

Interpretation of single-breath TLC

1 Background

Instruments for lung volume measurement (Body Plethysmography, Multi-Breath Nitrogen Washout or Helium equilibration methods) today require well trained personnel, stable conditions and significant maintenance to provide reliable results. Therefore, these tests are normally performed in larger, hospital based lung function laboratories.

It has been shown that a total lung capacity (TLC) measured from a single breath maneuver (TLCsb) systematically underestimates the TLC when compared to Body Plethysmography (TLCpleth) or Multi-Breath Washout (TLCwash) methods. The degree of underestimation has been shown to increase as airflow obstruction worsens.

A study by Punjabi, et al [1] shows that an approximation of the TLCpleth and TLCwash is possible by applying a simple correction formula to the single breath TLCsb.

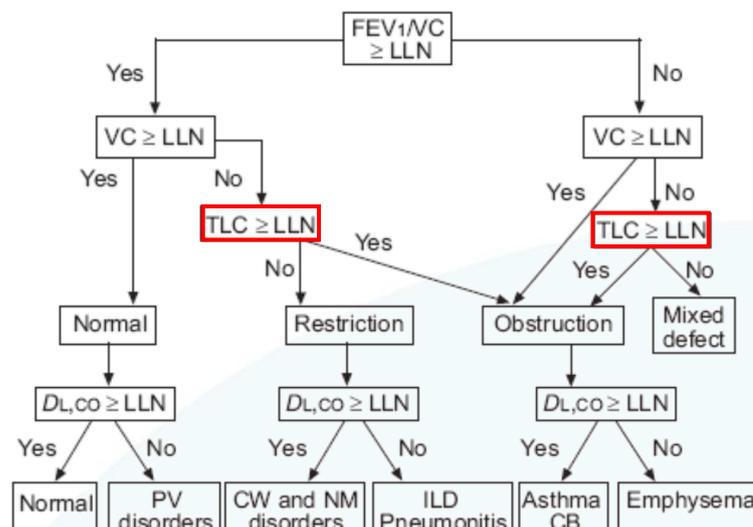
Without correction Punjabi showed that there is a very good correlation between TLCsb and TLCpleth ($r = 0.97 - 0.99$) in patients with $FEV_1/FVC > 70\%$; therefore, no correction of the TLCsb was necessary in patients without obstructive patterns. In patients with $FEV_1 / FVC < 70\%$, TLCsb is systematically underestimated and showed poor correlation to TLCwash ($r = 0.67 - 0.94$).

After using the simple correction equation they showed that in patients with $FEV_1 / FVC < 70\%$ had an acceptable correlation between TLCsb and TLCwash ($r = 0.83 - 0.94, p < 0.05$).

This means that in patients with $FEV_1 / FVC > 70\%$, the TLCsb is reliable and can be used directly in the ATS/ERS interpretative strategies diagnostic algorithm. When the TLCsb is measured in the presence of an obstructive pattern ($FEV_1 / FVC < 70\%$), it first needs adjustment by the equation of Punjabi and can then be applied to the ATS/ERS diagnostic algorithm. The only possibility of a difference in diagnosis between using a corrected TLCsb and a TLC measured with Plethysmography or N_2 -washout is when the corrected TLCsb falls below the lower limit of normal.

2 Decision Tree according to the ATS/ERS Task force

In the decision tree published by the ATS/ERS Task Force [2] “Standardization of Lung Function Testing” some of the decisions are based on TLC (see diagram below). The value of TLC being above or below the lower limit of normal (LLN) determines the diagnostic path.

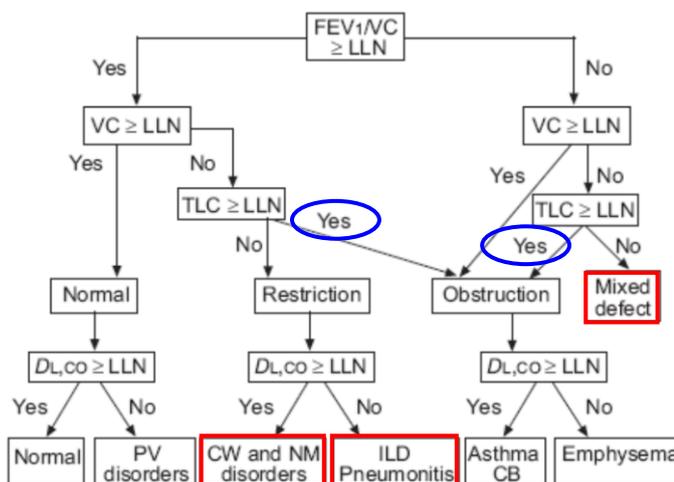


Two cases have to be discussed:

1. For the case that TLCsb from the single breath maneuver is above LLN, it is always correct to use the measured result in the ATS/ERS algorithm for the decision. Note below, that in both decision nodes, where the $TLCsb > LLN$, the diagnosis would be “Obstruction”.
2. In the case that an uncorrected single breath TLCsb is below the lower limit of normal there is a risk of incorrectly concluding a “Restriction” or a “Mixed Defect” (Obstruction AND Restriction) when none is actually present. If the FEV1 / FVC ratio is smaller than 70%, the regression equation by Punjabi et al can be used to correct the TLCsb to a value more consistent with the TLCpleth or TLCwash, reducing the possibility of an incorrect decision.

3 Implementation in EasyOne Pro

The EasyOne Pro Summary report shows the decision tree and indicates the outcome according to the actual result. In addition the result will be shown in written form (translated into local language). All TLCsb will be corrected by the regression equation of Punjabi et al when the patient’s FEV1 / FVC falls below 70%, and is used for the interpretation. Further, a warning will be given if application of the regression equation causes a change in the diagnostic outcome (see decisions circled in blue).



No interpretation will be shown if the QC grade of either the spirometry or the DLCO test is F.

The following messages may appear in addition to the automated interpretation:

1. All Interpretations:
 - “QC Grade F – no interpretation possible” – poor test quality.
 - “QC Grade D - Interpret with care” – spirometry and/or DLCO test quality is only Grade D and may not reflect accurate patient values.
2. Interpretation related to low TLC (marked in red):
 - “Underestimation of Lung Volume possible – Specific Lung Volume measurement may be considered”
3. Interpretation related to regression equation if the TLC is only above LLN because the regression equation was applied (applies only for decision marked in blue):
 - “Overestimation of Lung Volume possible – Specific Lung Volume measurement may be considered”

References

- [1] N.M. Punjabi, D. Shade, R.A. Wise. Correction of single-breath helium lung volumes in patients with airflow obstruction. CHEST, Sept 1998.
- [2] Pellegrino et al. Interpretative Strategies for Lung Function Tests. Eur Respir. J. 2005; 26:948-968.

This description has been approved by R. Jensen; N. MacIntyre; M. R. Miller; F. Burgos in May 2009.