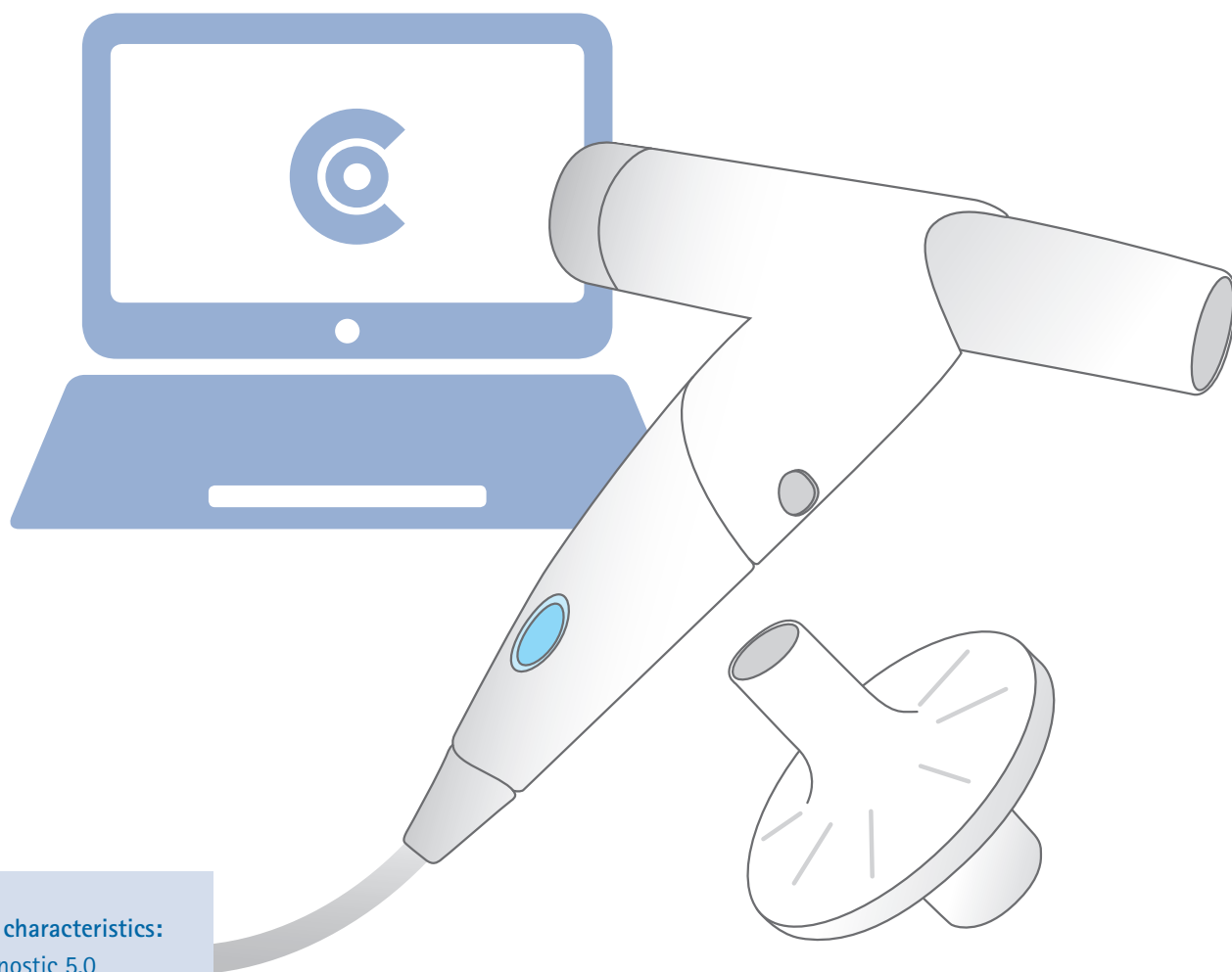Operating Manual

Spirometry

| 1 Safety | 2 Hardware | 3 Software | 4 Hygiene |

Part 3: custo diagnostic software for custo spiro mobile

Operating characteristics:
custo diagnostic 5.0
and higher
for Windows®

MSW 0006 – DK 1688
Version 002 – 16/01/2019

CE 0123

custo·med
EXCELLENCE IN DIAGNOSTICS

CAUTION:
This Operating Manual is part of a modular system, consisting of four parts. All four parts must be downloaded from the Internet or from a CD to ensure the Operating Manual is complete.

Spirometry

| 1 Safety | 2 Hardware | 3 Software | 4 Hygiene |

Part 3: custo diagnostic software for custo spiro mobile

Table of contents

3.1   Symbols used in this Operating Manual

ACTIONS THAT ARE PROHIBITED

or not allowed under any circumstances!

WARNING

used to indicate situations which, if not avoided, could result in personal injury or property damage

NOTE

provides important information which must be observed

TIP

contains practical information to assist you with your work

Words highlighted in colour indicate buttons or click paths to the corresponding program point, e.g. Examination, Spirometry

Words highlighted in colour...

3.2 custo diagnostic program structure

The custo diagnostic program is divided into three areas – User, Patient and Examination. This structure ensures that you can always recognise who (which user) is carrying out what type of examination with whom (which patient). The main menus of each area can be reached by clicking on User, Patient or Examination.

In the User ❶ main menu, the user of the system can be selected. The administration of users takes place in the custo diagnostic service centre (creating users, allocating user rights, user-specific settings).

The Patient ❷ main menu is used for patient management. Its most important functions include Search for patient, Add new patient and Search Evaluation.

The Examination ❸ main menu lists all of the examination types which are possible with custo diagnostic. Modules already purchased are active (black font), all other modules are inactive (light grey font).
This menu is also linked to the Settings ❹ area. This area is for making cross-program, examination-related and user-specific settings.

3.3   Connecting and configuring the device

Prerequisite: custo diagnostic is installed on your PC and ready to use. The custo med devices and components may only be connected to the PC after custo diagnostic has been installed. The required device drivers are installed on the PC via the custo diagnostic standard setup or by specific selection during the custo diagnostic setup.

3.3.1   Connecting custo spiro mobile to the PC

➤ Connect custo spiro mobile to the PC. Driver installation takes place automatically. Wait until the installation is complete.

➤ Start custo diagnostic. Open the Examination, Spirometry, Settings, Device, Device connection screen ❶.

➤ Activate the spiro mobile option ❷.

➤ If working with custo spiro protect bacterial and viral filters, activate the spiro protect option. ❸

➤ Enter the code for the custo spiro protect bacterial and viral filters ❹. The five-digit code can be found on the packaging of the filters (refer to the Cat. No. line).

➤ Click on Save ❺ to apply your input.

➤ Click on End ❻ to close the settings screen.

3.3.2   Calibrating custo spiro mobile

➤ Before using the device for the first time, a calibration must be carried out.
   Observe the instructions provided in the hardware description.

➤ Connect custo spiro mobile to the PC.
   Connect the devices together as illustrated ❶.

➤ Start custo diagnostic and open the
   Examination, Spirometry, Calibration ❷ screen.

➤ Specify the volume of your pump ❸.

➤ Enter your name in the performed by ❹ field.

➤ Click on Start Calibration ❺.

➤ Follow the instructions issued by the system ❻.

➤ **After the start, pump rapidly from end stop to end stop. If your**
   speed is not optimal, you will receive precise instructions.

➤ As soon as the exact pump volume has been measured,
   the calibration process is automatically ended.

➤ The last calibrations are listed under "Documentation ..." ❼.

➤ The Print calibration entries ❽ button can be used
   to print a list of calibrations performed so far.

➤ The Delete calibration entries ❾ button can be used to delete older entries
   from the list as required (delete entries that are older than ...).

3.4 Performing the spirometry measurement with custo diagnostic

Note on the procedure

The steps necessary to perform and evaluate a spirometry measurement in custo diagnostic are shown without a surgery IT system or HIS connection.

3.4.1 Reference measurement

Program start, calling the spirometry

- ➤ Start custo diagnostic and log in.
- ➤ Click on Examination ❶, Spirometry ❷, New Spirometry ❸.

Selecting the patient

- ➤ Select a patient for the examination:
  Enter the patient's name into the input fields in the search screen ❹.
- ➤ Select the patient from the list.
  Confirm your selection with Select Patient ❺.
  You can also select the patient by double-clicking on the name.

New patient

- ➤ If the patient does not yet exist in your database: Click on New Patient ❻.
- ➤ Enter the patient data. The fields marked with an asterisk are mandatory.
  In order to perform a spirometry measurement, you have to enter information on the patient's age, gender, height, weight and ethnicity [1].
- ➤ Save the data; the patient is entered into the database.
- ➤ The settings for the reference measurement are then opened.

1) This information is used to determine the predicted value and to calculate the predicted values individually. If the required information has not been stored, you will be prompted to enter it later.

Reference measurement settings

➤ Predicted value ❶: The default setting is GLI (Global Lung Initiative)[2].
The area of validity is displayed at the bottom of the screen ❷.
If the patient data deviate from the area of validity, the system will propose
a suitable predicted value. If no suitable predicted value is available,
"none" is displayed in the "Predicted value" field. In this case, select a predicted
value yourself from the menu. The determined predicted values are displayed in
brackets during the measurement and may be incomplete.

➤ Smoking habit ❸: Select the corresponding entry from the menu.
The "Smoking habit" option is included on the printout in the
"Unconfirmed report" field.

➤ Measurement type ❹: The first measurement taken from a patient is always
a reference measurement. The measurement type can only be changed
with follow-up measurements (spasmolysis or provocation).

➤ Medication and Dosage (optional) ❺: You can specify here what medication
was administered to the patient. For this function to be available, a selection of
possible medications must have been previously stored in custo diagnostic.
To do so, open the Examination, Spirometry, Settings, Diagnostic, Drugs screen.
Enter the medication in the "Drugs" area ❻ and click on Add ❼.
The procedure is identical in the "Dosage" area. Save your input.

➤ Test with custo spiro protect ❽: To obtain precise measurements,
indicate if you are using bacterial and viral filters.

➤ Environment Data ❾: Set the environment data correctly
(weather station, Internet). Confirm your input.

2) The preset predicted value can
be changed in the custo diagnostic
settings, see chapter 3.6 Settings for
the spirometry.

GLI is characterised by the
following features:
• The underlying population for
the predicted values is much more
extensive and broad than for other
predicted values.
• The equation for determining the
average predicted values is more
accurate than for other predicted
values.
• There is no noticeable transition
from childhood to adulthood.

Overview of the measurement interface

ⓐ The predicted value that has been selected for the measurement series, in this case GLI

ⓑ Orientation aid (only for GLI, otherwise predicted value curve) constructed from FVC and FEF25-75, with the display of the predicted value range (green bars) formed from the predicted value and LLN[3]

ⓒ Display of the results for FEV, FVC and FEV1/FVC in a bar diagram; arrows mark the respective result after the measurement.
Values within the green ranges can be considered as acceptable.
Values located in the grey areas of the bars are considered pathological, divided into light, moderate and severe.

ⓓ During the measurement: Inclination sensor to check the posture of the patient[4]
After the measurement: Miniature views of the performed measurements

ⓔ Table of measured values with predicted values, measured values obtained, Z-score[5] and measured value deviations in percentage from the predicted values

ⓕ Instructions for performing the breathing manoeuvre

ⓖ Display of the time-volume chart in real-time

ⓗ Settings for the measurement (change predicted value, animation on/off)

ⓘ Starting or stopping the measurement

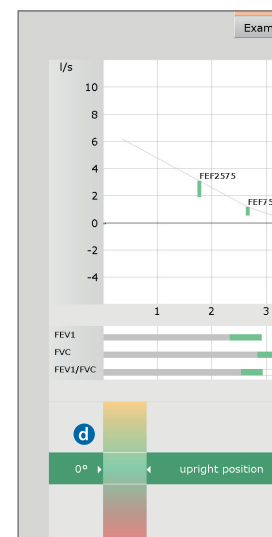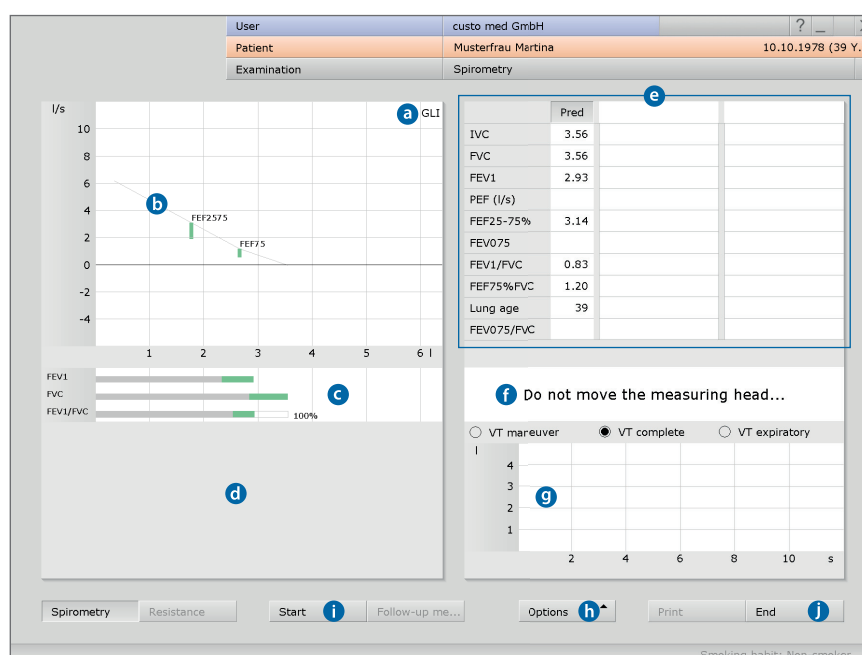**ⓙ** Ending the measurement, closing the measurement interface

Note on the functionality:

The Z-score, LLN, report assessment and the explanation according to clinical and occupational criteria are only available for measurements with the GLI predicted value.

3) LLN (Lower Limit of Normal) is the lower limit value, used to assess "normal" or "pathological". LLN corresponds to the 5% percentile of a healthy population. This means that if a measured value is below the 5% percentile, there is a 95% probability that a pathological finding exists or a patient with the corresponding value is healthy in only 5% of the cases.
The green bars in the area of the measurement curve or in the coordinate system – orientation aid (b) – are formed from the predicted value (upper edge) and LLN (lower edge). Measurement curves above or within the green bars can be considered acceptable. The same applies to all other green bars in the spirometry surface. Measured values ≥ LLN, i.e. within the green range, are considered acceptable.

4) The "Inclination sensor" function is part of the professional software and not included in the standard scope of supply. If no inclination sensor is used, this area remains empty during the first measurement. The miniature views of the measurements that have already been performed are then displayed.

5) The Z-score indicates by how many standard deviations a certain measured value deviates from the average predicted value.
For example, Z = 0 corresponds exactly to the average predicted value and Z = -2 means that the measured value is two standard deviations below the average predicted value. A specific percentile can always be assigned to each Z-score. A Z-score of -1.645 corresponds to the 5% percentile (LLN). If the Z-score is greater than or equal to -1,645, the measured value is not in the pathological range. The Z-score for the corresponding measured value is marked with a green square in the table of measured values. If the Z-score is smaller than -1.645, the value is marked with an orange-coloured square (see the guideline on spirometry. Pulmonology. 2015; 69: 146–163).

Optional: Spirometry measurement with animation for children[6]

To perform a measurement with animation for children, click on Options, Animation **k**. The procedure for performing a spirometry measurement is now demonstrated by means of animated drawings: the little dragon tries to spit fire in order to light a candle **l**. With his/her breathing, the patient supports the dragon to light the candle [7]. The procedure with animation can be shown and explained before the start of the measurement via Options, Instruction **m**.

The animation should run on a separate screen for the patient. To set an additional screen, open the Examination, Spirometry, Settings, Menu/Functions, Animation **n** screen and select the Own window **o** option in the "Animation" area. On this screen it is also possible to set for which age groups the animation should be automatically displayed **p**. Save your input (left bottom button).

6)   The "Animation for children" function is part of the "professional" software and not included in the standard scope of supply.

7)   Under Options, Setting, Animation you can define the exhalation level (PEF) at which the candle is lit. The lower the percentage, the easier it is to light the candle. Click on Confirm to apply the changes.

Performing a reference measurement

➤ The patient must wear a nose clip.

➤ Click on Start ❶.

➤ Next, the patient places the mouthpiece of the device into his/her mouth. The mouthpiece must be held firmly between the patient's lips. Provide clear instructions on how to perform the breathing manoeuvre[8]. The maximum recording time is two minutes.

➤ Remove the device from the patient after the breathing manoeuvre.

➤ To cancel an on-going measurement, e.g. if the device is handled incorrectly or the breathing manoeuvre is performed wrongly, click on the Stop button.

➤ Measurements that have been performed are displayed in the form of miniature views ❷ (several if the Repeat function was used).

➤ The most recent measurement is displayed in the coordinate system ❸. Other measurements can be displayed by clicking on the corresponding miniature views ❷.

8) Before the breathing manoeuvre takes place, the patient must take a few resting breaths. The number of resting breaths can be changed in the settings.
To do so, open the *Examination, Spirometry, Settings, Diagnostic, Parameters* screen. The setting can be found in the "Breathing manoeuvre" area. *Save* your input.

Additional feature inclination sensor

The inclination sensor ❶ is displayed after pressing the Start button. This feature is used to check the posture of the patient during the measurement. An upright posture improves the quality of the measurement and allows a more precise identi-fication of the measured values, in particular, FEV1.

The white arrows of the inclination sensor ❷ should be located in the middle, green area of the display. If the patient leans too far to the front or rear, the arrows will move into the red or yellow area, which may affect the determination of the measured values. The miniature views of the measurements that have been performed have a green, yellow or red background ❸ in order to provide information about the patient's posture during the measurement. Green: upright posture (-10° to +10°), yellow: inclined too far back, red: inclined too far forward.

Repeat measurement

- Click on Repeat ❹ in order to perform another reference measurement.
  Up to six repetitions are possible.
- If more repeat measurements are required (more than six),
  measurements in the miniature views area will need to be deleted.
- To do so, click with the left mouse button on the measurement
  that you would like to delete ❺, open the context menu by right-clicking
  and click on Delete Meas. ❻.

Defining the best measurement

- The best measurement in a series of measurements is determined by the
  software [9] and marked in bold in the same colour as the measurement curve ❼.
  This measurement is shown later when the evaluation is opened.
- To define another measurement as the best measurement, click with the
  left mouse button on the miniature view of the desired measurement,
  open the context menu by right-clicking and click on Best Meas. ❽.

Documenting patient cooperation

- Open the context menu by right-clicking, select Cooperation ❾
  and evaluate the patient's cooperation.
  Click on Confirm to transmit your data into the unconfirmed report.

Ending and closing the measurement

- With the default settings, the measurements are checked for reproducibility.
  If there are two reproducible measurements [10], a corresponding message ❿
  appears and the measurement can be finished.
- Starting a follow-up measurement: If spasmolysis or provocation is to be
  carried out immediately after the reference measurement, click on
  Follow-up measurement ⓫.
- Click on End (bottom right) and then
  on Confirm ⓬ in the End dialogue.

9) The best measurement is determined from the sum of FVC and FEV1. The best measurement can also be determined using other values. This setting can be found on the *Examination*, *Spirometry*, *Settings*, *Diagnostic*, *Parameter* screen in the "Identification best value" area.

10) This function can be switched on and off in the settings. In addition, the required number of reproducible measurements can be changed and the criteria for reproducibility adapted. These settings can be found on the *Examination*, *Spirometry*, *Settings*, *Menu/Functions*, *Menu/Functions* screen in the "Flow Control" area at the very bottom. *Save* your input.

Options during the reference measurement

➤ During the reference measurement, the following editing and reporting functions are available in the Options **a** menu:

b Print…: Print menu for compiling a printout

c Change the Predicted value

d Information on the spirometric lung age [11],

e Autom. Report [12],

f Explain Report: Table with measured values, predicted values, limit values and the Z-score. Explanation of the assessment criteria underlying the assessment functions clinical, occupational and COPD-GOLD [13].

g Report evaluation on/off: Assessment of the measurement results in a bar diagram below the measurement curve

h Progress: Superimposition of the measurement curves to check plausibility

11) The spirometric lung age is determined using the FEV1 value, if FEV1 is calculated depending on age (not for all predicted values). The spirometric lung age is calculated based on the deviation from the predicted value. The spirometric lung age can be displayed via Options, Lung age. On the Examination, Spirometry, Settings, Diagnostic, Parameter screen you can define which predicted value should be used to calculate the spirometric lung age.

12) The following types of unconfirmed reports can be selected: Standard (70% rule for FEV1/FVC and 80% rule for IVC and FVC), COPD-GOLD, clinical or occupational evaluation according to GLI.

13) Z-Score, LLN and assessment criteria clinical and occupational only for GLI.

3.4.2   Follow-up measurements: Spasmolysis and provocation

Spasmolysis and provocation are referred to as sequential measurement. These measurement types can only be carried out after a reference measurement.

Calling the follow-up measurement

➤ Start the follow-up measurement via
   Examination, Spirometry, Follow-up measurement ❶.

➤ A list will open including all patients for whom a reference measurement has already been carried out on the current day (= Spirometry group [1]) ❷.

➤ Select the patient from the list ❸ and confirm your selection with Select Patient ❹ or double-click on the name.

Sequential measurement settings

➤ Define the settings for the follow-up measurement.
   Check and, if necessary, change the data.

➤ Select the measurement type – spasmolysis or provocation ❺.

➤ You can only enter data for "Medication" ❻ if a medication list has been previously created in the settings for spirometry
   (Examination, Spirometry, Settings, Diagnostic, Drugs).
   You can also carry out a follow-up measurement without indicating the medicine administered.

➤ Click on Confirm ❼ to continue.

1)   Note on the spirometry group:
A patient is deleted from the spirometry group if a follow-up measurement has been saved, if a new measurement has been generated (via Examination, Spirometry, Measurement) or on the next day.

> **Note on follow-up measurements**
> The setting options and control elements for follow-up measurements are the same as for a reference measurement, e.g. Start, Repeat and Best Meas..

Performing a spasmolysis

➤ The patient must wear a nose clip.

➤ Click on Start.

➤ Next, the patient places the mouthpiece of the device into his/her mouth. The mouthpiece must be held firmly between the patient's lips. **Provide clear instructions on how to perform the breathing manoeuvre.** The maximum recording time is two minutes.

➤ Remove the device from the patient after the breathing manoeuvre.

➤ Repeat ❽ the measurement if necessary. Measurements that have been performed are displayed in the form of miniature views ❾ at the bottom left.

➤ The results of the spasmolysis (orange) are shown together with the results of the reference measurement (blue) for direct comparison ❿.

➤ To close the measurement interface, click on End (bottom right).

Performing a provocation test [2]

➤ The patient must wear a nose clip.

➤ Click on Start.

➤ Next, the patient places the mouthpiece of the device into his/her mouth. The mouthpiece must be held firmly between the patient's lips. **Provide clear instructions on how to perform the breathing manoeuvre.** The maximum recording time is two minutes.

➤ Remove the device from the patient after the breathing manoeuvre.

➤ Repeat the measurement if necessary.

➤ The results of the provocation (green) are shown together with the results of the reference measurement (blue) for direct comparison ⓫.

➤ Under Options, Provocation test the PD20 provocation dosage is displayed [3].

➤ The next measurement is triggered via the Follow-on measurement ⓬ button (or later via Examination, Spirometry, Follow-on measurement).

➤ To close the measurement interface, click on End ⓭.

[2] Procedure for performing a provocation test: A maximum of eight provocation measurements are followed by one dilation measurement and up to eight control measurements.
The different measurement types for a provocation test are highlighted in colour in custo diagnostic to enable them to be distinguished more easily:

Reference measurement _____ blue
Provocation _____ green
Dilatation _____ orange-brown
Control measurement orange-brown

[3] PD20 provocation dosage: Medication dosage for the 20 percent drop of FEV1 in a provocation measurement compared to the initial value in the reference measurement.

3.4.3   Unconfirmed report

To open the Unconfirmed Report ❶, right-click on the measurement interface and select Report in the context menu.

If the Unconfirmed report option is enabled in the system settings, the unconfirmed report dialogue will already contain an automatic system report ❷. This option is enabled by default and can be disabled under Spirometry, Settings, Diagnostic, Reports. You can modify and supplement the text in the unconfirmed report dialogue. To save your input, click on Confirm ❸. By pressing Cancel ❹, the unconfirmed report is closed without any changes being applied.

If you save your input with Confirm ❸, the unconfirmed report becomes a (preliminary) report, depending on the reporting rights of the current user. The evaluation is thus (pre-)confirmed. If the evaluation is not to be classified as (pre-)confirmed at this point, you can reset the report status when selecting End in the End dialogue.

> All unconfirmed reports produced by the system should be considered as suggestionsonly. For diagnosis and therapy purposes it is essential that the results are checked and assessed by a qualified physician.

Additional automatic reports

By selecting Options, Autom. Report, you can add the following evaluations to the report ❺:

- ➤ Standard, according to the 70% rule for FEV1/FVC and 80% rule for IVC and FVC
- ➤ COPD-GOLD[1], information about the presence of chronic obstructive pulmonary disease and its severity
- ➤ Clinical evaluation according to GLI
- ➤ Occupational evaluation according to GLI

1)   custo diagnostic can be set so that the COPD-GOLD report is automatically included in the unconfirmed report. To do so, open the Examination, Spirometry, Settings, Diagnostic, Autom. Report screen and activate the COPD-GOLD option. Specify whether the COPD-GOLD report should be included after a reference measurement or after a spasmolysis in the unconfirmed report. The other automatic reports can also be configured here. Save your input.

3.4.4   Printing the measurement

➤ **Print with system settings:**

In the measurement interface, click on the Print[1] ❶ button.

➤ **Print with temporarily changed print settings:**

If you do not want to print with the system settings,
open the Options, Print... screen in the measurement interface ❷
and carry out your print settings there. Changes in this print menu
only affect the current print.
Start printing by clicking on the Print ❸ button.

➤ **Print with the Job Manager:**

The print orders will be collected in the Job Manager from where they can be
printed collectively at a later point in time. In order to store print jobs
in the Job Manager, open the Options, Print... ❷ screen and click on
Print Task ❹. The existing print jobs are started on the Examination,
Job Manager using the Execute/Execute all button.

[1]   The system settings for the
printed pages of a spirometry
measurement can be found in custo
diagnostic on the *Examination*,
Spirometry, *Settings*, *Print*, *Printed
pages* screen. On the *Examination*,
Spirometry, *Settings*, *Print*, *General*
screen you can define in the "Print
sequence control" area which
printed pages are printed when the
Print button is pressed
(Current page, Pre-set pages or
Total Printout PA).

3.5   Working with the evaluation

3.5.1   Opening an evaluation

custo diagnostic offers different options to open an evaluation, e.g. via the evaluation search or the main menu of the respective examination.

➤ **Evaluation search**
Right-click on the Patient ❶ button. This opens the evaluation search.

In the Examinations area, enter what type of evaluation you are searching for, e.g. Spirometry ❷. In the Properties area ❸ you can define more search criteria. Example: If you set the "confirmed" property to No, you will receive a list of all the evaluations which have not yet been confirmed – a type of to-do-list.

To start the search, click on Search evaluations ❹ or activate Search automatically ❺. This option triggers an automatic search in your database whenever the search criteria are changed.

The right half of the screen displays a list of all the evaluations which correspond to the activated search criteria. To open the desired evaluation, select it from the list and click on the Show Evaluation ❻ button or double-click on the evaluation.

If you want to use the same search criteria for the next search, activate the Save selection ❼ option.

Reference between the end dialogue and the evaluation search

In order to make proper use of the evaluation search, the status of the evaluation must be set correctly in the end dialogue when you exit an evaluation.

Example:
An evaluation can only be found in the evaluation search with the property confirmed "No" if the status "Evaluation confirmed" is NOT selected in the end dialogue.

➤ **Examination main menu**

Open the examination main menu via Examination, Spirometry and click there on Show Evaluation ❶.

The patient search mask appears. In this screen select the patient whose evaluation you want to open. Enter the patient's name into the input fields in the search screen ❷.

Select the patient from the list below the input fields ❸ and confirm your selection by clicking on the Select Patient ❹ button. You can also select the patient by double-clicking on the corresponding name.

A list containing all the patient's evaluations is then displayed. Select the desired evaluation from the list ❺ and open it by means of a double-click or via the Show Evaluation ❻ button.

3.5.2 Structure of reference and spasmolysis measurements

Overview of the reference and spasmolysis measurements:
Display of the best measurement(s) each with a measurement curve(s) and a table of measured values

Comparison
of 2 evaluations for a patient

Overlay
the measurement curves

Process control
Three reference and spasmolysis measurements with measured values and measurement curves for direct comparison

Options menu:

Print...
Export...
Predicted value
Medications
allocate new
Repeatability

Options menu:

Print...
Trend [1]
Export...
Predicted value
Medications
Miller Quadrant [2]
Lung age [3]
Autom. Report [4]
Explain Report [5]
allocate new

Note on the functionality:
The Z-score, LLN, report assessment and the explanation according to clinical and occupational criteria are only available for measurements with the GLI predicted value.

!

1) All evaluations for a patient as a bar diagram with a table of measured values. In addition, the Z-score trend can be displayed for each measured value.
2) Indicates the probability of developing a disease and its severity.
3) Specified in years, calculated based on FEV1 depending on age, not possible for all predicted values.
4) The following types of unconfirmed reports can be selected and added to the report text: Standard (70% rule for FEV1/FVC and 80% rule for IVC and FVC), COPD-GOLD, clinical or occupational evaluation according to GLI.
5) Assessment criteria for clinical , occupational and COPD-GOLD reports
6) PD20 provocation dosage: Medication dosage for the 20 percent drop of FEV1 in a provocation measurement compared to the initial value.

3.5.3   Structure of provocation measurements

Overview of provocation
Bar diagram and table of measured values with reference, provocation, dilatation and control measurements

Comparison
of 2 evaluations for a patient

Overlay
the measurement curves

Single test
Measurement selected in the
overview with measurement curve
and table of measured values

Options menu:
Print...
Trend [1]
Export...
Predicted value
Medications
Miller Quadrant [2]
Lung age [3]
Autom. Report [4]
Explain Report [5]
allocate new

Options menu:
Print...
Trend [1]
Export...
Predicted value
Medications
Lung age [3]
Provocation test [6]
allocate new

Note on the functionality:
The Z-score, LLN, report assessment and the explanation according to clinical and occupational criteria are only available for measurements with the GLI predicted value.

1) All evaluations for a patient as a bar diagram with a table of measured values. In addition, the Z-score trend can be displayed for each measured value.
2) Indicates the probability of developing a disease and its severity.
3) Specified in years, calculated based on FEV1 depending on age, not possible for all predicted values.
4) The following types of unconfirmed reports can be selected and added to the report text: Standard (70% rule for FEV1/FVC and 80% rule for IVC and FVC), COPD-GOLD, clinical or occupational evaluation according to GLI.
5) Assessment criteria for clinical , occupational and COPD-GOLD reports
6) PD20 provocation dosage: Medication dosage for the 20 percent drop of FEV1 in a provocation measurement compared to the initial value.

3.5.4 Navigation in the evaluation

The buttons for opening the various evaluation screens are located at the bottom of the screen. By pressing one of the buttons, e.g. Comparison ❶, the comparison view is opened and the name of the button changes to Evaluation ❷ (the name of the previous screen). When you click on the Evaluation ❷ button you can return to the overview.

"Overview"
evaluation screen

"Comparison"
evaluation screen

3.5.5   Reference and spasmolysis evaluation

a Flow-volume charts
(reference measurement: blue, spasmolysis: orange)

b Predicted value, in this case GLI

c Display of the results for FEV, FVC and FEV1/FVC in a bar diagram;
blue or orange arrows mark the respective result.
Values within the green ranges can be considered as acceptable [1].
Values located in the grey areas of the bars are considered pathological,
divided into light, moderate and severe. The evaluation can be performed
according to the criteria clinical, occupational or COPD-GOLD,
refer to the options below the diagram

d Table of measured values with predicted values, measured values, Z-score [2]
and deviations in percentage; clicking on the column header
shows or hides the corresponding curve (**a**)

e Volume-time curve

f Environmental data input before the measurement

g Comparison between the patient's current and previous evaluation

h Comparison of individual measurements from a series of measurements
(plausibility check)

i Reduced report assessment (**c**) and, if applicable, resistance results

j Options menu: Print menu, Trend (all evaluations for the patient as a bar
diagram and Z-score trend of all evaluations),
Export evaluation (e.g. Excel, PDF, e-mail), Change predicted value,
Medication Overview, Miller Quadrant [3], Lung age [4], Autom. Report [5],
Explain Report [6], Reallocate evaluation

k Print with system settings

l End evaluation

1) The green ranges in the bar diagram are defined by the predicted value (upper limit/right end) and LLN – Lower Limit of Normal (lower limit/ left end). LLN is the lower limit value used to assess "normal" or "pathological". LLN corresponds to the 5% percentile of a healthy population. This means that if a measured value is below the 5% percentile, there is a 95% probability that a pathological finding exists or a patient with the corresponding value is healthy in only 5% of the cases.

2) The Z-score indicates by how many standard deviations a certain measured value deviates from the average predicted value. For example, Z = 0 corresponds exactly to the average predicted value and Z = –2 means that the measured value is two standard deviations below the average predicted value. A specific percentile can always be assigned to each Z-score. A Z-score of – 1.645 corresponds to the 5% percentile (LLN). If the Z-score is greater than or equal to –1,645, the measured value is not in the pathological range. The Z-score for the corresponding measured value is marked with a green square in the table of measured values. If the Z-score is smaller than –1.645, the value is marked with an orange-coloured square (see the guideline on spirometry. Pulmonology. 2015; 69: 146–163).

3) The Miller Quadrant indicates the probability of the existence of a disease and its severity. The relationship between FEV1%VC and FVC is determined and the result is entered in the coordinate system. The coordinate system is divided into the four areas Obstruction, Obstruction & Restriction, Restriction and Normal. The FEV1%VC value is entered as a percentage on the x-axis, the FVC value achieved in comparison to the predicted value is entered as a percentage on the y-axis. The intersection of these values is marked with a cross. The marking crosses are in the colour of the measurement type.

4) The spirometric lung age is determined using the FEV1 value, if FEV1 is calculated depending on age (not for all predicted values). The spirometric lung age is calculated based on the deviation from the predicted value. The spirometric lung age can be displayed via Options, Lung age. On the Examination, Spirometry, Settings, Diagnostic, Parameter screen you can define which predicted value should be used to calculate the spirometric lung age.

5) The following types of unconfirmed reports can be selected: Standard (70% rule for FEV1/FVC and 80% rule for IVC and FVC), COPD-GOLD, clinical or occupational evaluation according to GLI.
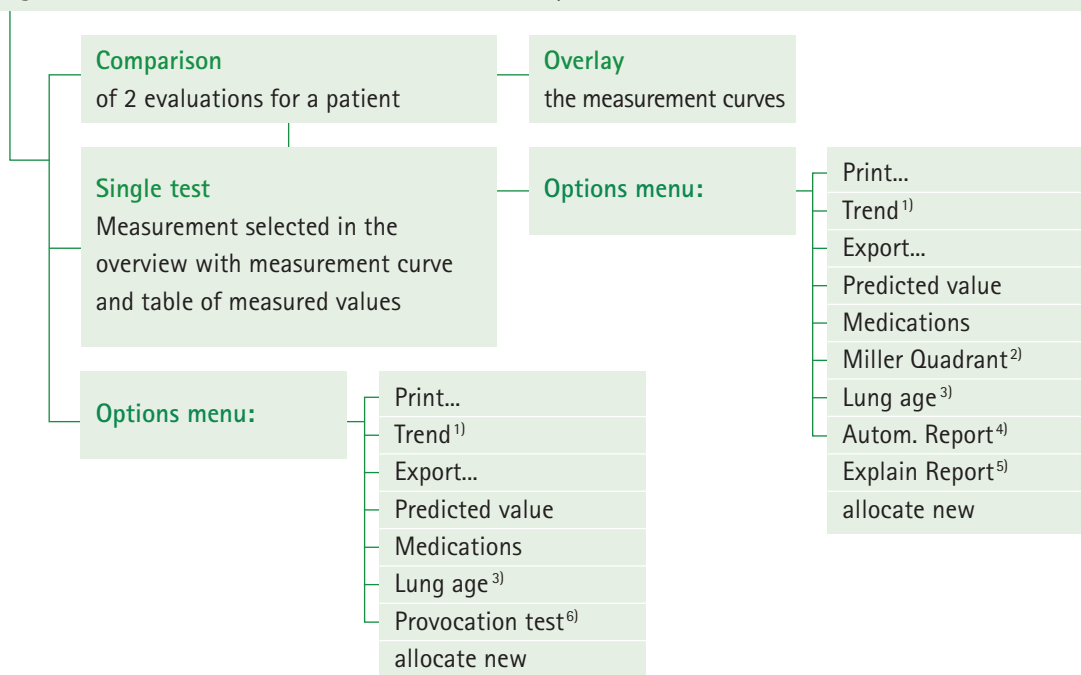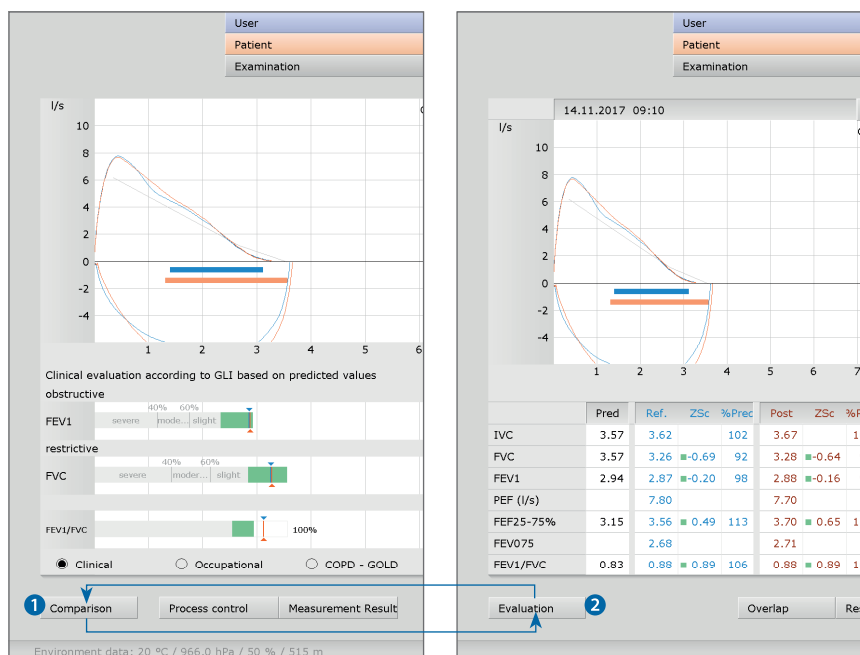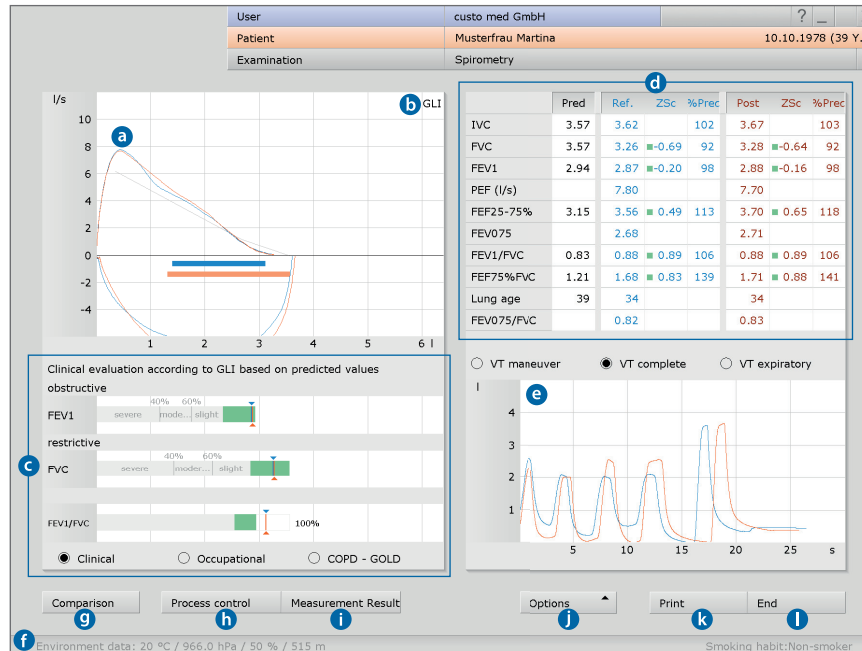
6) Table with measured values and predicted values, limit values and the Z-score. Explanation of the evaluation criteria underlying the evaluation functions.

3.5.6 Provocation evaluation

	Pre. value GLI	Reference 10:10	Provocation 10:13	Provocation 10:15	Provocation 11:09	Dilation 11:09	Control 11:10	Control 11:20
IVC	3.57	3.55	3.00	2.41	2.38	3.33	3.26	3.44
FVC	3.57	3.28	2.83	2.23	2.25	2.97	3.13	2.87
FEV1	2.94	2.88	2.64	2.20	2.20	2.86	2.93	2.85
PEF (l/s)		8.08	5.49	4.66	4.32	7.86	7.96	7.66
FEF25-75%	3.15	3.53	3.88	3.68	3.34	4.35	4.19	4.60
FEV075		2.69	2.47	2.09	2.07	2.70	2.75	2.72
FEV1/FVC	0.83	0.88	0.93	0.99	0.98	0.96	0.93	0.99
FEF75%FVC	1.21	1.72	2.03	2.26	2.14	2.52	2.32	2.82
Lung age	39	34	43	61	61	34	32	35

Environment data: 20 ºC / 966.0 hPa / 50 % / 515 m   Smoking habit:Non-smoker

a Graphical representation of all the measurements of the measurement series with the selected measured value displayed as a bar, here IVC

b Measured value buttons for displaying another measured value in the graphic **a**

c Table of measured values – the value selected in the range **b** is highlighted in red

d Buttons for selecting a measurement in the measurement series, e.g. to open the selected measurement in the single view (Single Test **g** button)

e Environmental data input before the measurement

f Comparison between the patient's current and previous evaluation

g The selected measurement **d** is displayed as a as a single test (Same interface as in *3.5.5 Reference and spasmolysis evaluation*)

h Options menu: Print menu, Trend (all evaluations for the patient as a bar diagram and Z-score trend of all evaluations), Export evaluation (e.g. Excel, PDF, e-mail), Change predicted value, Medication Overview, Lung age [1], Provocation test [2], Reallocate evaluation

i Print with system settings

j End evaluation

1) The spirometric lung age is determined using the FEV1 value, if FEV1 is calculated depending on age (not for all predicted values). The spirometric lung age is calculated based on the deviation from the predicted value. The spirometric lung age can be displayed via Options, Lung age. On the Examination, Spirometry, Settings, Diagnostic, Parameter screen you can set which predicted value should be used to calculate the spirometric lung age.

2) PD20 provocation dosage: Medication dosage for the 20 percent drop of FEV1 in a provocation measurement compared to the initial value in the reference measurement.

3.5.7 Additional screens of a spirometry evaluation

➤ **Process control**
 (only for reference and spasmolysis evaluations)

	Pred	Meas. 09:10		Meas. 09:10		Best 09:11		Best 10:05		Meas. 10:06		Meas. 10:06	
IVC	3.57	3.36	94	3.42	96	3.62	102	3.67	103	3.51	98	3.56	100
FVC	3.57	3.08 ■-1.12	86	3.21 ■-0.80	90	3.26 ■-0.69	92	3.28 ■-0.64	92	3.28 ■-0.64	92	3.29 ■-0.63	92
FEV1	2.94	2.73 ■-0.58	93	2.83 ■-0.32	96	2.87 ■-0.20	98	2.88 ■-0.16	98	2.86 ■-0.21	97	2.86 ■-0.22	97
PEF (l/s)		6.84		7.17		7.80		7.70		7.63		7.67	
FEF25-75%	3.15	3.59 ■ 0.53	114	3.55 ■ 0.48	113	3.56 ■ 0.49	113	3.70 ■ 0.65	118	3.51 ■ 0.43	111	3.46 ■ 0.38	110
FEV075		2.56		2.64		2.68		2.71		2.68		2.67	
FEV1/FVC	0.83	0.89 ■ 1.06	107	0.88 ■ 0.91	106	0.88 ■ 0.89	106	0.88 ■ 0.89	106	0.87 ■ 0.77	105	0.87 ■ 0.73	105
FEF75%FVC	1.21	1.66 ■ 0.79	137	1.64 ■ 0.77	136	1.68 ■ 0.83	139	1.71 ■ 0.88	141	1.58 ■ 0.67	131	1.63 ■ 0.74	134
Lung age	39	40		36		34		34		34		34	

Environment data: 20 ºC / 966.0 hPa / 50 % / 515 m   Smoking habit:Non-smoker

ⓐ Flow-volume charts (reference measurement: blue, spasmolysis: orange)

ⓑ Predicted value, in this case GLI

ⓒ Miniature views of the existing measurements
 clicking on a measurement displays the respective measurement curve
 in the ⓐ area

ⓓ Table of measured values with predicted values, measured values, Z-score [2]
 and deviations in percentage

ⓔ The selected measurement ⓒ is displayed as a as a single test

ⓕ Options menu: Print menu, Export evaluation (e.g. Excel, PDF, e-mail), Change
 predicted value, Medication Overview, Reallocate evaluation, repeatability [2]

ⓖ Print with system settings

ⓗ End evaluation

This screen is opened via the Progress Control button. The Single Test button opens
the overview again.

The Process Control option is used to compare a series of reference and/or
spasmolysis measurements in order to check the quality of the patient's cooperation
as well as the plausibility of the results. It is a precondition that the measurements
have been made in direct succession.

By clicking on the miniature views of the curves the measurements can be super-
imposed. By clicking on the miniature again, the superimposition is disabled again.
Strong deviations between the measurement curves show that the patient has not
cooperated correctly.

[1] The Z-score indicates by how many standard deviations a certain measured value deviates from the average predicted value.
For example, Z = 0 corresponds exactly to the average predicted value and Z = -2 means that the measured value is two standard deviations below the average predicted value.
A specific percentile can always be assigned to each Z-score. A Z-score of -1.645 corresponds to the 5% percentile (LLN). If the Z-score is greater than or equal to -1,645, the measured value is not in the pathological range. The Z-score for the corresponding measured value is marked with a green square in the table of measured values. If the Z-score is smaller than -1.645, the value is marked with an orange-coloured square (see the guideline on spirometry. Pulmonology. 2015; 69: 146-163).

[2] In order to make a statement on the quality and plausibility of a measurement series, the FEV1 values of a measurement series and the FVC values of a measurement series are compared with each other. If the deviation is less than 5%, the reproducibility criteria are met. The measured values and limits on which the check is based can be adjusted as required on the Examination, Spirometry, Settings, Menu/Functions screen. Save your input.

➤ **Comparison**

With the Compare function (at the bottom left of the evaluation overview), the open evaluation can be compared with another evaluation of the patient. The comparison can also be called in the spirometry main menu with Show Comparison.

When you click on Overlap **a** the measurement curves of both evaluations are superimposed. The Evaluation **b** button leads back to the single view of the selected evaluation (pressed date line **c**).
The comparative measurement can also be displayed as an individual measurement. For this, click on the date line above the measurement curve **d** and on Evaluation **b**. The arrow buttons **e** provide you with lists of all the available evaluations for the patient. To open one of these evaluations, select the desired evaluation and click on the Evaluation **b** button.

➤ Trend

The trend view is opened in the spirometry main menu with Show Trend or in the open evaluation via Options, Trend.

The trend view serves to display developments over a longer period of time. All the measurements for a patient are shown as a bar diagram **a** with a table of measured values **b**. The selected measured value **c** is displayed in the chart **a** (measured value: blue, predicted value: grey/green). The line with the corresponding measured values is highlighted in colour in the table of measured values **b**. To display another measured value, click on the desired measured value button **d**.

For measurement series with predicted value GLI: The green areas on the grey bars show the standard value range **e** (upper limit: predicted value, lower limit: LLN). Blue measured value bars whose upper edges are level with the green areas or above can be considered as acceptable. Values below the green areas are in all probability to be considered as pathological. Measured values that are not taken into account with GLI do not have the green standard value ranges for the predicted value display.

In addition, the Z-score values for the patient are shown in the table of measured values **f**. Values with a green marking are ≥ -1.645 and therefore acceptable; values with an orange-coloured marking are < -1.645 and probably to be assessed as pathological. The development of the Z-score for the values FEV1, FVC and FEV1/FVC can be displayed via the ZScore Trend **g** button[3].

Additional measurements can be displayed using the scroll bar at the bottom of the screen **h**. To open a measurement from the trend, select the desired measurement by clicking on the button with the date of creation **i** [4]. Then click on Evaluation **j**.

3) The Z-score values of the respective measured value are plotted over time (y-axis: Z-score, x-axis: date). The standard value range is within the green lines. Values below the lower green line are to be considered as pathological.

Colour marking of the measured values in the Z-score trend:
FEV1 _____ orange
FVC _____ pink
FEV1/FVC _____ blue

4) The trend view also considers the results of already deleted and archived measurements. These results can no longer be shown in the single view.

3.5.8 Confirming the evaluation

Unconfirmed report and report

The unconfirmed report is opened by right-clicking on the evaluation interface. Select Report via the context menu. Enter your data in the text field ❶. If the Unconfirmed report or Interpretation option is selected in the system settings, an automatic system unconfirmed report is already present in the text field[1].

If necessary, older reports can be displayed via the report history (collapsible list above the text input field). When you click on Confirm ❷ your input is saved and the unconfirmed report becomes a (preliminary) report, depending on the report rights of the current user. If your (unconfirmed) report is not yet complete but you want to save it nevertheless without reaching the "Evaluation (pre)confirmed" status, the

report status is reset upon ending (End) the evaluation.

Text modules – an aid for writing reports
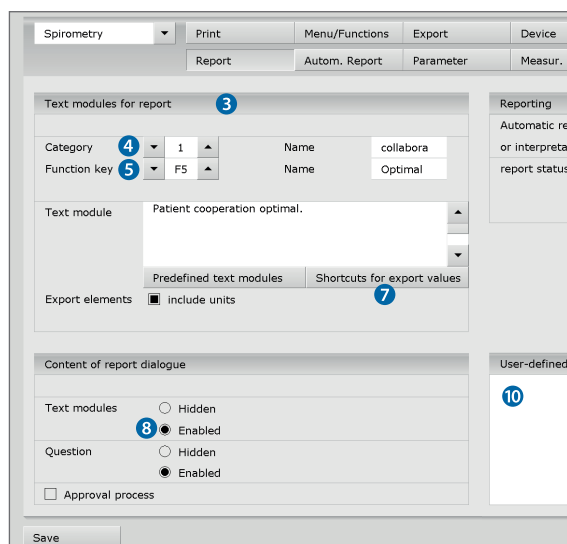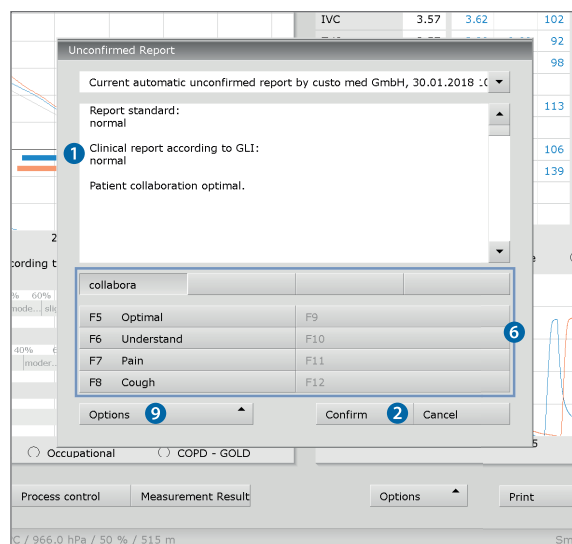
On the Examination, Spirometry, Settings, Diagnostic, Report screen you can create text modules for confirming an evaluation ❸. A total of four groups ❹ can be stored with up to eight text modules ❺. The text modules are called in the unconfirmed report dialogue using the keyboard (F5 to F12) ❻.

A text module can be created from normal text as well as variables. When you use a text module in the unconfirmed report, the actual value from the evaluation is inserted in the report text instead of a variable. The structure of a variable is {VARIABLE} (e.g. FVC predicted value: {FVC_S}). The Short-cuts for export values ❼ button provides you with a list containing all the variables. If the text modules should be shown in the unconfirmed report, make sure that the Enabled ❽ option is enabled. Alternatively, the text modules can be shown in the unconfirmed report via Options, Texts on ❾.

You also have the option of entering a text, which will be automatically shown in each unconfirmed report ❿. The text can be changed later in the unconfirmed report dialogue. Save your input.

1) In addition, further automatic reports may already be included, e.g. according to the criteria clinical, occupational or COPD-GOLD. These automatic reports can be supplemented via Options, Autom. Report.
In the settings, you can define which automatic reports should be included in the unconfirmed report by default. To do so, open the Examination, Spirometry, Settings, Diagnostic, Autom. Report screen. Save your input.

3.5.9   Ending the evaluation

Click on End (bottom right) in the evaluation. The End dialogue opens. This is where the "Status of evaluation" ❶ is defined [1].

➤ evaluation preconfirmed ❷: active if a user with the reporting right "Preconfirm evaluations" has confirmed the unconfirmed report of an evaluation.

➤ confirmed ❸ – active if a user with the reporting right "Confirm evaluations" has confirmed the unconfirmed report. The "confirmed" status can be reset if required.

➤ printed ❹ – indicates if the evaluation has been printed.

➤ indelible ❺ – can be selected after reporting has been completed. The evaluation can now only be viewed and can no longer be changed.

Click on Confirm ❻ to close the evaluation.

1) *The assignment of properties (status of evaluation) in the End dialogue makes it easier to find evaluations in the evaluation search.*

3.5.10   Optional: Reporting with approval process

If custo diagnostic is used with approval process, then authorised persons with the corresponding user rights can save pre-reports of other persons as a report, without having to close the evaluation which was opened previously (shortened workflow) or enter pre-reports/reports directly if the evaluation was created by a person without reporting rights.

The approval process is visible in the unconfirmed report dialogue ❶ of an evaluation. The user or reporter can be changed there (User name ❷, Password ❸, Enter). During the log-on process, the user rights of the respective user are checked and the software interface is adapted accordingly ❹. The reporting is documented in the evaluation information ❺ (context menu).

The approval process must be activated user and project-related in the settings and in the custo service centre. The user rights must be set according to the workflow [2]. Contact your authorised custo med dealer or custo med.

2) *Note: Pre-reporting physicians must have the user right Preconfirm evaluations, reporting physicians must have the user rights Confirm evaluations and Change reports of other users.*

3.6   Settings for the spirometry

➤ **Configuring the printout**

On the Examination, Spirometry, Settings, Print, General ⓐ screen you can define which printed pages are printed when the Print button is pressed. In the "Print sequence..." area, select either:

➤ Current page ⓑ (creates a printout of the open evaluation screen),

➤ Pre-set pages ⓒ (refer to paragraph below for information on configuration)

➤ or Total Printout PA ⓓ (professional association, the contents are predefined).

On this screen you can also select the printer for spirometry printouts (on the right half of the screen). Save ⓔ your input.

Defining the contents for the Pre-set pages option:

The settings for the printed pages can be found on the Examination, Spirometry, Settings, Print, Printed pages ⓕ screen. The contents of the printout can be compiled in the "Printed pages" ⓖ area.

The Summary ⓗ option is the default setting. This contains a table of measured values, a flow-volume chart, a volume-time curve and an unconfirmed report. The summary can be combined with all other options (report assessment, total table of measured values etc.).

The steps shown are for defining your standard print settings ⓘ. The standard print settings ⓘ apply automatically to all other types of printout (print job via the Job Manager, PDF export).

To change the print settings for other types of printout, select the desired printout type in the "Type of printout" area and define the screen contents as described above. Save ⓙ your input.

➤ **Parameters for the spirometry measurement**

On the Examination, Spirometry, Settings, Diagnostic, Parameter **a** screen you can set various parameters for the measurement:

Predicted values and area of validity Define which predicted value should be proposed by default for children and adults **b**. If you enable the Also outside **c** option in the "Validity" area, the predicted value **b** will also be proposed if the patient data do not match the area of validity of the predicted value. In this case, the predicted values are displayed in brackets in the software interface.

Comparison d: You can specify here whether the percentage deviation of the measured values in comparison to the predicted value is to be specified for reference measurements and whether the percentage deviation of the measured values in comparison to the reference or predicted values is to be specified for follow-up measurements.

Spirometric lung age e: Select the predicted value according to which the spirometric lung age is to be calculated. The spirometric lung age is determined using the FEV1 value, if FEV1 is calculated depending on age.

Breathing manoeuvre f: Adjust the required resting breaths before the breathing manoeuvre.

Identification best value g: Define which measured value is to be used to determine the best measurement of a test series. In the "Identification best value" area, select either Sum of FVC and FEV1, FEV1, FVC or IVC.

Flow-volume chart h: For an ATS-compliant display of the flow-volume chart in custo diagnostic, enable Show flow-volume chart by ATS... .

Save your input.

➤ **Display of measured values in the software interface and in the printout**

On the Examination, Spirometry, Settings, Diagnostic, Measur. Display **a** screen you can set for each predicted value which measured values are to be displayed in the software interface and in the printout (if a different display from the default setting is desired).

In the "Predicted values" area, select the predicted value **b**. Up to seven measured values can then be selected for display **c**. The selected measured values are displayed on the right half of the screen in the "Measurement display" area **d**. The order of the selected measured values can be changed using the arrow keys **e**. The measured values IVC, FVC and FEV1 are always displayed and cannot be changed **f**.

By pressing the reset default values **g** button, the default settings are displayed again. Save **h** your input.

➦ Procedures and functions for the spirometry measurement

These settings can be found on the Examination, Spirometry, Settings, Menu/Functions, Menu/Functions ⓐ screen.

Measurement units for the environmental data ⓑ

You can change the environmental data units in the Environment Data area. The default settings are °Celsius (°C), hPascal (hPa) and Metre (m).

Flow control, Expiratory only ⓒ

If this option is enabled, the patient has to exhale forcefully into the device only once for the spirometry measurement (no resting breathing).

Flow control, Check measurements for repeatability ⓓ

In order to make a statement on the quality and plausibility of a measurement series, the FEV1 values of a measurement series and the FVC values of a measurement series are compared with each other. If the deviation is less than 5%, the reproducibility criteria are met. If there are three measurements within the specified limits, a message appears indicating that the measurement series can be ended.

Save ⓔ your input.

➤ **Quality management**

These settings can be found on the Examination, Spirometry, Settings, Menu/Functions, Quality management **a** screen. The Quality management **b** function can be switched on and off as required.

This function supports the correct use of the custo spiro mobile testing device as well as its maintenance and care in order to permanently ensure the quality of the measurements. The checking mechanism examines the best reference measurements of five consecutive patients. If there are deviations from the set limits in five consecutive patients, the system displays corresponding information. The limits are preset as follows:

➤ If FEV1 is 10 % smaller than the predicted value and the tilt of the measuring head is simultaneously in the red range (> 10°) **c**, custo diagnostic displays the message " ... Please make sure that the patient is in an upright position during the measurement. ..."

➤ If IVC or FVC are 10 % greater than the predicted value **d**, custo diagnostic displays the message " ... The value for FVC or IVC was more than 10% above the predicted value. We therefore recommend to clean the measuring head and to check the calibration.". The values for checking can be adjusted if necessary.

Save **e** your input.

3.7 Error messages and remedies

Error message: Spirometry device not ready for use

➤ Confirm the error message, close the spirometry software if necessary.

➤ Disconnect the USB plug of the spirometry testing device from the PC.

➤ After a few seconds reconnect the device to the PC.
When the LED in the handhold is illuminated, the device is ready for use.

➤ Call the spirometry software again. This re-initialises the device.

➤ Afterwards you can continue with the examination.

➤ If the system still does not recognise your device,
custo diagnostic must be restarted.

Error message: Breathing manoeuvre could not be recognised

➤ If the patient's breathing is too weak or incorrect during the measurement,
custo diagnostic might not be able to recognise the breathing manoeuvre.
Without a breathing manoeuvre the system cannot create an evaluation.

➤ Confirm the error message.

➤ Repeat the measurement, give the patient clear breathing instructions
and follow the system's instructions on breathing.

➤ Important: The patient must not breathe into the device until
you have clicked on the Start button!

3.8 Appendix

3.8.1 Abbreviations of the spirometry measured values

Abbreviation	Unit	Description
AFEV	l2/s	Area under flow volume curve
BF	l/min	Breathing frequency at rest
ERC	l	Expiratory reserve volume
FEF25%FVC	l/s	= MEF75%FVC
FEF25-75%	l/s	Average forced expiratory flow between 25% and 75% of FVC
FEF50%FVC	l/s	= MEF50%FVC
FEF75%FVC	l/s	= MEF25%FVC
FEF75-85%	l/s	Average forced expiratory flow between 75% and 85% of FVC
FET100	s	Forced expiratory time for the total FVC
FET25-75	s	Forced expiratory time between 25 and 75% of FVC
FET95%FVC	s	Forced expiratory time at 95% of FVC
FEV0.5	l	0.5 second capacity (forced expiratory volume in 0.5 seconds)
FEV0.5%FVC	%	Relative 0.5 second capacity of forced vital capacity in percent
FEV0.5/FVC	---	Relative 0.5 second capacity of forced vital capacity
FEV0.5/VC	%	Relative 0.5 second capacity of VC
FEV0.75	l	0.75 second capacity (forced expiratory volume in 0.75 seconds)
FEV0.75/FVC	---	Relative 0.75 second capacity of forced vital capacity
FEV0.75/VC	%	Relative 0.75 second capacity of VC
FEV1	l	Absolute second capacity
FEV1%VC	%	Relative second capacity of vital capacity in percent
FEV1.5	l	1.5 second capacity (forced expiratory volume in 1.5 seconds)
FEV1.5/FVC	---	Relative 1.5 second capacity of forced vital capacity
FEV1.5/VC	%	Relative 1.5 second capacity of VC
FEV1/FEV6	---	Ratio of forced expiratory volume in the first to sixth second
FEV1/FVC	---	Relative second capacity of forced vital capacity
FEV1/VC	%	Relative second capacity of VC
FEV2	l	2 second capacity (forced expiratory volume in 2 seconds)
FEV2/FVC	---	Relative 2 second capacity of forced vital capacity
FEV2/VC	%	Relative 2 second capacity of VC
FEV3	l	3 second capacity (forced expiratory volume in 3 seconds)
FEV3/FVC	---	Relative 3 second capacity of forced vital capacity
FEV3/VC	%	Relative 3 second capacity of VC
FEV6	l	6 second capacity (forced expiratory volume in 6 seconds)
FEV6/FVC	---	Relative 6 second capacity of forced vital capacity
FEV6/VC	%	Relative 6 second capacity of VC
FIF25-75%	l/s	Average forced expiratory flow between 25% and 75% of FVC
FIT100	s	Forced inspiratory time for the total FVC

Abbreviation	Unit	Description
FIV0.5	l	0.5 second capacity (forced inspiratory volume in 0.5 seconds)
FIV0.5/VC	%	Relative 0.5 second capacity of VC (inspirat.) in percent
FIV0.75	l	0.75 second capacity (forced inspiratory volume in 0.75 seconds)
FIV0.75/VC	%	Relative 0.75 second capacity of VC (inspirat.) in percent
FIV1	l	Second capacity (forced inspiratory volume in 1 second)
FIV1%VC	%	Relative second capacity of VC (inspirat.) in percent
FIV1.5	l	1.5 second capacity (forced inspiratory volume in 1.5 seconds)
FIV1.5/VC	%	Relative 1.5 second capacity of VC (inspirat.) in percent
FIV2	l	2 second capacity (forced inspiratory volume in 2 seconds)
FIV2/VC	%	Relative 2 second capacity of VC (inspirat.) in percent
FIV3	l	3 second capacity (forced inspiratory volume in 3 seconds)
FIV3/VC	%	Relative 3 second capacity of VC (inspirat.) in percent
FVC	l	Forced vital capacity
IC	[l]	Inspiratory capacity (amount of air that can be inhaled after normal expiration) IRC + T
IRC	l	Inspiratory reserve volume
IVC	l	Inspiratory vital capacity
Lung age	Years	The patient's spirometric lung age is determined using the measured FEV1, if FEV1 is calculated depending on age (different depending on the predicted value).
MEF25%FVC	l/s	Forced expiratory flow at 25% of FVC
MEF50%FVC	l/s	Forced expiratory flow at 50% of FVC
MEF75%FVC	l/s	Forced expiratory flow at 75% of FVC
MIF25%FVC	l/s	Forced inspiratory flow at 25% of FVC
MIF50%FVC	l/s	Forced inspiratory flow at 50% of FVC
MIF75%FVC	l/s	Forced inspiratory flow at 75% of FVC
MVV	l	Maximum voluntary ventilation
OBQ		Obstruction ratio
PEF	l/s	Peak flow, maximum expiratory flow
PIF	l/s	Peak flow, maximum inspiratory flow
tE	s	Average time of expiration at rest
tI	s	Average time of inspiration at rest
TV	l	Tidal Volume
VCmax	l	Maximum vital capacity, inspiratory or expiratory
VTtI	l/s	Average inspiratory flow at rest

3.8.2   Calculation tables for predicted values

The predicted values define their areas of validity using age, height, weight, ethnicity etc. A suitable predicted value for the measurement is allocated to the patient according to his/her data. The standard setting for children and adults is GLI.

Abbreviations in the calculation tables

- A = Age
- H = Height
- G = Weight
- B = Broca index = Weight: (Height - 100)
- Fi = Obesity = $H : \sqrt[3]{W}$

- M = Predicted value
- S = Coefficient of variation
- AfrAm = Afro-American ethnicity
- NEAsia = North-East Asian ethnicity
- SEAsia = South-East Asian ethnicity
- Other = other ethnic groups

Multicèntrico di Barcelona		Boys	Girls
		H = 85 – 180 cm │ A = 6 – 20 years	H = 85 – 180 cm │ A = 6 – 20 years
FVC	[l]	0.02800 * H + 0.03451 * G + 0.05728 * A – 3.21	0.03049 * H + 0.02220 * G + 0.03550 * A – 3.04
FEV1	[l]	0.02483 * H + 0.02266 * G + 0.07148 * A – 2.91	0.02866 * H + 0.01713 * G + 0.02955 * A – 2.87
MVV	[l]	(0.02483 * H + 0.02266 * G + 0.07148 * A – 2.91) * 37.5	(0.02866 * H + 0.01713 * G + 0.02955 * A – 2.87) * 37.5
FEF25-75%	[l/s]	0.038 * H + 0.140 * A – 4.33	0.046 * H + 0.051 * A – 4.30
PEF	[l/s]	0.075 * H + 0.275 * A – 9.08	0.073 * H + 0.134 * A – 7.57
MEF25%FVC	[l/s]	0.024 * H + 0.066 * A – 2.61	0.027 * H + 0.032 * A – 2.68
MEF50%FVC	[l/s]	0.017 * H + 0.157 * A + 0.029 * G – 2.17	0.046 * H + 0.067 * A – 4.17
FEV1%VC	[%]	–0.1902 * A + 85.58	–0.224 * A – 0.1126 * G + 94.88
		Men	Women
		H = 150 – 200 cm │ A = > 20 years	H = 150 – 200 cm │ A = > 20 years
FVC	[l]	0.0678 * H – 0.0147 * A – 6.05	0.0454 * H – 0.0221 * A – 2.83
FEV1	[l]	0.0499 * H – 0.0211 * A – 3.84	0.0317 * H – 0.0250 * A – 1.23
MVV	[l]	(0.0499 * H – 0.0211 * A – 3.84) * 37.5	(0.0317 * H – 0.0250 * A – 1.23) * 37.5
FEF25-75%	[l/s]	0.0392 * H – 0.0430 * A – 1.16	0.0230 * H – 0.0456 * A – 1.11
PEF	[l/s]	0.0945 * H – 0.0209 * A – 5.77	0.0448 * H – 0.0304 * A – 0.35
MEF25%FVC	[l/s]	0.0190 * H – 0.0356 * A – 0.14	0.02 * H – 0.031 * A – 0.0062 * G – 0.21
MEF50%FVC	[l/s]	0.0517 * H – 0.0397 * A – 2.40	0.0242 * H – 0.0418 * A – 1.62
FEV1%VC	[%]	–0.1902 * A + 85.58	–0.224 * A – 0.1126 * G + 94.88

Polgar79		Boys	Girls
		H = 85 – 180 cm │ A = 4 – 17 years	H = 85 – 180 cm │ A = 4 – 18 years
		Men	Women
		H = 150 – 200 cm │ A = 18 – 120 years	H = 150 – 200 cm │ A = 18 – 120 years
FVC	[l]	$2.12 * 0.000001 * H^{2.81}$	$2.34 * 0.000001 * H^{2.78}$
IVC	[l]	$2.12 * 0.000001 * H^{2.81}$	$2.34 * 0.000001 * H^{2.78}$
FEF25–75%	[l/s]	(219.66 + 2.72 * H) : 60	(219.66 + 2.72 * H) : 60
PEF	[l/s]	(467.96 + 5.59 * H) : 60	(376.51 + 4.85 * H) : 60

Polgar71		Boys	Girls
		H = 85 – 180 cm │ A = 4 – 17 years	H = 85 – 180 cm │ A = 4 – 18 years
		Men	Women
		H = 150 – 200 cm │ A = 18 – 120 years	H = 150 – 200 cm │ A = 18 – 120 years
FVC	[l]	$4.4 * 0.000001 * H^{2.67}$	$3.3 * 0.000001 * H^{2.72}$
IVC	[l]	$4.4 * 0.000001 * H^{2.67}$	$3.3 * 0.000001 * H^{2.72}$
FEV1	[l]	$2.1 * 0.000001 * H^{2.8}$	$2.1 * 0.000001 * H^{2.8}$
MVV	[l]	99.507 + 1.276 * H	99.507 + 1.276 * H
FEF25–75%	[l/s]	(207.7 + 2.621 * H) : 60	(207.7 + 2.621 * H) : 60
PEF	[l/s]	(425.5714 + 5.2428 * H) : 60	(–425.5714 + 5.2428 * H) : 60
PIF	[l/s]	5.26 + 0.06 * H	5.26 + 0.06 * H

Crapo		Men	Women
		H = 150 – 220 cm │ A = 18 – 120 years	H = 150 – 220 cm │ A = 18 – 120 years
FVC	[l]	6.00 * H – 0.0214 * A – 4.650	4.91 * H – 0.0216 * A – 3.590
IVC	[l]	6.00 * H – 0.0214 * A – 4.650	4.91 * H – 0.0216 * A – 3.590
FEV0.5	[l]	3.27 * H – 0.0152 * A – 1.914	2.38 * H – 0.0185 * A – 0.809
FEV1	[l]	4.14 * H – 0.0244 * A – 2.190	3.42 * H – 0.0255 * A – 1.578
MVV	[l]	(4.14 * H – 0.0244 * A – 2.190) * 37.5	(3.42 * H – 0.0255 * A – 1.578) * 37.5
FEV3	[l]	5.35 * H – 0.0271 * A – 3.512	4.42 * H – 0.0257 * A – 2.745
FEV1%VC	[%]	13.0 * H – 0.152 * A + 110.49	20.20 * H – 0.252 * A + 126.58
FEV3/VC	[%]	6.27 * H – 0.145 * A + 112.09	9.37 * H – 0.163 * A + 118.16
FEF25–75%	[l/s]	2.04 * H – 0.038 * A + 2.133	1.54 * H – 0.046 * A + 2.683

Morris		Men	Women
		H = 150 – 220 cm │ A = 20 – 120 years	H = 150 – 220 cm │ A = 20 – 120 years
FVC	[l]	5.83 * H - 0.025 * A - 4.241	4.52 * H - 0.024 * A - 2.852
IVC	[l]	5.83 * H - 0.025 * A - 4.241	4.52 * H - 0.024 * A - 2.852
FEV1	[l]	3.62 * H - 0.032 * A - 1.260	3.50 * H - 0.025 * A - 1.932
MVV	[l]	3.62 * H - 0.032 * A 1.260 * 37.5	3.50 * H - 0.025 * A - 1.932 * 37.5
FEV1%VC	[%]	107.12 - 12.28 * H - 0.2422 * A	88.70 - 2.67 * H - 0.1815 * A
FEF25–75%	[l/s]	1.85 * H - 0.045 * A + 2.513	2.36 * H - 0.030 * A + 0.551

Austrian reference values[1]		Men	Women
		H = 1.44 – 2.00 m │ A = 18 – 90 years	H = 1.40 – 1.90 m │ A = 16 – 90 years
FVC	[l]	$-11.606 + 8.172H - 0.0339A * H + 1.2869 \ln(A)$	$-10.815 + 6.640H - 0.0408A * H + 1.7293 \ln(A)$
FEV1	[l]	$-8.125 + 6.212H - 0.0300A * H + 0.9770 \ln(A)$	$-6.995 + 5.174 - 0.0314A * H + 1.0251 \ln(A)$
PEF	[l/s]	$(1.798 + 2.311 \ln(H) + 0.0159A - 0.000248A^2)^2$	$(1.832 + 1.838 \ln(H) + 0.0078A - 0.000172A^2)^2$
MEF75%FVC	[l/s]	$(1.581 + 1.854 \ln(H) + 0.0213A - 0.000283A^2)^2$	$(1.779 + 1.421 \ln(H) + 0.0096A - 0.000179A^2)^2$
MEF50%FVC	[l/s]	$(1.490 + 1.290 \ln(H) + 0.0125A - 0.000218A^2)^2$	$(1.561 + 1.177 \ln(H) + 0.0045A - 0.000140A^2)^2$
MEF25%FVC	[l/s]	$(1.314 + 0.898 \ln(H) - 0.0083A - 0.000026A^2)^2$	$(1.372 + 0.938 \ln(H) - 0.0152A + 0.000036A^2)^2$
FEV1%VC	[%]	$101.99 - 1.191H^2 - 3.962 \ln(A)$	$118.993 - 3.0320H^2 - 6.9053 \ln(A)$
		Boys	**Girls**
		H = 1.09 – 1.96 m │ A = 5 – 17.99 years	H = 1.10 – 1.82 m │ A = 5 – 15.99 years
FVC	[l]	$\exp(-1.142 + 1.259H + 0.004070A \sqrt{W})$	$\exp(-3.842 + 4.1632 \sqrt{H} + 0.1341 \sqrt{A} - 1.614Fi)$
FEV1	[l]	$\exp(-1.178 + 1.221H + 0.003841A \sqrt{W})$	$\exp(-3.877 + 3.9808 \sqrt{H} + 0.1485 \sqrt{A} - 1.322Fi)$
PEF	[l/s]	$\exp(-0.214 + 0.921H + 0.0467A + 0.0020W)$	$\exp(0.411 + 1.793 \ln(H) + 0.4251 \ln(A) - 0.910Fi)$
MEF75%FVC	[l/s]	$\exp(-0.077 + 0.770H + 0.0373A + 0.0025W)$	$\exp(0.455 + 1.616 \ln(H) + 0.3738 \ln(A) - 0.861Fi)$
MEF50%FVC	[l/s]	$\exp(-0.522 + 0.843H + 0.0300A + 0.0035W)$	$\exp(0.256 + 1.643 \ln(H) + 0.3481 \ln(A) - 1.089Fi)$
MEF25%FVC	[l/s]	$\exp(-1.576 + 1.166H + 0.0219A + 0.0021W)$	$\exp(-0.772 + 2.002 \ln(H) + 0.3063 \ln(A) - 0.409Fi)$
FEV1%VC	[%]	$(101.99 - 1.191H^2 - 3.962 \ln(A))$	92

Cherniak[2]		Men	Women
		H = 150 – 190 cm │ A = 15 – 79 years	H = 150 – 190 cm │ A = 15 – 79 years
FVC	[ml]	47.6 * H - 14 * A - 3180	30.7 * H - 15 * A - 1310
FEV1	[ml]	35.9 * H - 23 * A - 1510	23.7 * H - 19 * A - 0190
MVV	[ml]	(35.9 * H - 23 * A - 1510) * 37.5	(23.7 * H - 19 * A - 0190) * 37.5
PEF	[ml/s]	57.6 * H - 24 * A + 0230	35.9 * H - 18 * A + 1130
MEF75%FVC	[ml/s]	35.6 * H - 20 * A + 2730	27.1 * H - 19 * A + 2150
MEF50%FVC	[ml/s]	25.7 * H - 30 * A + 2400	24.5 * H - 23 * A + 1430
MEF25%FVC	[ml/s]	14.1 * H - 41 * A + 1610	09.2 * H - 35 * A + 2220
		Boys	**Girls**
		H = 75 - 180 cm │ A = 3 - 17 years	H = 75 - 180 cm │ A = 3 - 17 years
FVC	[ml]	40.53 * H + 51.34 * A - 3655	27.86 * H + 90.96 * A - 2554

Knudson[3]		Men	Women
		H = 150 – 195 cm │ A = 25 – 80 years	H = 150 – 195 cm │ A = 25 – 80 years
FVC	[ml]	65 * H – 29 * A – 5460	37 * H – 22 * A – 1770
FEV1	[ml]	52 * H – 27 * A – 4200	27 * H – 21 * A – 790
MVV	[ml]	(52 * H – 27 * A – 4200) * 37.5	(27 * H – 21 * A – 790) * 37.5
FEV1%VC	[%]	0.087 * H – 0.14 * A + 103.64	0.111 * H – 0.109 * A + 107.38
PEF	[ml/s]	94 * H – 35 * A – 5993	49 * H – 25 * A – 735
MEF75%FVC	[ml/s]	88 * H – 35 * A – 5620	43 * H – 25 * A – 130
MEF50%FVC	[ml/s]	69 * H – 15 * A – 5400	35 * H – 13 * A – 440
MEF25%FVC	[ml/s]	44 * H – 12 * A – 4140	–14 * A + 3040
		Boys	**Girls**
		H = 140 – 193 cm │ A = 12 – 25 years	H = 140 – 193 cm │ A = 12 – 25 years
FVC	[ml]	59.0 * H – 73.9 * A – 6887	41.6 * H + 69.9 * A – 4447
FEV1	[ml]	51.9 * H – 6118	35.1 * H + 6.94 * A – 3762
MVV	[ml]	(51.9 * H – 6118) * 37.5	(35.1 * H + 6.94 * A – 3762) * 37.5
FEV1%VC	[%]	–0.0813 * H + 100.439	–0.1909 * H + 0.6655 * A + 109.97
PEF	[ml/s]	78.0 * H + 166 * A – 8060	49.0 * H + 157 * A – 3916
MEF75%FVC	[ml/s]	70.0 * H + 147 * A – 7054	44.0 * H + 144 * A – 3365
MEF50%FVC	[ml/s]	54.3 * H + 115 * A – 6385	28.8 * H + 111 * A – 2304
MEF25%FVC	[ml/s]	39.7 * H – 5.7 * A – 4242	$24.3 * H + 292.3 * A – 7.5 * A^2 – 4400.9$
		Boys	**Girls**
		H = 112 – 155 cm │ A = 6 – 12 years	H = 112 – 155 cm │ A = 6 – 12 years
FVC	[ml]	40.9 * H – 3376	43.0 * H – 3749
FEV1	[ml]	34.0 * H – 2814	33.6 * H – 2758
MVV	[ml]	(34.0 * H – 2814) * 37.5	(33.6 * H – 2758) * 37.5
FEV1%VC	[%]	0.0813 * H + 100.439	–0.1909 * H + 0.6655 * A + 109.97
PEF	[ml/s]	78.0 * H + 166 * A – 8060	49.9 * H + 157 * A – 3916
MEF75%FVC	[ml/s]	70.0 * H + 147 * A – 7054	44.0 * H + 144 * A – 3365
MEF50%FVC	[ml/s]	37.8 * H + 2545	184.6 * A + 736
MEF25%FVC	[ml/s]	17.1 * H – 1014.9	10.9 * H – 165.7

Ulmer[4]		Men H = 150 – 195 cm │ A = 15 – 75 years G = 40 – 170 kg	Women H = 150 – 195 cm │ A = 15 – 75 years G = 40 – 170 kg
IVC	[ml]	82.243 * H – 20.4 * A – 8420.5 – 69.8 * B	56.695 * H – 19.4 * A – 5096 – 69.7 * B
IRC	[ml]	47.291 * H – 11.3 * A – 6632 + 1297.3 * B	35.751 * H – 6.4 * A – 4241.4 – 1016.1 * B
ERC	[ml]	41.995 * H – 7.8 * A – 3523.8 – 1875 * B	12.126 * H – 14.4 * A + 136 – 624.6 * B
FVC	[ml]	77.576 * H – 21.7 * A – 7769.5 – 151.3 * B	52.467 * H – 19.9 * A – 4412.3 – 400.4 * B
FEV1	[ml]	53.212 * H – 26.1 * A – 4234 – 71.8 * B	23.939 * H – 20.7 * A – 641.6 – 209 * B
MVV	[ml]	(53.212 * H – 26.1 * A – 4234 – 71.8 * B) * 37.5	(23.939 * H – 20.7 * A – 641.6 – 209 * B) * 37.5
PEF	[ml/s]	66.067 * H – 20.8 * A – 2981.3 – 1249.3 * B	55.175 * H – 31.4 * A – 1683.4 – 115.1 * B
MEF50%FVC	[ml/s]	30.584 * H – 44 * A + 672.3 + 668.5 * B	26.181 * H – 22.4 * A + 2618.1 + 124 * B
MEF25%FVC	[ml/s]	25.108 * H – 39 * A – 1254.2 + 697.4 * B	20.129 * H – 35.2 * A – 438.6 + 593.6 * B

Baur[5]		Men H = 1.55 – 1.95 m │ A = 18 – 70 years	Women H = 1.45 – 1.80 m │ A = 18 – 70 years
FVC	[l]	6.00 * H – 0.0214 * A – 4.650	4.91 * H – 0.0216 * A – 3.590
FEV1	[l]	4.14 * H – 0.0244 * A – 2.190	3.42 * H – 0.0255 * A – 1.578
MVV	[l]	(4.14 * H – 0.0244 * A – 2.190) * 37.5	(3.42 * H – 0.0255 * A – 1.578) * 37.5
PEF	[l/s]	6.14 * H – 0.043 * A + 0.15	5.50 * H – 0.030 * A – 1.11
MEF75%FVC	[l/s]	5.46 * H – 0.029 * A – 0.47	3.22 * H – 0.025 * A + 1.60
MEF50%FVC	[l/s]	3.79 * H – 0.031 * A – 0.35	2.45 * H – 0.025 * A + 1.16
MEF25%FVC	[l/s]	2.61 * H – 0.026 * A – 1.34	1.05 * H – 0.025 * A + 1.11

ECCS/Quanjer[6]		Men H = 150 – 195 cm │ A = 25 – 75 years	Women H= 150 – 190 cm │ A= 25 – 75 years
IVC	[ml]	61.03 * H – 28 * A – 4654	46.64 * H – 26 * A – 3284
FVC	[ml]	57.57 * H – 26 * A – 4345	44.26 * H – 26 * A – 2887
FEV1	[ml]	43.01 * H – 29 * A – 2492	39.53 * H – 25 * A – 2604
MVV	[ml]	(43.01 * H – 29 * A – 2492) * 37.5	(39.53 * H – 25 * A – 2604) * 37.5
FEV1%VC	[%]	87.21 * H – 0.179 * A	89.10 * H – 0.192 * A
PEF	[ml/s]	61.46 * H – 43 * A + 154	55.01 * H – 30 * A –1106
MEF75%FVC	[ml/s]	54.59 * H – 29 * A – 470	32.18 * H – 25 * A + 1596
MEF50%FVC	[ml/s]	37.94 * H – 31 * A – 352	24.50 * H – 25 * A + 1156
MEF25%FVC	[ml/s]	26.05 * H – 26 * A – 1336	10.50 * H – 25 * A + 1107
FEF25–75%	[ml/s]	19.4 * H – 43.0 * A + 2700.0	12.5 * H – 34.0 * A + 2920.0

Hankinson		Boys
		Caucasian/Asian
		H = 75 – 180 cm │ A = 4 – 19 years
FEV1%VC	[%]	88.066 + (−0.2066 * A)
FEV1	[l]	0.7453 + (−0.04106 * A) + (0.004477 * A * A) + (0.00014098 * H * H)
MVV	[l]	(0.7453 + (−0.04106 * A) + (0.004477 * A * A) + (0.00014098 * H * H)) * 37.5
FEV6	[l]	−0.3119 + (−0.18612 * A) + (0.009717 * A * A) + (0.00018188 * H * H)
FVC	[l]	−0.2584 + (−0.20415 * A) + (0.010133 * A * A) + (0.00018642 * H * H)
IVC	[l]	−0.2584 + (−0.20415 * A) + (0.010133 * A * A) + (0.00018642 * H * H)
PEF	[l/s]	−0.5962 + (−0.12357 * A) + (0.013135 * A * A) + (0.00024962 * H * H)
FEF25–75%	[l/s]	−1.0863 + (0.13939 * A) + (0.00010345 * H * H)
		Afro–American
		H = 75 – 180 cm │ A = 4 – 19 years
FEV1%VC	[%]	89.239 + (−0.1828 * A)
FEV1	[l]	−0.7048 + (−0.05711 * A) + (0.004316 * A * A) + (0.00013194 * H * H)
MVV	[l]	((−0.7048 + (−0.05711 * A) + (0.004316 * A * A) + (0.00013194 * H * H)) * 37.5
FEV6	[l]	−0.5525 + (−0.14107 * A) + (0.007241 * A * A) + (0.00016429 * H * H)
FVC	[l]	−0.4971 + (−0.15497 * A) + (0.007701 * A * A) + (0.00016643 * H * H)
IVC	[l]	−0.4971 + (−0.15497 * A) + (0.007701 * A * A) + (0.00016643 * H * H)
PEF	[l/s]	−0.2684 + (−0.28016 * A) + (0.018202 * A * A) + (0.00027333 * H * H)
FEF25–75%	[l/s]	−1.1627 + (0.12314 * A) + (0.00010461 * H * H)
		Latin–American
		H = 75 – 180 cm │ A = 4 – 19 years
FEV1%VC	[%]	90.024 + (−0.2186 * A)
FEV1	[l]	−0.8218 + (−0.04248 * A) + (0.004291 * A * A) + (0.00015104 * H * H)
MVV	[l]	(−0.8218 + (−0.04248 * A) + (0.004291 * A * A) + (0.00015104 * H * H)) * 37.5
FEV6	[l]	−0.6646 + (−0.11270 * A) + (0.007306 * A * A) + (0.00017840 * H * H)
FVC	[l]	−0.7571 + (−0.09520 * A) + (0.006619 * A * A) + (0.00017823 * H * H)
IVC	[l]	−0.7571 + (−0.09520 * A) + (0.006619 * A * A) + (0.00017823 * H * H)
PEF	[l/s]	−0.9537 + (−0.19602 * A) + (0.014497 * A * A) + (0.00030243 * H * H)
FEF25–75%	[l/s]	−1.3592 + (0.10529 * A) + (0.00014473 * H * H)

Hankinson		Girls
		Caucasian/Asian
		H = 75 – 180 cm │ A = 4 – 17 years
FEV1%VC	[%]	$90.809 + (-0.2125 * A)$
FEV1	[l]	$-0.8710 + (0.06537 * A) + (0.00011496 * H * H)$
MVV	[l]	$(-0.8710 + (0.06537 * A) + (0.00011496 * H * H)) * 37.5$
FEV6	[l]	$-1.1925 + (0.06544 * A) + (0.00014395 * H * H)$
FVC	[l]	$-1.2082 + (0.05916 * A) + (0.00014815 * H * H)$
IVC	[l]	$-1.2082 + (0.05916 * A) + (0.00014815 * H * H)$
PEF	[l/s]	$-3.6181 + (0.60644 * A) + (-0.016846 * A * A) + (0.00018623 * H * H)$
FEF25–75%	[l/s]	$-2.5284 + (0.52490 * A) + (-0.015309 * A * A) + (0.00006982 * H * H)$
		Afro–American
		H = 75 – 180 cm │ A = 4 – 17 years
FEV1%VC	[%]	$91.655 + (-0.2039 * A)$
FEV1	[l]	$-0.9630 + (0.05799 * A) + (0.00010846 * H * H)$
MVV	[l]	$((-0.9630 + (0.05799 * A) + (0.00010846 * H * H)) * 37.5$
FEV6	[l]	$0.6370 + (-0.04243 * A) + (0.003508 * A * A) + (0.00013497 * H * H)$
FVC	[l]	$-0.6166 + (-0.04687 * A) + (0.003602 * A * A) + (0.00013606 * H * H)$
IVC	[l]	$-0.6166 + (-0.04687 * A) + (0.003602 * A * A) + (0.00013606 * H * H)$
PEF	[l/s]	$-1.2398 + (0.16375 * A) + (0.00019746 * H * H)$
FEF25–75%	[l/s]	$-2.5379 + (0.43755 * A) + (-0.012154 * A * A) + (0.00008572 * H * H)$
		Latin–American
		H = 75 – 180 cm │ A = 4 – 17 years
FEV1%VC	[%]	$92.360 + (-0.2248 * A)$
FEV1	[l]	$-0.9641 + (0.06490 * A) + (0.00012154 * H * H)$
MVV	[l]	$((-0.9641 + (0.06490 * A) + (0.00012154 * H * H)) * 37.5$
FEV6	[l]	$-1.2410 + (0.07625 * A) + (0.00014106 * H * H)$
FVC	[l]	$-1.2507 + (0.07501 * A) + (0.00014246 * H * H)$
IVC	[l]	$-1.2507 + (0.07501 * A) + (0.00014246 * H * H)$
PEF	[l/s]	$-3.2549 + (0.47495 * A) + (-0.013193 * A * A) + (0.00022203 * H * H)$
FEF25–75%	[l/s]	$-2.1825 + (0.42451 * A) + (-0.012415 * A * A) + (0.00009610 * H * H)$

Hankinson		Men
		Caucasian/Asian
		H = 150 – 200 cm │ A = 20 – 120 years
FEV1%VC	[%]	88.066 + (−0.2066 * A)
FEV1	[l]	0.5536 + (−0.01303 * A) + (−0.000172 * A * A) + (0.00014098 * H * H)
MVV	[l]	(0.5536 + (−0.01303 * A) + (−0.000172 * A * A) + (0.00014098 * H * H)) * 37.5
FEV6	[l]	0.1102+(−0.00842 * A) + (−0.000223 * A * A) + (0.00018188 * H * H)
FVC	[l]	−0.1933 + (0.00064 * A) + (−0.000269 * A * A) + (0.00018642 * H * H)
IVC	[l]	−0.1933 + (0.00064 * A) + (−0.000269 * A * A) + (0.00018642 * H * H)
PEF	[l/s]	1.0523 + (0.08272 * A) + (−0.001301 * A * A) + (0.00024962 * H * H)
FEF25–75%	[l/s]	2.7006 + (−0.04995 * A) + (0.00010345 * H * H)
		Afro–American
		H = 150 – 200 cm │ A = 20 – 120 years
FEV1%VC	[%]	89.239 + (−0.1828 * A)
FEV1	[l]	0.3411 + (−0.02309 * A) + (0.00013194 * H * H)
MVV	[l]	(0.3411 + (−0.02309 * A) + (0.00013194 * H * H)) * 37.5
FEV6	[l]	−0.0547 + (−0.02114 * A) + (0.00016429 * H * H)
FVC	[l]	−0.1517 + (−0.01821 * A) + (0.00016643 * H * H)
IVC	[l]	−0.1517 + (−0.01821 * A) + (0.00016643 * H * H)
PEF	[l/s]	2.2257 + (−0.04082 * A) + (0.00027333 * H * H)
FEF25–75%	[l/s]	2.1477 + (−0.04238 * A) + (0.00010461 * H * H)
		Latin–American
		H = 150 – 200 cm │ A = 20 – 120 years
FEV1%VC	[%]	90.024 + (−0.2186 * A)
FEV1	[l]	0.6306 + (−0.02928 * A) + (0.00015104 * H * H)
MVV	[l]	(0.6306 + (−0.02928 * A) + (0.00015104 * H * H)) * 37.5
FEV6	[l]	0.5757 + (−0.02860 * A) + (0.00017840 * H * H)
FVC	[l]	0.2376 + (−0.00891 * A) + (−0.000182 * A * A) + (0.00017823 * H * H)
IVC	[l]	0.2376 + (−0.00891 * A) + (−0.000182 * A * A) + (0.00017823 * H * H)
PEF	[l/s]	0.0870 + (0.06580 * A) + (−0.001195 * A * A) + (0.00030243 * H * H)
FEF25–75%	[l/s]	1.7503 + (−0.05018 * A) + (0.00014473 * H * H)

Hankinson		Women
		Caucasian/Asian
		H = 140 – 200 cm │ A = 18 – 120 years
FEV1%VC	[%]	90.809 + (-0.2125 * A)
FEV1	[l]	0.4333 + (-0.00361 * A) + (-0.000194 * A * A) + (0.00011496 * H * H)
MVV	[l]	(0.4333 + (-0.00361 * A) + (-0.000194 * A * A) + (0.00011496 * H * H)) * 37.5
FEV6	[l]	-0.1373 + (0.01317 * A) + (-0.000352 * A * A) + (0.00014395 * H * H)
FVC	[l]	-0.3560 + (0.01870 * A) + (-0.000382 * A * A) + (0.00014815 * H * H)
IVC	[l]	-0.3560 + (0.01870 * A) + (-0.000382 * A * A) + (0.00014815 * H * H)
PEF	[l/s]	0.9267 + (0.06929 * A) + (-0.001031 * A * A) + (0.00018623 * H * H)
FEF25-75%	[l/s]	2.3670 + (-0.01904 * A) + (-0.000200 * A * A) + (0.00006982 * H * H)
		Afro-American
		H = 140 – 200 cm │ A = 18 – 120 years
FEV1%VC	[%]	91.655 + (-0.2039 * A)
FEV1	[l]	0.3433 + (-0.01283 * A) + (-0.000097 * A * A) + (0.00010846 * H * H)
MVV	[l]	(0.3433 + (-0.01283 * A) + (-0.000097 * A * A) + (0.00010846 * H * H)) * 37.5
FEV6	[l]	-0.1981 + (0.00047 * A) + (-0.000230 * A * A) + (0.00013497 * H * H)
FVC	[l]	-0.3039 + (0.00536 * A) + (-0.000265 * A * A) + (0.00013606 * H * H)
IVC	[l]	-0.3039 + (0.00536 * A) + (-0.000265 * A * A) + (0.00013606 * H * H)
PEF	[l/s]	1.3597 + (0.03458 * A) + (-0.000847 * A * A) + (0.00019746 * H * H)
FEF25-75%	[l/s]	2.0828 + (-0.03793 * A) + (0.00008572 * H * H)
		Latin-American
		H = 140 – 200 cm │ A = 18 – 120 years
FEV1%VC	[%]	92.360 + (-0.2248 * A)
FEV1	[l]	0.4529 + (-0.01178 * A) + (-0.000113 * A * A) + (0.00012154 * H * H)
MVV	[l]	(0.4529 + (-0.01178 * A) + (-0.000113 * A * A) + (0.00012154 * H * H)) * 37.5
FEV6	[l]	0.2033 + (0.00020 * A) + (-0.000232 * A * A) + (0.00014106 * H * H)
FVC	[l]	0.1210 + (0.00307 * A) + (-0.000237 * A * A) + (0.00014246 * H * H)
IVC	[l]	0.1210 + (0.00307 * A) + (-0.000237 * A * A) + (0.00014246 * H * H)
PEF	[l/s]	0.2401 + (0.06174 * A) + (-0.001023 * A * A) + (0.00022203 * H * H)
FEF25-75%	[l/s]	1.7456 + (-0.01195 * A) + (-0.000291 * A * A) + (0.00009610 * H * H)

HSU		Boys	Girls
		H = 75 – 180 cm | A = 7 – 18 years	H = 75 – 180 cm | A = 7 – 18 years
FVC	[l]	$(3.58 : 10000) * H^{3.18} : 1000$	$(2.57 : 1000) * H^{2.78} : 1000$
IVC	[l]	$(3.58 : 10000) * H^{3.18} : 1000$	$(2.57 : 1000) * H^{2.78} : 1000$
FEV1	[l]	$(7.74 : 10000) * H^{3.00} : 1000$	$(3.79 : 1000) * H^{2.68} : 1000$
MVV	[l]	$(7.74 : 10000) * H^{3.00} : 1000 * 37.5$	$(3.79 : 1000) * H^{2.68} : 1000 * 37.5$
PEF	[l/s]	$((3.35 : 10000) * H^{2.79}) : 60$	$((2.58 : 1000) * H^{2.37}) : 60$
FEF25–75%	[l/s]	$((7.98 : 10000) * H^{2.46}) : 60$	$((3.79 : 1000) * H^{2.16}) : 60$

Schindl[7]		Boys	Girls
		H = 110 – 180 cm | A = 10 – 18 years	H = 110 – 180 cm | A = 10 – 18 years
FVC	[ml]	49.2 * H + 118.2 * A – 6006.0	41.7 * H + 91.3 * A – 4660.6
FEV1	[ml]	41.9 * H + 79.0 * A 4674.4	41.9 * H + 70.6 * A – 4176.1
PEF	[ml/s]	76.8 * H + 224.2 * A 8381.5	62.1 * H + 176.3 * A – 5623.2
MEF75%FVC	[ml/s]	56.2 * H + 175.4 * A – 5530.3	46.5 * H + 154.7 * A – 3627.9
MEF50%FVC	[ml/s]	41.5 * H + 109.5 * A – 3988.0	48.3 * H + 115.6 * A – 4896.6
MEF25%FVC	[ml/s]	30.3 * H + 39.0 * A – 3059.9	38.8 * H + 51.4 * A – 4331.9

ECCS–children/Quanjer		Boys	Girls
		H = 75 – 180 cm | A = 4 – 17 years	H = 75 – 180 cm | A = 4 – 17 years
FVC	[l]	$H^{2.7}$	$0.95 * H^{2.7}$
IVC	[l]	$H^{2.7}$	$0.95 * H^{2.7}$
FEV1	[l]	$0.84 * H^{2.7}$	$0.81 * H^{2.7}$
MVV	[l]	$0.84 * H^{2.7} * 37.5$	$0.81 * H^{2.7} * 37.5$
FEV1%VC	[%]	84	84
PEF	[l/s]	8.2 * H – 6.8	6.7 * H – 5.3
FEF50%FVC	[l/s]	5.6 * H – 4.4	4.6 * H – 3.3
MEF50%FVC	[l/s]	5.6 * H – 4.4	4.6 * H – 3.3

Zapletal[8]		Boys	Girls
		H = 115 – 180 cm │ A = 6 – 17 years	H = 115 – 180 cm │ A = 6 – 17 years
logVC	[ml]	-2.5768 + 2.7799 log(H)	-2.2970 + 2.6361 log(H)
logIRC	[ml]	-2.79590 + 2.73794 log(H)	-2.69813 + 2.67126 log(H)
logERC	[ml]	-3.81064 + 3.12550 log(H)	-2.74262 + 2.61668 log(H)
logVT	[ml]	-1.3956 + 1.8643 log(H)	-1.3956 + 1.843 log(H)
logFVC	[ml]	-2.9239 + 2.9360 log(H)	-2.7040 + 2.8181 log(H)
logFEV1	[ml]	-2.86521 + 2.87294 log(H)	-2.60565 + 2.74136 log(H)
FEV1%VC	[%]	90.6043 - 0.04104 * H	90.6043 - 0.0410 * H
logPEF	[l/s]	-4.37221 + 2.34275 log(H)	-4.37221 + 2.34275 log(H)
logMEF75%FVC	[l/s]	-4.01648 + 2.1541 log(H)	-4.01648 + 2.15414 log(H)
logMEF50%FVC	[l/s]	-4.21684 + 2.17719 log(H)	-4.21684 + 2.17719 log(H)
logMEF25%FVC	[l/s]	-4.58082 + 2.21169 log(H)	-4.58082 + 2.21169 log(H)
MVV	[ml]	-1.9178 + 3.0388 log(H)	-1.9178 + 3.0388 log(H)

GLI – Global Lung Function Initiative [9]	Men and women
	Age = 3 – 95 years
	(FEF25–75% and MEF25%FVC: 3 to 90 years)

The predicted values are calculated for:

- ➽ FVC
- ➽ FEV1
- ➽ FEV1/FVC
- ➽ FEF25–75%
- ➽ FEF75%FVC
- ➽ FEV075 (only children 3 to 7 years, Caucasian)
- ➽ FEV075/FVC (only children 3 to 7 years, Caucasian)

The predicted values are calculated depending on age, gender, height and ethnicity
(African American, North-East Asian, South-East Asian, Caucasian and other/mixed).

The predicted values are calculated using this formula:

$$M = \exp(a0 + a1 * \ln(\text{Height}) + a2 * \ln(\text{Age}) + a3 * \text{AfrAm} + a4 * \text{NEAsia} + a5 * \text{SEAsia} + a6 * \text{Other} + \text{Mspline})$$

For the coefficients a1, a2, a3 etc. there are defined value tables for each measured value of GLI from which the corresponding
values are inserted into the calculation formula. The calculation formula remains the same for all the measured values mentioned above.
Mspline is an age and measured value-dependent coefficient which is also taken from a value table defined by GLI.

The value PEF is not calculated when using the predicted value GLI.
Therefore, no predicted value curve can be mapped in the coordinate system in custo diagnostic.

Kainu (Finland) [10]

Men and women

Age = 18 – 83.99 years, Ethnicity: none

The predicted values are calculated for:

FEV1, FVC, FEV1FVC, MEF75, MEF50, MEF25, MMEF (FEF25–75), PEF, FEV6, FEV1FEV6

The predicted values are calculated depending on gender, height and age.

The predicted values are calculated using these formulas:

$M = \exp(a0 + a1 * \ln(height) + a2 * \ln(age) + Mspline)$

$S = \exp(b0 + b1 * \ln(Age) + Sspline)$

$LLN = M - 1.645 * S$

For the coefficients a0, a1, a2, b0 and b1, there are defined values for each measured value of Kainu,

which are inserted into the calculation formula to calculate the respective predicted value.

The calculation formula remains the same for all the measured values mentioned above.

Mspline and Sspline are age and measured value-dependent coefficients

which are also taken from a value table defined by Kainu.

Siriraj, Thailand [11]

Men

H = 155 – 185 cm ｜ A = 18 – 80 years

FVC	[l]	$-2.601 + 0.122 * A - 0.00046 * A^2 + 0.00023 * H^2 - 0.00061 * A * H$
FEV1	[l]	$-7.914 + 0.123 * A + 0.067 * H - 0.00034 * A^2 - 0.0007 * A * H$
FEF25-75%	[l/s]	$-19.049 + 0.201 * A + 0.207 * H - 0.00042 * A^2 - 0.00039 * H2 - 0.0012 * A * H$
PEF	[l/s]	$-16.895 + 0.307 * A + 0.141 * H - 0.0018 * A^2 - 0.001 * A * H$
FEV1/FVC	---	$19.362 + 0.49 * A + 0.829 * H - 0.0023 * H^2 - 0.0041 * A * H$

Women

H = 155 – 185 cm ｜ A = 18 – 80 years

FVC	[l]	$-5.914 + 0.088 * A + 0.056 * H - 0.0003 * A2 - 0.0005 * A * H$
FEV1	[l]	$-10.6 + 0.085 * A + 0.12 * H - 0.00019 * A^2 - 0.00022 * H^2 - 0.00056 * A * H$
FEF25-75%	[l/s]	$-21.528 + 0.11 * A + 0.272 * H - 0.00017 * A^2 - 0.0007 * H^2 - 0.00082 * A * H$
PEF	[l/s]	$-31.355 + 0.162 * A + 0.391 * H - 0.00084 * A^2 - 0.00099 * H^2 - 0.00072 * A * H$
FEV1/FVC	---	$83.126 + 0.243 * A + 0.084 * H + 0.002 * A^2 - 0.0036 * A * H$

Danish Reference Values [12]

Men

H = 155 – 200 cm ｜ A = 20 – 90 years

FEV1	[l]	$-2.87615 - 0.00026 * A2 + 0.04201 * H$
FVC	[l]	$-5.17591 - 0.00026 * A2 + 0.06015 * H$
FEV1/FVC	---	$105.77443 - 0.00126 * A2 - 0.12261 * H$

Women

H = 150 – 195 cm ｜ A = 20 – 90 years

FEV1	[l]	$-1.35015 - 0.00024 * A2 + 0.02923 * H$
FVC	[l]	$-2.80132 - 0.00023 * A2 + 0.04203 * H$
FEV1/FVC	---	$105.57449 - 0.00165 * A2 - 0.12431 * H \; FVC$

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9) www.lungfunction.org

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3.8.3   Keyboard navigation and short-cuts in custo diagnostic

Use the quick links in the main navigation, the keyboard navigation and the keyboard short-cuts to enable fast and convenient working.

Quick links in the main navigation

	User	custo med GmbH ❶		? _ ✕
	Patient ❶	❷ ❷		
	Examination	❸ ❸		▾

LEFT–CLICK

❶ Change user's password
❷ Call last patient
❸ Examination main menu

RIGHT–CLICK

❶ Evaluation search
❷ Call last patient
❸ Most recently opened evaluation

	User	custo med GmbH ❹		? _ ✕
	Patient	Musterfrau Martina ❺ ❹	10.10.1978 (39 Y.)	
	Examination	Spirometry ❻ ❺		▾

LEFT–CLICK

❹ Change user's password
❺ Patient master data
❻ Menu for the current examination

RIGHT–CLICK

❹ All evaluations for the patient
❺ Most recently opened evaluation for this examination

Keyboard navigation

When you press the Alt key, the initial letter of all the buttons on a screen page is underlined. Pressing an initial letter again triggers the corresponding button.

	User	custo med GmbH		? _ ✕
	Patient			
	Examination	Spirometry		▾
Holter				
ABPM				
Resting ECG				
Stress ECG				
Cardiopulmonary Exercise Testing				
Spirometry				
Telemetry				
Cardiac Rehab				
Mobile Cardiac Telemetry				
Blood glucose				
Ecg Streaming				
Task Manager				

Generally valid keyboard short-cuts

| Esc | End, cancel |

| ⏎ | Confirm, continue |

| Ctrl | I | Program information |

| Ctrl | H | User main menu |

| Ctrl | P | Patient main menu |

| Ctrl | U | Examination main menu |

| Ctrl | S | Patient master data for the selected patient |

| Ctrl | A | All examinations belonging to the selected patient |

| Ctrl | G | List of the most recently opened evaluations (same as clicking on the arrow button at top right) |

| Ctrl | F | List of the most recently opened evaluations |

| Ctrl | L | Evaluation search |

| Ctrl | W | Waiting room list |

| Ctrl | Q | Device list |

| Ctrl | M | Switch to Metasoft |

| Ctrl | F1 | Create system report, service e-mail |

Generally valid keyboard short-cuts in an open evaluation

`Ctrl` `N`   Unconfirmed report input dialogue

`Ctrl` `K`   Medication input dialogue

`Ctrl` `R`   Open comparison [1]

`Ctrl` `T`   Open trend [1]

`Ctrl` `D`   Open Print dialogue [1]

`Ctrl` `E`   Open settings [1]

`Ctrl` `O`   Open Options menu [1]

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1)   *Keyboard short-cuts will only work if the corresponding button is available on the screen page.*