REVIEW ARTICLE

ISSN 2508-190X

CLL 10(2):48-52, 2025

www.kslymph.or.kr

Current Challenges and Future Directions in Lymphedema Diagnosis and Staging

Eun Joo Yang, MD, PhD

Department of Rehabilitation Medicine, Seoul National University Bundang Hospital, Seongnam, Republic of Korea

Lymphedema is a chronic, progressive disorder that leads to irreversible tissue changes, functional disability, and psychosocial distress among cancer survivors. In Korea, diagnostic criteria and stage-based management systems remain fragmented despite technological progress. Conventional volume-based approaches cannot detect early physiological changes, while newer modalities such as bioimpedance spectroscopy (BIS), ultrasound, and indocyanine green (ICG) lymphography lack standardization in interpretation and application. This review examines the current limitations in Korea's lymphedema diagnostic and staging systems and outlines evidence-based strategies for standardization, clinical integration, and outcome-driven management. Diagnostic tools, including questionnaires (LBCQ, LLIS, LYMQOL), volume-based methods (circumference, Perometer), physiological assessments (BIS, TDC), and imaging (ultrasound, lymphoscintigraphy, ICG, MRI), are inconsistently applied without harmonized timing or sensitivity thresholds. The International Society of Lymphology (ISL) 0-3 staging is seldom used to guide treatment intensity or complex decongestive therapy (CDT) duration. Moreover, partial reimbursement for imaging contrasts with the lack of coverage for BIS or ultrasound, reinforcing care inequality. An action-linked staging model aligning CDT intensity, quantitative indicators (BIS, ultrasound, volume change), and patient-reported outcomes (PROMs) is proposed. Standardized cut-offs and PROM integration can establish feedback loops between patient monitoring, clinical intervention, and policy evaluation. Unified national guidelines that integrate multimodal diagnostic standards, stage-based therapeutic linkage, and PROM-based quality assessment are essential to prevent chronic progression and ensure equitable, value-based lymphedema care.

Key Words: Surveillance · Diagnosis · Staging · Bioimpedance Spectroscopy · Ultrasound

INTRODUCTION

Lymphedema represents one of the most common and disabling chronic sequelae following cancer treatment in Korea, particularly among breast, gynecologic, and genitourinary cancer survivors[1]. The condition leads not only to physical discomfort and functional impairment but also to psychosocial distress and diminished quality of life[2]. Although lymphedema poses a growing clinical and public health challenge, Korea's national management framework has yet to evolve into a preventive, stage-oriented model. The lack of a standardized framework for early diagnosis, together with inconsistencies in staging and fragmented clinical pathways, has impeded the establishment of an integrated continuum of care encompassing early detection, intervention, and long-term follow-up[3].

Traditional diagnostic approaches for lymphedema are predominantly volume-based, relying on objective but crude measures such as limb circumference differences of ≥2 cm or interlimb volume discrepancies exceeding 10%[4]. While simple to apply, these absolute thresholds suffer from high inter-operator variability. More critically, they fail to capture the underlying patho-

▸ Received: November 6, 2025, ▸ Accepted: November 19, 2025

Address for correspondence: **Eun Joo Yang,** MD, PhD
Department of Rehabilitation Medicine, Seoul National University Bundang Hospital, 82 Gumi-ro, 173 Beon-gil, Bundang-gu, Seongnam, 13620, Republic of Korea
Tel: +82-31-787-7734, Fax: +82-31-787-4051
E-mail: graceloves@gmail.com

physiologic progression—lymphatic flow stagnation, increased interstitial fluid retention, and early tissue compliance changes. As a result, lymphedema is often diagnosed only after irreversible structural changes have occurred such as fibrosis, dermal thickening, and adipose tissue deposition. At this late stage, therapeutic interventions are far less effective. This highlights the urgent need for diagnostic tools capable of detecting subclinical or preclinical disease[5].

Recent advances in physiologic and imaging-based technologies offer promise in overcoming these limitations. Bioimpedance spectroscopy (BIS) and tissue dielectric constant (TDC) measurements quantitatively assess extracellular fluid accumulation, detecting lymphatic dysfunction before visible swelling appears[6]. Similarly, ultrasound-based segmented echogenicity analysis visualizes dermal and subcutaneous tissue changes associated with fibrosis and fluid retention[7,8]. Despite their diagnostic sensitivity, these modalities face critical constraints which are the absence of validated cut-off thresholds, standardized measurement protocols, and established links to clinical staging systems[9]. Their use in research and practice remains inconsistent, limiting comparability and hindering widespread clinical adoption.

Beyond technical gaps, Korea's lymphedema management system faces policy and structural fragmentation. Diagnostic methods are chosen based on institutional preference rather than national guidelines. Treatment decisions are rarely aligned with objective, stage-linked criteria. Reimbursement structures remain inconsistent —volume-based measures are recognized but not incentivized, while advanced imaging and physiologic diagnostics receive only partial coverage. These systemic discrepancies disrupt the integration of diagnosis, treatment, and quality assessment, ultimately impeding evidence-based, patient-centered care. Addressing these challenges requires an action-linked staging framework that connects multimodal diagnostics with therapeutic planning and reimbursement policy fostering a more coherent, preventive, and data-driven model of lymphedema management.

This review addresses the structural and methodological barriers that hinder Korea's transition from reactive, volume-based lymphedema management to a proactive, preventive model. It pursues three objectives:

(1) to compare conventional circumference and volume-based diagnostics with advanced physiologic and imaging tools such as BIS, TDC, and ultrasound to emphasize the need for multimodal integration

(2) to propose an action-linked staging framework aligning diagnostic modalities with stage-specific therapeutic planning and follow-up

(3) to analyze policy and reimbursement gaps that limit the adoption of innovative diagnostics. Collectively, this review provides a foundation for an integrated, evidence-based, and quality-linked national framework for lymphedema care.

DISCUSSION

1. Inconsistency in Diagnostic Interpretation and Ambiguity in Staging Standards

Lymphedema is currently assessed using a wide variety of tools such as self-report questionnaires (Lymphedema Functioning, Disability and Health questionnaire (Lymph-ICF)[10], Lymphedem Life Impact Scale (LLIS) [11], Lymphedema Quality-of-life questionnaire (LYMQOL)) [12], volume measurements such as circumference or perometer, physiological methods, and imaging modalities. However, their application timing, interpretation, and diagnostic thresholds vary among institutions. Traditional volume-based criteria have limited sensitivity and are prone to operator variability, making them insufficient for detecting early pathologic changes.

Ultrasound provides quantitative evaluation of subcutaneous thickness and fibrosis caused by lymphatic congestion, and segmented echogenicity analysis has demonstrated diagnostic accuracy with an AUC exceeding 0.94. Nonetheless, standardized cut-offs have not yet been established. BIS[13] offers indirect assessment of lymphatic dysfunction by measuring extracellular-to-total body water ratios (ECW/TBW), but reproducibility and measurement posture variability limit standardization. The lack of cross-comparative studies and absence of unified diagnostic algorithms continue to hin-

Table 1. Overview of Lymphedema Evaluation Methods Across Screening, Diagnosis, Treatment and Follow-up Stages

Screening	LBCQ, LLIS	Circumference, Perometer	BIS, TDC	Ultrasound
Confirmatory	–	Circumference, Perometer	BIS, TDC	ICG lymphography, MRI, Ultrasound
Treatment Response	LYMQOL	Circumference, Perometer	BIS, TDC	Ultrasound
Follow-up / Monitoring	LBCQ, LLIS	Circumference, Perometer	BIS, TDC	Ultrasound

LBCQ, Lymphedema Breast Cancer Questionnaire; LLIS, Lymphedem Life Impact Scale; BIS, Bioimpedance spectroscopy; TDC, tissue dielectric constant; ICG, indocyanine green; LYMQOL, Lymphedema Quality-of-life questionnaire

Table 2. Clinical Staging of Lymphedema According to the International Society of Lymphology (ISL)

Stage	Definition
0	Lymphatic dysfunction without visible edema
1	Spontaneously reversible edema that improves with rest or elevation
2	Persistent, non-reversible edema
3	Advanced stage with dermal thickening, adipose deposition, and fibrosis

der consistency in clinical practice (Table 1).

As shown above, appropriate diagnostic tools should be applied differently according to purpose and stage. However, in practice, these modalities are often used interchangeably, without standardized sensitivity or reproducibility comparisons. Consequently, clinical staging still depends largely on visual inspection and circumference differences rather than functional or structural lymphatic assessment.

2. Disconnection Between Staging and Therapeutic Application

Internationally, lymphedema is classified into four stages (0-3) according to the International Society of Lymphology (ISL) [14](Table 2).

Despite its clinical clarity, this staging system is seldom used to guide treatment decisions in Korea. Patients within the same stage can exhibit significant variability in lymphatic function, infection risk, and responsiveness to complex decongestive physical therapy (CDPT) [15]. Clinical decisions regarding CDPT intensity, duration, and transition to self-management are frequently empirical, leading to inconsistent outcomes and discontinuity of care[16].

To resolve this, staging should be redefined as an action-linked framework rather than a static classification. Each stage should specify corresponding CDPT intensity, treatment termination criteria, self-management transition thresholds, and re-intervention conditions based on quantitative indicators such as BIS, ultrasound, or limb volume change. This model would transform staging from a descriptive label into a practical decision-making tool.

3. Technical and Policy Fragmentation

While diagnostic technologies for lymphedema are rapidly advancing, policy implementation has lagged. ICG lymphography[17] and low-level laser therapy (LLLT)[18] have been partially reimbursed, but key diagnostic tools for early detection and longitudinal follow-up—such as BIS and volume measurement—remain uncovered. Ultrasound is only partly reimbursed, resulting in unequal access across hospitals. The absence of standardized cut-offs, stage-linked thresholds, and treatment transition guidelines leads to significant inter-institutional discrepancies, creating inequality in care quality and efficiency (Table 3).

Although technology adoption is ongoing, the lack of structured clinical guidelines prevents consistent use. Without policy frameworks that link diagnostic results to therapeutic and evaluative processes, healthcare quality improvement and cost-effectiveness cannot be achieved simultaneously[19].

4. Toward an Action–Linked Staging Framework

As a chronic condition characterized by temporal fluctuations, lymphedema requires continuous monitoring

Table 3. Classification of Lymphedema Technologies by Category, Purpose, and Reimbursement Status

Category	Representative Technology	Purpose	Application Site	Reimbursement
Diagnosis				
Physiologic / Functional	BIS, TDC	Early detection, treatment monitoring	Hospital, community	Not reimbursed
Volume-based	Circumference, Perometer	Limb volume measurement	Hospital, community	Not reimbursed
Lymphatic Imaging	ICG lymphography, Lymphoscintigraphy, MR lymphography	Flow evaluation and confirmation	Hospital	Partially reimbursed (MRI non-covered)
Tissue Imaging	Ultrasound	Early diagnosis, treatment response	Hospital	Partially reimbursed
Therapy	LLLT, Pneumatic pump	Edema reduction	Hospital, home	Hospital use only reimbursed

BIS, Bioimpedance spectroscopy; TDC, Tissue dielectric constant; ICG, indocyanine green; LLLT, low-level laser therapy

and early-warning systems[20]. Self-monitoring enables patients to measure and record changes in limb condition, providing a realistic approach to detect early progression and sustain treatment adherence[21]. Regular home-based assessment of volume or BIS indicators can quantify fluid retention and edema trends[22]. When abnormalities exceed pre-defined thresholds, patients can adjust compression or exercise intensity and seek medical consultation, forming a preventive feedback loop.

This approach not only prevents stage progression but also enhances patient motivation and self-efficacy while promoting equity for elderly or rural patients with limited healthcare access. Furthermore, integrating patient-reported outcome measures (PROMs) into diagnosis and evaluation is essential. LLIS can serve as a screening tool[11], and LYMQOL as a treatment- response index, with ≥10-point improvements representing clinically meaningful benefit[12]. Incorporating self-management adherence, remeasurement compliance after alerts, cellulitis incidence, and readmission rates into quality indicators (QIs) would enable reimbursement systems to reflect both clinical performance and patient-centered outcomes, establishing a sustainable cycle of prevention, intervention, and evaluation[23].

CONCLUSION

The fundamental challenges in Korea's lymphedema management stem from inconsistent diagnostic interpretation, the lack of stage-linked clinical action, and fragmented reimbursement and quality evaluation systems. To overcome these barriers, diagnostic modalities must be standardized, and staging must be restructured into an action-based framework that clearly links treatment intensity and transition timing. Incorporating self-monitoring into standard diagnostic pathways allows patients to recognize early warning signs and engage in active management. Integrating PROM- and QI-based outcome indicators with reimbursement evaluation can enhance both quality and cost efficiency. This unified model would not only reduce irreversible tissue damage but also improve patient function and quality of life, representing a foundational step toward a preventive, value-based healthcare paradigm for lymphedema management in Korea.

Acknowledgement

This research was supported by a grant of Patient-Centered Clinical Research Coordinating Center (PACEN) funded by the Ministry of Health & Welfare, Republic of Korea (grant number: RS-2025-25413565).

REFERENCE

1. Kim SI, Lim MC, Lee JS, Lee Y, Park K, Joo J, et al. Impact of lower limb lymphedema on quality of life in gynecologic

cancer survivors after pelvic lymph node dissection. Eur J Obstet Gynecol Reprod Biol 2015;192:31-36.
2. Pinto M, Gimigliano F, Tatangelo F, Megna M, Izzo F, Gimigliano R, et al. Upper limb function and quality of life in breast cancer related lymphedema: a cross-sectional study. Eur J Phys Rehabil Med 2013;49:665-673.
3. Hahamoff M, Gupta N, Munoz D, Lee BT, Clevenger P, Shaw C, et al. A Lymphedema Surveillance Program for Breast Cancer Patients Reveals the Promise of Surgical Prevention. J Surg Res 2019;244:604-611.
4. Gjorup C, Zerahn B, Hendel HW. Assessment of volume measurement of breast cancer-related lymphedema by three methods: circumference measurement, water displacement, and dual energy X-ray absorptiometry. Lymphat Res Biol 2010;8:111-119.
5. Soran A, Bengur FB, Rodriguez W, Chroneos MZ, Sezgin E. Early Detection of Breast Cancer-Related Lymphedema: Accuracy of Indocyanine Green Lymphography Compared with Bioimpedance Spectroscopy and Subclinical Lymphedema Symptoms. Lymphat Res Biol 2023;21:359-365.
6. Lahtinen T, Seppala J, Viren T, Johansson K. Experimental and Analytical Comparisons of Tissue Dielectric Constant (TDC) and Bioimpedance Spectroscopy (BIS) in Assessment of Early Arm Lymphedema in Breast Cancer Patients after Axillary Surgery and Radiotherapy. Lymphat Res Biol 2015; 13:176-185.
7. Canales-Lachen E, Asunsolo A, Manrique OJ, Blazquez J, Holguin P, Maldonado AA. The Use of Ultrasound Imaging for Upper Extremity Lymphedema after Breast Cancer: A Systematic Review. J Reconstr Microsurg 2023; 39:102-110.
8. Jonis YMJ, van der Hel SR, Misere R, van der Hulst R, Qiu SS. Measuring Lymph Flow Velocity in Lymphatic Collecting Vessels Using a Transit Time Ultrasound Flowprobe. Lymphat Res Biol 2025.
9. Oropallo A, Donis-Garcia M, Ahn S, Rao A. Current Concepts in the Diagnosis and Management of Lymphedema. Adv Skin Wound Care 2020;33:570-580.
10. Devoogdt N, Van Kampen M, Geraerts I, Coremans T, Christiaens MR. Lymphoedema Functioning, Disability and Health questionnaire (Lymph-ICF): reliability and validity. Phys Ther 2011;91:944-957.
11. Weiss J, Daniel T. Validation of the Lymphedema Life Impact Scale (Llis): A Condition-Specific Measurement Tool for Persons with Lymphedema. Lymphology 2015;48:128-138.
12. van de Pas CB, Biemans AA, Boonen RS, Viehoff PB, Neumann HA. Validation of the Lymphoedema Quality-of-Life Questionnaire (LYMQOL) in Dutch Patients Diagnosed with Lymphoedema of the Lower Limbs. Phlebology 2016; 31:257-263.
13. Jeffers EJ, Wagner JL, Korentager SS, Larson KE, Balanoff CR, Baker J, et al. Breast Cancer-Related Lymphedema (BCRL) and Bioimpedance Spectroscopy: Long-Term Follow-Up, Surveillance Recommendations, and Multidisciplinary Risk Factors. Ann Surg Oncol 2023;30:6258-6265.
14. Executive Committee of the International Society of L. The diagnosis and treatment of peripheral lymphedema: 2020 Consensus Document of the International Society of Lymphology. Lymphology 2020;53:3-19.
15. Haas Y, Williams OP, Masia J, Pons G, Taylor EM, Katapodi MC, et al. Microsurgical versus complex physical decongestive therapy for chronic breast cancer-related lymphoedema. Cochrane Database Syst Rev 2025;2:CD016019.
16. Nawaz M, Bashir MS, Noor R, Ikram M. Effects of complex decongestive physical therapy on upper limb circumference and sensory function in post-mastectomy lymph oedema, A quasi-experimental study. J Pak Med Assoc 2024;74: 2168-2170.
17. Liu M, Liu S, Zhao Q, Cui Y, Chen J, Wang S. Using the Indocyanine Green (ICG) Lymphography to Screen Breast Cancer Patients at High Risk for Lymphedema. Diagnostics (Basel) 2022;12.
18. Baxter GD, Liu L, Petrich S, Gisselman AS, Chapple C, Anders JJ, et al. Low level laser therapy (Photobiomodulation therapy) for breast cancer-related lymphedema: a systematic review. BMC Cancer 2017;17:833.
19. Weiss R. Cost of a lymphedema treatment mandate - 16 years of experience in the Commonwealth of Virginia. Health Econ Rev 2022;12:40.
20. Skjodt Rafn B, Jensen S, Bjerre ED, Wittenkamp MC, Benjaminsen K, Christensen LP, et al. Prospective surveillance for breast cancer-related lymphedema (PROTECT). Acta Oncol 2023;62:808-813.
21. Karaca-Mandic P, Solid CA, Armer JM, Skoracki R, Campione E, Rockson SG. Lymphedema self-care: economic cost savings and opportunities to improve adherence. Cost Eff Resour Alloc 2023;21:47.
22. Teranishi-Hashimoto C, Padilla M, Heo Y, Bravi L. At-Home Bioelectrical Impedance Analysis (BIA) Monitoring of Adult Females at Risk of Breast Cancer-Related Lymphedema: Nonrandomized One-Year Longitudinal Feasibility Study. JMIR Form Res 2025;9:e73978.
23. Stout NL, Weiss R, Feldman JL, Stewart BR, Armer JM, Cormier JN, et al. A systematic review of care delivery models and economic analyses in lymphedema: health policy impact (2004-2011). Lymphology 2013;46:27-41.