

WHAM Evidence summary: Managing lymphoedema: Pneumatic compression

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CLINICAL QUESTIONS

What is the best available evidence on the effectiveness of pneumatic compression for managing lymphoedema?

KEYWORDS

Lymphoedema, oedema, lymphatic system, compression, pneumatic compression

SUMMARY

Intermittent pneumatic compression (IPC) is used to treat lymphoedema. The application of pressure assists in the reduction of oedema by creating pressure differentials within the affected limb that promote shifting of fluid from interstitial space to the lymph system. There is Level 1 evidence from good quality studies that show a significant effect of IPC in reducing lymphoedema measured by either limb circumference or limb volume.¹⁻³ There is also some Level 1^{2, 3} and Level 3⁴ evidence that IPC reduces pain^{2, 3} and promotes physical function.^{3, 4} There is insufficient evidence to recommend specific regimens; applied pressure should be individualised.

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 intermittent pneumatic compression significantly reduces lymphoedema after a four- to 12-week course of therapy; with the effect evident for up to six months (Grade A).

There is some evidence that intermittent pneumatic compression significantly improves functional outcome measures and pain in individuals with upper or lower limb lymphoedema (Grade B).

There is insufficient evidence to recommend any specific type of intermittent pneumatic compression device or regimen.

SOURCES OF EVIDENCE

This summary was conducted using methods published by the Joanna Briggs Institute.⁵⁻⁸ This evidence summary is based on a structured database search using variations of the search terms describing lymphoedema and pneumatic compression. Searches were conducted in EMBASE, Medline, AMED and the Cochrane Library for evidence from 1990 to 2014 in English. Levels of evidence for intervention studies are reported in the table below.

Table 1: Sources of evidence and the level

Level 1 Evidence	Level 2 Evidence	Level 3 Evidence	Level 4 Evidence	Level 5 Evidence
Experimental Designs	Quasi-experimental Designs	Observational – Analytic Designs	Observational – Descriptive Studies	Expert Opinion/ Bench Research
1.b Systematic review of RCTs and other designs ^{1, 9} 1.c RCT ^{2, 3, 10, 11}	None	3.e Observational study without a control group ^{4, 12, 13}	4.c Case series ¹⁴	5.a Systematic review of expert opinion ¹⁵ 5.b Expert consensus ^{16, 17} 5.c Expert opinion ¹⁸⁻²⁴

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. This fluid contains a range of inflammatory mediators and adipogenic factors.^{9, 16, 18, 19, 23} The lymphatic system is unable to manage the volume of accumulated fluid.¹⁹

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).^{17, 20, 21} 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.^{12, 17, 20} 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.²⁴ 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.^{14, 17, 20}

Without management, lymphoedema may lead to:^{19, 22}

- 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.^{3, 10} However, some studies suggest that protein may not shift with fluid, reducing the long term sustainability of the intervention.¹

Intermittent pneumatic compression devices are air-inflated sleeves that fit over the limb in order to exert pressure. They vary with respect to:¹⁵

- number of air chambers in the device;
- sequential/dynamic (i.e. changing between chambers) or static pressure;
- cycle lengths of compression versus decompression; and
- peak pressure applied.

CLINICAL EVIDENCE

Effectiveness in reducing oedema

One systematic review¹ included 13 studies that reported on the effectiveness of IPC in managing lymphoedema. The studies ranged from RCTs to observational studies and variability in results was reported, possibly related to the variation in devices used or the study designs. The review concluded that there is good quality evidence that IPC at pressures between 30 and 60 mmHg are effective in leading to clinically relevant reduction in lymphoedema. Consideration should be given to tissue resistance and blood pressure in determining appropriate pressure for each individual¹ (*Level 1*).

In an RCT,³ IPC (2 hours at 60 mmHg administered five times weekly for four weeks) was effective in significantly reducing oedema which was measured using difference between healthy and oedematous limbs in limb circumference (n = 24 women post-mastectomy) immediately following the therapy regimen (18.9 cm versus 13.9 cm, p < 0.001). The effect remained evident at three (18.9 cm versus 14.4 cm, p < 0.001) and six months (18.9 cm versus 14.8 cm, p < 0.01) follow up but was no longer significant 12 months following therapy (18.9 cm versus 18.2 cm, p = not significant [ns]). When compared to a group (n = 23) receiving low level laser therapy (20 minutes at 2800 Hz, 1.5 J/cm² three times weekly for four weeks), the low level laser therapy was associated with significantly greater reduction in limb circumference immediately following treatment (p = 0.04) and at 12 month follow up (p = 0.02)³ (*Level 1*).

In one RCT,² IPC (25 mmHg for 45 minutes administered daily for six weeks) in conjunction with self-administered lymphatic drainage (n = 15 women post cancer surgery) was effective in significantly reducing mean arm volume after six weeks (3,581 ml

versus 3142 ml, 14.9% decrease, $p < 0.001$). There was no significant difference in effect when compared to a group ($n = 15$) receiving daily manual lymphatic drainage performed by a physiotherapist and compression bandaging² (*Level 1*).

Various advanced IPC devices for treating participants with lower limb lymphoedema ($n = 196$) were investigated in an observational study.⁴ There was an overall mean reduction in limb volume of 8% ($p < 0.0001$) at 60 day follow up. Participants who had a larger baseline limb volume, larger body mass index (BMI) and those who had bilateral lymphoedema were more likely to experience a beneficial response to IPC⁴ (*Level 3*).

Effectiveness in reducing pain

Intermittent pneumatic compression administered five times weekly for four weeks was effective in significantly reducing pain measured on a 100 mm visual analogue scale (VAS) in post-mastectomy women with lymphoedema ($n = 24$) immediately following the therapy regimen (23.9 mm versus 13.5 mm, $p < 0.01$). The effect was not significant at three, six or 12 months follow up³ (*Level 1*).

Intermittent pneumatic compression administered daily for six weeks in women following cancer surgery ($n = 15$) was effective in significantly reducing pain ($p = 0.005$) scored on a 4 point Likert scale² (*Level 1*).

Effectiveness in improving function

In an RCT,³ IPC (2 hours at 60 mmHg administered five times weekly for four weeks) was effective in significantly improving grip strength measured using a hand dynamometer in post-mastectomy women with lymphoedema ($n = 24$) immediately following treatment and at three, six and 12 month follow up ($p = 0.05$ for all). There was no significant difference in effect compared with a group ($n = 23$) receiving low level laser therapy³ (*Level 1*).

Intermittent pneumatic compression administered daily for six weeks ($n = 15$ women post cancer surgery) did not influence self-rated (4-point Likert scale) physical function ($p = ns$). However, significant improvements were noted in self-rated emotional functioning ($p = 0.03$) and self-rated social function ($p = 0.003$)² (*Level 1*).

In one study⁴ in participants with lower limb lymphoedema receiving advanced IPC ($n = 196$), 85%

of participants were subjectively assessed by (non-blinded) clinicians as having an increased ability to perform activities of daily living and 77% demonstrated improvements in range of motion⁴ (*Level 3*).

Comparison of intermittent pneumatic compression regimens

In a four study group RCT¹¹ conducted in women with upper limb lymphoedema following breast cancer therapy, IPC regimens conducted over five weeks (25 sessions) and consisting of either a 45 second or 90 second cycle with either a single chamber or triple chamber sleeve at an individualized pressure (between 30 and 50 mmHg) were equally effective in achieving a statistically significant reduction in lymphoedema measured as a difference in limb volume between the healthy and oedematous limb. When a 45 second cycle was used, the triple sleeve chamber was more effective ($p = 0.04$) than the single sleeve chamber¹¹ (*Level 1*).

One RCT¹⁰ compared the effectiveness of a standard IPC device ($n = 18$, four chamber sleeve, slow cycle sequential pressure at 30 mmHg) to an advanced IPC device ($n = 18$, 26 to 28 chamber sleeve, fast cycle sequential pressure at 9 to 13 mmHg) in reducing lymphoedema of the upper limb in women who had undergone breast cancer therapy. Both groups had significant improvement in limb oedema measured as a percent oedema volume at 12 weeks, but the effect was greater in the group receiving advanced, fast cycle sequential compression¹⁰ (*Level 1*).

One study¹³ comparing various IPC regimens in 15 participants with lower limb oedema, found that varied pressure applied at different levels of the limb, together with longer compression times was more effective at attaining a tissue fluid pressure differential sufficient to promote fluid shifting¹³ (*Level 3*).

In an observational study⁴ comparing different IPC regimens for people with lower limb lymphoedema, there was no significant difference in outcomes for people with bilateral lymphoedema who received two treatments daily on both limbs versus one treatment daily on alternating limbs (8.5% reduction versus 8.4% reduction, $p = 0.93$)⁴ (*Level 3*).

CONSIDERATIONS FOR USE

Adverse events associated with intermittent pneumatic compression

In one study¹⁰ (n = 36), seven participants (19%) experienced adverse events. Three serious events were considered to be possibly related to treatment: increased arm swelling, breast inflammation leading to infection and fibrosis and increased axilla lymph node swelling. Serious hand swelling in two participants was considered to be definitely related to IPC (both using a device with a four chamber sleeve and slow cycle sequential pressure at 30 mmHg)¹⁰ (Level 1).

In another study⁴ (n = 196) four participants (2%) experienced adverse events. Two events were considered likely to be related to treatment: one case of muscle cramps and one case of increased limb erythema. These events resolved and did not interfere with treatment⁴ (Level 3).

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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REFERENCES

1. Feldman JL, Stout NL, Wanchai A, Stewart BR, Cormier JN, Armer JM. Intermittent pneumatic compression therapy: a systematic review. *Lymphology*, 2012. Mar;45(1):13-25.
2. Gurdal SO, Kostanoglu A, Cavdar I, Ozbas A, Cabioglu N, Ozcinar B, Igci A, Muslumanoglu M, Ozmen V. Comparison of intermittent pneumatic compression with manual lymphatic drainage for treatment of breast cancer-related lymphedema. *Lymphat Res Biol*, 2012. Sep;10(3):129-35.
3. Kozanoglu E, Basaran S, Paydas S, Sarpel T. Efficacy of pneumatic compression and low-level laser therapy in the treatment of postmastectomy lymphoedema: a randomized controlled trial. *Clin Rehabil*, 2009. Feb;23(2):117-24.
4. Muluk SC, Hirsch AT, Taffe EC. Pneumatic compression device treatment of lower extremity lymphedema elicits improved limb volume and patient-reported outcomes. *Eur J Vasc Endovasc Surg*, 2013. Oct;46(4):480-7.
5. Aromataris E, Munn Z. (editors). *JB I Manual for Evidence Synthesis*. <https://synthesismanual.jbi.global>: JBI, 2021.
6. Joanna Briggs Institute Levels of Evidence and Grades of Recommendation Working Party. *JB I Grades of Recommendation*. https://jbi.global/sites/default/files/2019-05/JBI-grades-of-recommendation_2014.pdf: JBI, 2013.
7. Joanna Briggs Institute Levels of Evidence and Grades of Recommendation Working Party. *JB I Levels of Evidence*.

- https://jbi.global/sites/default/files/2019-05/JBI-Levels-of-evidence_2014_0.pdf: JBI, 2013.
8. Joanna Briggs Institute Levels of Evidence and Grades of Recommendation Working Party. Supporting Document for the Joanna Briggs Institute Levels of Evidence and Grades of Recommendation. <https://jbi.global/sites/default/files/2019-05/JBI%20Levels%20of%20Evidence%20Supporting%20Documents-v2.pdf>: JBI, 2014.
 9. DiSipio T, Rye S, Newman B, Hayes S. Incidence of unilateral arm lymphoedema after breast cancer: a systematic review and meta-analysis. *Lancet Oncol*, 2013;14:500-15.
 10. Fife CE, Davey S, Maus EA, Guillod R, Mayrovitz HN. A randomized controlled trial comparing two types of pneumatic compression for breast cancer-related lymphedema treatment in the home. *Support Care Cancer*, 2012. Dec;20(12):3279-86.
 11. Pilch U, Wozniowski M, Szuba A. Influence of compression cycle time and number of sleeve chambers on upper extremity lymphedema volume reduction during intermittent pneumatic compression. *Lymphology*, 2009. Mar;42(1):26-35.
 12. Kim L, Jeon JY, Sung IY, Jeong SY, Do JH, Kim HJ. Prediction of treatment outcome with bioimpedance measurements in breast cancer related lymphedema patients. *Ann Rehabil Med*, 2011. Oct;35(5):687-93.
 13. Zaleska M, Olszewski WL, Jain P, Gogia S, Rekha A, Mishra S, Durlik M. Pressures and timing of intermittent pneumatic compression devices for efficient tissue fluid and lymph flow in limbs with lymphedema. *Lymphat Res Biol*, 2013. Dec;11(4):227-32.
 14. Greene AK, Grant FD, Slavin SA. Lower-extremity lymphedema and elevated body-mass index. *N Engl J Med*, 2012. May 31;366(22):2136-7.
 15. Leal NF, Carrara HH, Vieira KF, Ferreira CH. Physiotherapy treatments for breast cancer-related lymphedema: a literature review. *Rev Lat Am Enfermagem*, 2009. Sep-Oct;17(5):730-6.
 16. Lymphoedema Framework. Best Practice for the Management of Lymphoedema. London: MEP Ltd, 2006.
 17. International Society Of Lymphology. The diagnosis and treatment of peripheral lymphedema. Consensus document of the International Society Of Lymphology. *Lymphology*, 2013;46:1-11.
 18. Armer J. The problem of post-breast cancer lymphedema: Impact and measurement issues. *Cancer Invest* 2005;1:76-83.
 19. Balci F, DeGore L, Soran A. Breast cancer-related lymphedema in elderly patients. *Top Geriatr Rehabil*, 2012;28(4):242-53.
 20. General Practice Divisions of Victoria. Lymphoedema: Guide for diagnosis and management in general practice. Melbourne: General Practice Divisions of Victoria, 2014.
 21. Mayo Clinic staff. Diseases and Conditions: Lymphoedema. Available from: <http://www.mayoclinic.org/diseases-conditions/lymphedema/basics/causes/con-200256032014>.
 22. Renshaw M. Lymphorrhoea: 'leaky legs' are not just the nurse's problem. *Br J Community Nurs*, 2007. Apr;12(4):S18-21.
 23. Todd M. Chronic oedema: impact and management. *Br J Nurs*, 2013;22(11):623-27.
 24. World Health Organization. Lymphatic filariasis: Fact Sheet No 102. www.who.int/mediacentre/factsheets/fs102/en/: WHO, 2014.