

# WHAM Evidence summary: Lymphoedema: Objective assessment using circumference measurement

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## CLINICAL QUESTIONS

What is the best available evidence on circumference measurement to assess lymphoedema?

## KEYWORDS

Lymphoedema, oedema, lymphatic system, assessment

## SUMMARY

Of the various objective and subjective strategies to assess lymphoedema, circumference measurement has the greatest utility in clinical practice, with demonstrated validity and reliability of measurement and greatest accessibility for most clinicians<sup>1,2</sup> (Level 2 and 5).

## CLINICAL PRACTICE RECOMMENDATIONS

All recommendations should be applied with consideration to the wound, the person, the health professional and the clinical context:

**There is good evidence that circumference measurement is a reliable and valid strategy for assessing the presence and degree of lymphoedema (Grade A).**

## SOURCES OF EVIDENCE

This summary was conducted using methods published by the Joanna Briggs Institute.<sup>3-6</sup> This evidence summary is based on a structured database search using variations of the search terms describing lymphoedema and assessment. Searches were conducted in EMBASE, Medline, AMED and the Cochrane Library for evidence from 1990 to November 2014 in English. Levels of evidence for diagnostic studies are reported in the table below.

## BACKGROUND

Lymphoedema is a form of chronic, progressive oedema in which there is significant, persistent swelling of a limb or other body region due to excess and abnormal accumulation of protein-rich fluid in body tissues. The lymphatic system is unable to manage the volume of accumulated fluid.<sup>7</sup>

**Table 1: Sources of clinical evidence and the level**

Level 1 Evidence	Level 2 Evidence	Level 3 Evidence	Level 4 Evidence	Level 5 Evidence
<b>Studies of test accuracy among consecutive patients</b>	<b>Studies of test accuracy among non-consecutive patients</b>	<b>Diagnostic case control studies</b>	<b>Diagnostic yield studies</b>	<b>Expert Opinion/ Bench Research</b>
1.a Systematic review of studies of test accuracy among consecutive patients 1.b Study of test accuracy among consecutive patients <sup>8</sup>	2.a Systematic review of studies of test accuracy among non-consecutive patients <sup>2</sup> 2.b Study of test accuracy among non-consecutive patients <sup>9, 10</sup>	None	4.b Individual diagnostic yield study <sup>11-13</sup>	5.a Systematic review of expert opinion 5.b Expert consensus 5.c Expert opinion <sup>1, 7, 14</sup>

Lymphoedema occurs due to primary, secondary or mixed causes. Primary causes are described as congenital (e.g. an inherited disorder such as Milroy's disease), praecox (onset at puberty, e.g. Meige's disease) or tarda (sudden onset no apparent cause).<sup>15-17</sup> Secondary causes arise from direct damage or trauma to the lymphatic system such as injury surgery or radiotherapy (usually related to treatment of breast cancer), or parasitic invasion.<sup>15, 16, 18</sup> Lymphatic filariasis (also called elephantitis) is a cause of secondary lymphoedema endemic in areas primarily in Africa and Asia. Lymphatic filariasis is a parasitic (roundworm) infection that is spread by mosquitoes and causes damage to the lymphatic system that may result in lymphoedema. Infection generally occurs in childhood, although. Management focuses on large-scale treatment programs to reduce disease spread.<sup>19</sup> Mixed lymphoedema describes lymphoedema arising from decompensation or failure of the lymphatic system associated with other disease or conditions, including but not limited to obesity, immobility, venous disease or lipoedema.<sup>15, 16, 20</sup>

Without management, lymphoedema may lead to:<sup>7, 21</sup>

- progressive swelling,
- physical and functional limitations,
- chronic infection,
- fibrosis,
- lymphorrhoea (leaking of lymph fluid)
- pain and discomfort, and
- reduced ability to undertake activities of daily living (ADLs).

Intermittent pneumatic compression produces a pressure gradient through sequential inflation and deflation that is thought to promote the relocation of accumulated fluid from interstitial space into the lymphatic system, thereby reducing oedema.<sup>22, 23</sup> However, some studies suggest that protein may not shift with fluid, reducing the long term sustainability of the intervention.<sup>24</sup>

Comprehensive assessment of lymphoedema includes objective measures of volume/size, and subjective assessment of signs and symptoms, including their impact on the patient.<sup>25</sup> In patients with mixed lymphoedema, it is also important to assess factors associated with the underlying disease or condition (not addressed in this evidence summary).

This evidence summary presents evidence related to the reliability and validity of one objective measurement used to assess lymphoedema: circumference measurement.

Circumference measurement involves measuring around the oedematous limb using a measurement tape.<sup>7</sup> Circumference measurement, which is the most commonly used strategy for diagnosis and assessment of lymphoedema,<sup>26</sup> is reported to be both the easiest and most cost-effective strategy to assess limb size.<sup>1, 2</sup>

## CLINICAL EVIDENCE

### Performing circumference measurement

There is no standard position in which measurement should be performed<sup>2</sup> (*Level 2*). It is recommended that the measurement tape be applied perpendicular to the limb and with a consistent tauntness<sup>2</sup> (*Level 2*).

Defined distances along the limb are used as the measurement points (e.g., every 2 to 10 cms). There is no standard distance used between measurement points; however, the chosen distance should be consistent between repeated measures<sup>2, 7, 25</sup> (*Level 2 and 5*).

Using easily identifiable anatomical landmarks as the point to perform measurements is also reported,<sup>27, 27</sup> but this strategy does not appear to be more accurate.<sup>2</sup> The following landmarks have been recommended for arm circumference measurements (*Level 1 and 4*):

- midpoint of the upper arm<sup>27</sup>
- superior border of the olecranon<sup>27</sup>
- midpoint of the forearm<sup>27</sup>
- 10cm below the elbow<sup>11</sup>
- 10cm below the elbow<sup>11</sup>

Limb volume can be estimated using circumference measures using either the truncated cone formula or cylinder formula (n.b., this measurement is an estimation only, and is not inter-changeable with a measured limb volume<sup>9</sup>). The commonly used truncated cone formula is:<sup>2, 9, 12</sup>

$$\text{Volume} = \frac{L(X^2 + XY + Y^2)}{12\pi}$$

Where: L = length of the segment along the arm  
X = the circumference at the bottom of the segment  
Y = the circumference at the top of the segment.

Calculate the volume of each segment and add them to determine the volume of the entire limb.

For all measures of limb size and/or volume, comparison should be made with<sup>12, 25</sup> (*Level 4 and 5*):

- a pre-condition measurement of the affected limb (where available) to determine severity of lymphoedema,
- the unaffected limb to determine severity, and
- the affected limb over time to objectively assess the effectiveness of the management plan.

A 2 cm circumference difference in limb circumference is commonly used as a diagnostic cut-off point<sup>25</sup> (*Level 5*).

### Reliability of circumference measurement

In one validation study involving patients with breast cancer associated lymphoedema (n=14), arm circumference measures were taken at the upper arm, the elbow and forearm. Both intrarater (2 measurements) and interrater (2 raters) reliability were excellent for circumference measurements at all three anatomical sites (intraclass coefficient [ICC] > 0.90, p<0.05 for all comparisons). Standard error of measurement (SEM) ranged from 0.5% to 1.3% (0.13 to 0.21 cm), with error being slightly greater for measurements at the elbow<sup>27</sup> (*Level 1*).

In one study, interrater reliability (two raters) of circumference measurements at anatomical positions selected based on bony landmarks was excellent (ICC=0.97 to 0.99) in both women with (n = 19) and without upper limb lymphoedema (n = 22)<sup>12</sup> (*Level 4*).

In one cohort study (n = 51) circumference measurements were made at four points along the arm, and estimated limb volume was calculated. There was good reliability in arm volume estimation in women with lymphoedema (n = 33, ICC = 0.98, 95% confidence interval [CI] 0.96 to 0.99, standard error 94 ml) and in women without lymphoedema (n=18, ICC = 0.98, 95% CI 0.95 to 0.99, standard error 54 ml). There was a significant concordance with perometry measures (p<0.001) and bioimpedance spectroscopy (p<0.001)<sup>9</sup> (*Level 2*).

In another cohort study there was excellent interrater reliability (two raters) in calculations of estimated upper limb volume in women with (n = 19) and without (n = 22) lymphoedema (ICC = 0.95 to 0.98). The estimated calculation of volume was approximately 5% above

that measured using water displacement; however the difference was not significant<sup>12</sup> (*Level 4*).

In a retrospective cross-sectional study conducted with women with (n = 70) and without (n = 71) upper limb lymphoedema, volume estimate based on circumference measurement was found to have higher accuracy (area under curve [AUC] = 0.82 to 0.83, p < 0.001) than circumference measurement alone (AUC = 0.66 to 0.79, p < 0.001)<sup>13</sup> (*Level 4*).

### Figure-of-eight circumference measure

A figure-of eight measurement of the hand has also been used to measure the degree of hand swelling. A measuring tape is passed across the hand and around the wrist, and measures swelling in the hand region. Although the method incorporates measurement of more hand proportions in one measurement, limitations such as the tautness of the tape are not overcome.<sup>10</sup>

One study evaluated reliability of figure-of eight measuring compared to volumetry in 25 participants with hand swelling associated with breast cancer treatment. Two novice and blinded testers performed the figure-of-eight measurements after a one hour training session. Intrarater reliability was excellent for both testers (ICC > 0.800) and intrarater reliability was excellent (ICC > 0.800) compared with volumetry. There was a statistically significant correlation between the two measurement methods (r = 0.700 to 0.752, p < 0.001)<sup>10</sup> (*Level 2*).

## CONSIDERATIONS FOR USE

### Limitations of circumference measurement

The following are limitations of circumference measurement (*Level 1,2 and 5*):

- the method is unable to distinguish between muscle, bone, fat and fluid;<sup>2</sup>
- there can be difficulty identifying and consistently using the same site for location measurement;<sup>7, 10, 25</sup> leading to inaccurate ongoing comparison of change in measurement;<sup>27</sup>
- failure to ensure there is no slack in the tape, leading to over measurement;<sup>27</sup> and
- potential to create indentation in the tissue, leading to under measurement.<sup>27</sup>

## CONFLICTS OF INTEREST

The author declares no conflicts of interest in accordance with International Committee of Medical Journal Editors (ICMJE) standards.

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## ABOUT WHAM EVIDENCE SUMMARIES

WHAM evidence summaries are consistent with methodology published in

Munn Z, Lockwood C, Moola S. The development and use of evidence summaries for point of care information systems: A streamlined rapid review approach, *Worldviews Evid Based Nurs*. 2015;12(3):131-8.

Methods are provided in detail in resources published by the Joanna Briggs Institute as cited in this evidence summary. WHAM evidence summaries undergo peer-review by an international review panel. More information is available on the WHAM website: <https://www.whamwounds.com/>.

WHAM evidence summaries provide a summary of the best available evidence on specific topics and make suggestions that can be used to inform clinical practice. Evidence contained within this summary should be evaluated by appropriately trained professionals with expertise in wound prevention and management, and the evidence should be considered in the context of the individual, the professional, the clinical setting and other relevant clinical information.

## PUBLICATION

This evidence summary has been published in *Wound Practice and Research*:

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