Measurement properties of instruments for measuring of lymphedema: systematic review

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Introduction
Lymphedema is a common complication of cancer treatment, resulting in swelling and subjective symptoms, as described in the ICF Core Set Lymphedema. Reliable and valid measurement of this side effect of medical treatment is important.

Objective
To provide best evidence which measurement instruments are most appropriate in measuring lymphedema in its different stages.

Material and Methods
Data sources: PubMed and Web of Science, following the PRISMA guidelines, using QUADAS-2.
Study selection: Clinical studies on measurement instruments assessing lymphedema, using the Quadas-2 scoring instrument for quality assessment.
Data extraction: Reliability, concurrent validity, convergent validity, sensitivity, specificity, applicability and costs were extracted.

Results
Pooled data showed good intrarater intraclasscorrelations (0.89) for Bio Impedance Spectroscopy (BIS) in lower extremities, and high intraclass correlations intra- and interrater ICC for water volumetry, tape measurement and perometry (0.98 - 0.99) in upper extremities. In upper extremities, standard error of measurement of water volumetry was 3.6% (σ = 0.7%), of perometry 5.6% (σ = 2.1%), and of tape measurement 6.6% (σ = 2.6%). Sensitivity of tape measurement in upper extremities, using different cut-off points, varied from 0.73 to 0.90 and specificity from 0.72 to 0.78.

<table>
<thead>
<tr>
<th>Measurement instrument</th>
<th>Body part</th>
<th>ICC_intra (95% CI)</th>
<th>ICC_inter (95% CI)</th>
<th>Weighted SEM (variance)</th>
<th>Weighted mean SDC (variance)</th>
<th>Number of studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bio Impedance Spectroscopy</td>
<td>Lower extremity</td>
<td>0.89 (0.88 - 0.90)</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Volumeter</td>
<td>Upper extremity</td>
<td>0.99 (0.99 - 0.99)</td>
<td>0.99 (0.99 - 0.99)</td>
<td>0.7% (0.8%)</td>
<td>3.6% (2.7%)</td>
<td>8</td>
</tr>
<tr>
<td>Tape measurement</td>
<td>Upper extremity</td>
<td>0.99 (0.99 - 0.99)</td>
<td>0.98 (0.98 - 0.98)</td>
<td>2.8% (3.2%)</td>
<td>6.6% (4.6%)</td>
<td>9</td>
</tr>
<tr>
<td>Perometer</td>
<td>Upper extremity</td>
<td>0.99 (0.97 - 1.00)</td>
<td></td>
<td>2.1% (2.6%)</td>
<td>5.6% (4.2%)</td>
<td>2</td>
</tr>
</tbody>
</table>

Discussion
Limitations: No uniform definition of lymphedema was available and a gold standard as reference test was lacking. Items concerning risk of bias were study design, patient selection, description of lymphedema, blinding of test outcomes and number of included patients. Most studies were performed in upper extremities.

Conclusion
BIS can detect alterations in extracellular fluid in stage 1 lymphedema and the other measurement instruments alterations in volume starting from stage 2. Tonometry can detect tissue changes from stage 3.

We suggest: water volumetry (using a weighting scale) and tape measurement (using a well-defined protocol) as best practice in measuring lymphedema.

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