-100	124.8-65.2	296.8-223.2
100-120	116.8-57.2	262.8-189.2
120-140	108.8-49.2	228.2-155.2

2.2.5.3.If that minute's values are not plausible:

2.2.5.3.1.Move B, Q, or X accordingly <u>until it is plausible</u>

2.2.5.3.2.Note: Remember:

*2.2.5.3.2.1.*PEP = B – Q, where B, Q, and PEP are all in units of milliseconds

*2.2.5.3.2.2.*LVET = X – B, where B, X, and LVET are all in units of milliseconds

2.2.5.3.3.Common reasons for implausibility

2.2.5.3.3.1.You <u>may</u> need to move B further to the right (later in time) if PEP is too low and LVET is relatively high

2.2.5.3.3.2.You <u>may</u> need to move B further to the left when PEP is too high and LVET is too low

2.2.5.3.3.3.You may need to move X further to the right when PEP is fine but LVET is too low

2.2.5.3.3.4.You may need to move X further to the left when PEP is fine, but LVET is too high

2.2.5.3.3.5.You may need to move Q (on the ECG line) further to the right when PEP is too high but LVET is fine

2.2.5.3.3.6.You may need to move Q further to the left when PEP is too low but LVET is fine

2.2.5.4.After the data for this minute are confirmed to be plausible:

2.2.5.4.1.Finalize the values of PEP and LVET for this minute in the ZCG Data Spreadsheet

2.2.5.4.2.Ensure that the correct minute number is recorded in column A and the HR, PEP, and LVET for that minute are recorded on the same row in columns B, C, and D, respectively

2.2.5.4.3.In AcqKnowledge, save the work you did in the ensembled data file by going to "File" -> "Save"

2.2.5.4.4.Close the AcqKnowledge data files and temporary Excel files that you used to score this minute of data, but keep your ZCG Data Spreadsheet open

2.3.Repeat all of Step 2.2 for each minute of your data file

3. Save the ZCG Data Spreadsheet

3.1.After the last file, save the ZCG Data Spreadsheet, which you named in Step 2.1.2

¡¡Great Job!!