**Quality Control Functions**

**Assessing pulmonary function in 3-year-old children using respiratory oscillometry: a validation study in rural Guatemala**

Laura M. Grajeda, Keyla Castellanos, Tatiana Petrovick, Anaité Díaz-Artiga, Maria Reneé López, Albino Barraza-Villarreal, Lisa M. Thompson, Ye Shen, Jessica Knight, Luke P. Naeher, Thomas Clasen, Jennifer Peel, John P. McCracken, Eric D. McCollum

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## A. Goal

Perform quality control of oscillometry measurements collected with the Tremoflo C-100 Airwave Oscillometry System (THORASYS Thoracic Medical Systems, Montreal, Quebec, Canada) at 7 to 41 Hertz multifrequency range.

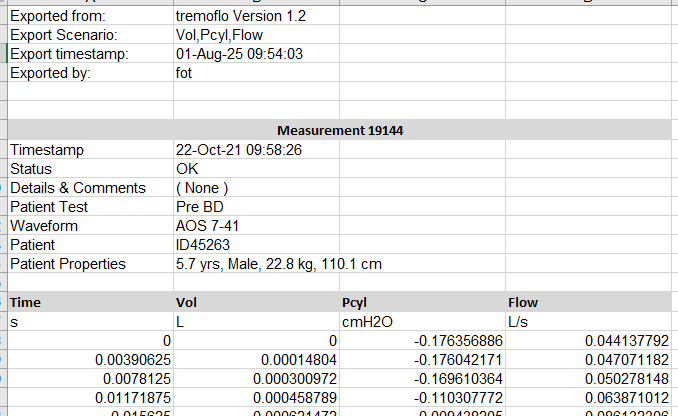
Quality control consists of:

1. Filter out incomplete breaths and breaths in which an upper airway artifact has been identified. A measurement must have at least 4 artifact-free breaths to be considered valid and usable.
2. Among the valid measurements, select the best ones and calculate test indices.

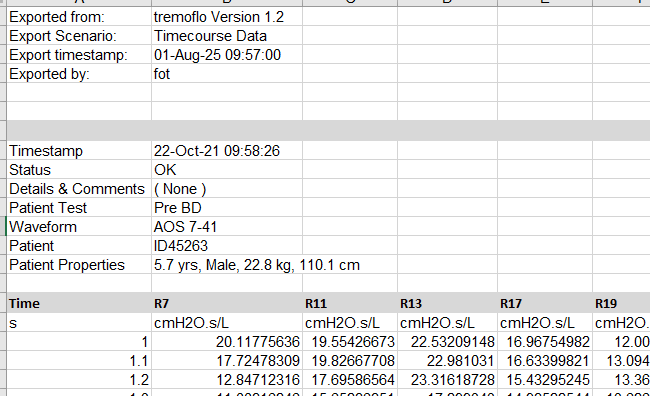
## B. Inputs

Measurement data exported from the Tremoflo software:

1. Vol,Pcyl,Flow: The export contains volume, pressure, and flow signals collected every 0.004 seconds. An example of the file is shown below.



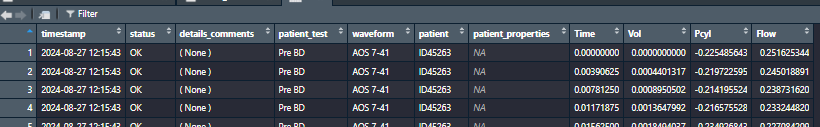
1. Timecourse Data: The export contains a time series of resistance and reactance endpoints calculated at each 0.1 seconds. An example of the file is shown below.



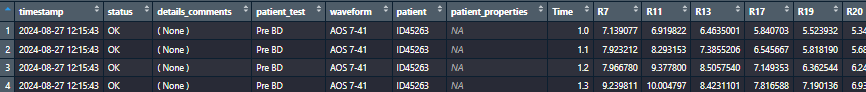
## C. Step 1: Artifact detection

### Procedure

1. Extract the time, volume, pressure, and flow data that corresponds to an individual measurement from the “Vol,Pcyl,Flow” export to a dataset in R.



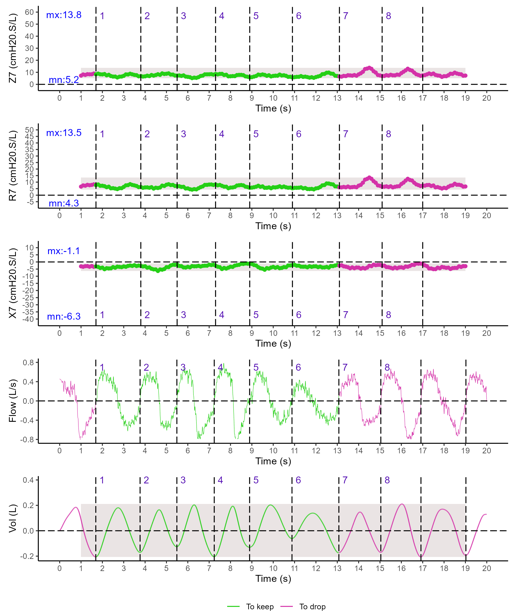
1. Extract the resistance and reactance data that correspond to an individual measurement from the “Timecourse Data” export to a dataset in R.



1. Apply the function “M.AllSteps()” on “Vol,Pcyl,Flow” and “Timecourse data”. This function uses other functions to:
   * Detect the start and end of all the breaths in the measurement
   * Trim the incomplete breaths and the start and end of the measurement
   * Remove periods that may not contain a breath
   * Apply functions to identify leaks
   * Apply functions to identify obstructions
   * Create an indicator variable as to whether the breath needs to be filtered out under each of the alternative artifact removal methods (AR1 or AR2)
   * Create an indicator variable as to whether the measure is valid (has more than 4 artifact-free breaths)

The output is a list containing two datasets, one for timecourse data and the other for Vol,Pcyl,Flow data. All the functions are defined in the file “Functions\_ArtifactDetection.Rmd”

1. Apply the function “M.AllPlots()” to create visualizations of the Z7, R7, X7, Flow, and Volume channels. Breaths colored in pink are to be filtered out according to the AR2 (SDExt) artifact removal method. The functions to create the plots are defined in the file “Functions\_ArtifactDetection.Rmd”



1. Rowbind all the measurements (Timecourse data) that belong to the same test.
2. Apply the function “T.AllSteps()” on binded Timecourse data. This function uses other functions to detect artifacts, similar to M.AllSteps(), but at the test level. The output will have an indicator variable to indicate whether each breath should be filtered out according to AR3 (TSDExt), and an indicator variable to indicate whether the measurement is valid (has more than 4 artifact-free breaths) under AR3 (TSDExt).
3. Save datasets.

### Outputs

After applying functions to detect artifacts (step 1 of quality control), the outputs will be:

1. A visualization of the Z7, R7, X7, Flow, and Volume channels for each measurement. The visualization shows in pink the breaths that are suggested to be filtered out by the AR2 (SDExt) method.
2. New “Vol,Pcyl,Flow” and Timecourse datasets including indicator variables for the breaths and measurements that are suggested to be filtered out by the AR methods.

## D. Step 2: Measurement selection

### Procedure

1. Open and rowbind all the individual Timecourse datasets that were created in the first step.
2. Apply the artifact removal filter you want to use (AR1-AR3). To do this, filter the dataset according to the indicator variables to determine whether to include the measurement (KeepMeasure) or breath (DropBreath) that were created in the first step. Then, apply the function “ComputeMeasures()” to calculate summary measurements from the filtered Timecourse data. The function is defined in the file “Functions\_MeasurementSelection”. In the new dataset, each row will be a measurement.
3. Apply functions to select the best measurements among the artifact-free measurements. The new dataset will contain only the selected measurements. The functions are:
   1. SelectClosest3\_exact(): Selects the closest 3 measurements from each oscillometry endpoint.
   2. SelectOnDisttoMean15(): Drops the 15% of the measurements with the highest absolute value between the measurement mean and the test mean for each oscillometry endpoint.
   3. ChooseXFromFirstY(): Selects the 3 measurements with a CoV for R7 <=15% among Y number of measurements.
4. Apply the function “ComputeTests()” to compute test summaries from measurement summaries.
5. Save datasets.

### Outputs

A dataset for each combination of artifact removal and measurement selection method. Each row in the dataset corresponds to one test.

The End