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Research

Indocyanine Green Lymphography in Conservative Lymphedema Management: An Exploration of the Impact on Lymphedema Therapy Plans

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ABSTRACT

Objectives: Information from indocyanine green (ICG) lymphography (ICG-L) can be used to guide an individual's lymphedema therapy plan. However, the mechanisms for this clinical translation are not well described. This study proposes a novel clinical decision support tool for translating ICG-L findings into individualized lymphedema therapy plans and describes subsequent changes in plan features of manual lymphatic drainage and compression.
Methods: This before-after study compared specific therapy plan features before and after ICG-L for participants with limb lymphedema. After participants had undergone ICG-L, the individuals' ICG-L findings were translated into an ICG-L–informed therapy plan using a novel clinical decision support tool, ICG-TRANSLATE. A predetermined coding tree was used to identify changes in elements of manual lymphatic drainage and compression therapy plan recommendations.
Results: Following the application of the ICG-TRANSLATE decision support tool, 100% (n = 25) of participants had a change in manual lymphatic drainage recommendations, including elements of terminal nodes, pathway, and technique. Additionally, 88% (n = 22) had a change in compression recommendations, which was most commonly a change in garment limb coverage.
Conclusions: ICG-L findings informed changes to traditional lymphedema therapy plan modalities of manual lymphatic drainage and compression. Whether this change to individual therapy recommendations translates into improved lymphedema outcomes requires further investigation.
Implications for Nursing Practice: A clinical decision support tool may assist practitioners in translating ICG-L findings into individualized lymphedema therapy plans for people with lymphedema. Further exploration is necessary to determine if the management changes derived through ICG-L–informed therapy plans improve outcomes for people with lymphedema.

Indocyanine green (ICG) lymphography (ICG-L) is an imaging technique that can be useful in cancer-related secondary lymphedema assessment and management. However, the impact of ICG-L on lymphedema conservative therapy, including planning, is not yet well understood. ICG-L is useful for lymphedema assessment and diagnosis through the visualization of an individual's lymphatic function.[1,2] ICG-L involves intradermal injection of ICG in the target limb and monitoring of dye movement in the superficial lymphatics to observe an individual's lymphatic function.[3,4] This direct lymphatic visualization with ICG-L has challenged historical descriptions of impaired lymphatic function in cancer-related lymphedema, which had assumed an absence of functional superficial lymphatic outflow in the affected body region.[5,6] Traditionally, anatomical principles of absent immediate lymphatic outflow translated to lymphedema therapy prescription focusing on directing fluid away from the congested affected body regions toward adjacent lymphatic territories or quadrants to unaffected nodal basins.[5,7,8] More recent observations of superficial lymphatics through ICG-L demonstrate that lymphatic drainage pathways more commonly continue to the immediate nodal regions of the affected limb.[9] How this new anatomical knowledge

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Layperson Summary

What we investigated and why

• We looked at how a new imaging scan (called indocyanine green [ICG] lymphography) is used by clinicians to plan lymphedema therapy. This scan uses dye to observe how lymphatic fluid flows in a person. We wanted to know if the scan helped plan therapy treatments like massage programs or compression garment prescriptions. Identifying if and how ICG lymphography might affect lymphedema therapy plans is important to understand how it might be useful in lymphedema care.

How we did our research

• We developed a clinical decision support tool to help clinicians use individual ICG lymphography findings to develop lymphedema therapy plans. We compared the lymphedema therapy plans of 25 people with lymphedema before and after ICG lymphography imaging and identified what changed in their therapy plans and how often the changes happened.

What we have found

• All people in the study had a change in their lymphedema therapy plan following ICG lymphography imaging and application of the ICG TRANSLATE decision tool. Every person (100%) had changes in manual lymphatic drainage (massage) recommendations, including changes to the massage pathway and techniques recommended. Most people (88%) also had a change to compression garments, including shortened limb coverage for some.

What it means

• ICG lymphography may be helpful in individualizing lymphedema therapy plans. A clinical decision support tool can help clinicians convert imaging findings into therapy plans for people with lymphedema. Knowing how to identify and describe the use of ICG lymphography in lymphedema therapy plans may be helpful for future research to explore if changes in therapy plans lead to better lymphedema therapy outcomes.

about lymphatic functioning affects lymphedema practitioners' (including nursing, physiotherapy, and occupational therapy) approaches to lymphedema therapy planning is not yet clearly described. This report presents a clinical reasoning model, ICG-TRANSLATE ("translating results into actionable therapy plans"), designed to link ICG-L findings with therapy modalities. Decision-making aids are particularly useful for the management of complex conditions as a clinical reasoning guide to organize information about a person's characteristics to inform intervention recommendations.[10] ICG-TRANSLATE integrates individualized ICG-L findings about a person's lymphatic functioning to support the clinical reasoning of lymphedema-trained practitioners about lymphedema therapy planning and describes the changes to therapy planning following ICG-L.

ICG-TRANSLATE combines two elements: recognition of features of ICG-L findings and recommendations for the translation of ICG-L findings to therapy modality features. The first element focuses on the features of the lymphatic system that can be observed from ICG-L. Synthesized from published evidence, these features identified detailed information about an individual's functional lymphatics. Individual findings reported from ICG-L include three common elements. First, altered lymphatic drainage in the form of regions of dermal backflow (DBF), which represent superficial lymphatic rerouting and are indicative of lymphedema, must be identified.[11-16] The location and amount of DBF observed have also informed several proposed ICG clinical severity scales. However, there is no consensus on the preferred scale or its relevance to clinical lymphedema severity.[1] Second, ICG-L enables observation of the direction or pathways of lymphatic drainage from the target body part specific to the individual.[9,17-19] Third, the dynamic process itself provides real-time feedback about lymphatic flow response to therapy inputs such as manual lymphatic drainage (MLD).[20-24] It is this ability of ICG-L to demonstrate individual lymphatic drainage patterns, along with visualization of altered lymphatic drainage in the form of DBF, that is proposed to inform individualized lymphedema therapy management.

The second element of the ICG-TRANSLATE tool integrated the above features of ICG-L findings with current best practice lymphedema management principles to guide the targeted selection of therapy modalities. Clinical reasoning to support therapy recommendations is a complex and multifaceted undertaking.[25] Clinical decision-making about therapy recommendations is influenced by multiple factors, which include environmental and contextual factors, the individual and their condition, and the therapist's skills and experience.[26] Therapy modalities traditionally applied in lymphedema management include education, skin care, weight management, exercise, compression, and MLD.[27] Two of the most commonly used and studied modalities are compression and MLD; therefore, these were used as the initial focus of ICG-TRANSLATE. The components of the second element of the ICG-TRANSLATE tool were developed by applying the identified literature to lymphedema clinical practice based on the experience of two of the authors (MT and AP), who are clinical experts in lymphedema management and the application of principles of lymphedema practice. For example, research has demonstrated DBF is indicative of lymphedema[14,16]; therefore, compression was recommended over regions of DBF. MLD is reported to facilitate increased lymphatic drainage in the lymphatic system.[6] Thus, MLD recommendations targeted the functional lymphatic flow pathway and pressure observed to be effective for an individual through ICG-L.[21,23,28]

The current evidence for some lymphedema therapy modalities, such as MLD, is variable, with lower quality or conflicting support.[29-32] Further to this, the treatment modalities (and their features) prescribed to people with lymphedema, such as compression or self-MLD, are based on assumptions about lymphatic routing derived from historic cadaver studies,[33] rather than being stratified with specific knowledge about the lymphatic function of each individual. These assumptions are not supported by more recent evidence of rerouting pathways observed with ICG-L, which show individual variations in lymphatic anatomy, many of which include the immediate nodal region of the limb.[9] In the absence of ICG-L, clinical decision-making to inform the selection and features of an individual's lymphedema self-management modalities, such as compression and MLD, typically relies on therapist observations and clinical assessment in the context of traditional knowledge about lymphatic anatomy and assumptions of lymphatic rerouting.[34] Therefore, lymphedema therapy management often includes generic recommendations for multimodality treatments, which can be burdensome to the individual and create barriers to the long-term engagement necessary for successful lymphedema management.[35,36] Moreover, daily, consistent application of therapy modalities is required for adequate lymphedema control, which means that engagement, intrinsic motivation, and prioritization by the individual are essential.[37,38] However, people with lymphedema report challenges in sustaining adherence to these generically applied management programs.[39] The use of ICG-L as a tool to inform individualized therapy may create more targeted selection, stratification, and prioritization of modalities for people with lymphedema based on their own real-time lymphatic function, thereby supporting their self-management and engagement over time by acting as an enabler in lymphedema therapy planning.

ICG-L is a relatively new imaging technique that, although time and resource intensive,[1,40] is acceptable to people with lymphedema, with many finding the experience itself as helpful.[41] Despite this, it does not have a widespread application in Australia; therefore, therapists are not familiar with the clinical interpretation of its findings. ICG-TRANSLATE may assist a trained lymphedema therapist to interpret ICG-L findings into their clinical practice. To date, precisely what features of ICG-L influence specific changes for an individual's therapy plan is not yet well defined. This report describes the application of ICG-TRANSLATE, an ICG-L–informed clinical reasoning approach, which has been driven by the current state of knowledge in cancer-related lymphedema and developed based on application and clinical reflection on guiding clinical reasoning in lymphedema therapy by two expert clinicians in lymphedema practice. In this context, ICG-L and the ICG-TRANSLATE tool are used by lymphedema practitioners to make decisions about two of the most common elements of therapy management, including compression, MLD, and self-MLD (referred to there as therapy plans). This study aimed to describe the changes to lymphedema therapy planning following participation in ICG-L and application of the novel clinical reasoning support tool ICG-TRANSLATE. In doing so, the clinical impact of ICG-L to lymphedema therapy management may be better understood to assist future targeted application to clinical lymphedema practice.

Methods

Design and Study Setting

A before-after design[42] was used to identify changes in MLD and compression prescription by comparing traditional (not ICG-L–informed) therapy plan features with ICG-L–informed therapy plan features. Consecutive eligible patients were prospectively recruited from the Multidisciplinary Lymphedema Service at a large quaternary hospital in Australia. The ICG-L technology was introduced in the setting in 2019 for the purposes of assessment of lymphedema and to support therapy practice.[1] Ethical clearance was approved through Metro South Human Research Ethics Committee (HREC/2019/QMS/49709) and The University of Queensland Ethics Committee (2019/HE000868). The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline designed to guide the reporting of cohort studies was used to direct the reporting of this study.[43]

Participants

Eligible participants were invited to participate in the study when they were referred for ICG-L to provide information about their lymphedema condition. Participants were eligible if they were older than 18 years, had a life expectancy of greater than 12 months as determined by a review of their medical record, and had upper or lower limb secondary cancer-related lymphedema and a staging classification ranging from subclinical (stage 0) to moderate volume edema with tissue changes (stage 2).[27] All participants provided written informed consent before the ICG-L procedure.

Study Procedure

Participants attended routine therapy reviews as part of existing standard care. As part of the standard care review, a therapist's clinical assessment was completed, including clinical observation, palpation, tape circumference measurements, and subjective report, and documented in the participant's medical record. Participants attended a dedicated appointment for a single session of ICG-L. The ICG-L procedure is described in detail elsewhere.[41] In summary, the procedure involved intradermal injection of ICG dye solution (~0.1-0.15 mL of 0.5-0.75 mg) in four distal sites on the affected target limb. Dye movement was subsequently observed via a handheld near-infrared camera (Photodynamic Eye; Hamamatsu Photonics, Japan) at regular intervals for approximately an hour. MLD and palpation were conducted during the procedure to facilitate dye movement and observation of target tissues. Lymphatic pathways and imaging features observed were marked on the skin, clinical photographs were taken, and findings along with resultant clinical recommendations were recorded in a clinical report compiled by a vascular medicine physician and advanced occupational therapist (MT), who jointly conducted the procedure.

Existing therapy plans were documented as part of standard care and were derived by their treating therapist from traditional, non-ICG-L–informed clinical assessment within an average of 1 month of ICG-L procedure appointment. The development of existing therapy plans was informed by the teachings of Foldi and Foldi[6] based on the clinical features observed in the participants in the context of documented medical history. At the completion of the ICG-L procedure, an ICG-L–informed therapy plan was developed and incorporated in the clinical report compiled by the clinicians conducting the procedure. The ICG-TRANSLATE tool principles were used to recognize features identified on ICG-L and guide individualized decision-making about compression and MLD in participants' lymphedema therapy plans.

ICG-TRANSLATE is a two-part framework developed to support translation of ICG-L findings to inform individualized lymphedema therapy plans in clinical practice (Fig. 1). Given the paucity of evidence for ICG-L utility in therapy planning,[1] this clinical decision support tool assists clinicians in applying and describing ICG-L–informed changes to therapy planning recommendations in patients with cancer-related lymphedema. During development, processes cited in other decision support tool development were followed, including synthesis of the best available evidence integrated with high-level clinical experience and expert opinion.[26,44-47] ICG-TRANSLATE was primarily informed by the aforementioned findings of research in the form of an evidence synthesis of the key clinical features identified using ICG-L (Fig. 1a). This was combined with the clinical knowledge of two clinical experts (MT and AP), with a collective 35 years' experience in the field, to determine the clinical implications to readily applicable most commonly prescribed modalities of compression and MLD (Fig. 1b).

Data Collection

Data were extracted from each participant's existing therapy plan (pre–ICG-L) and from the ICG-L–informed therapy plan documented in the participant's medical record. ICG-L findings were recorded in a clinical report by the vascular medicine specialist and advanced occupational therapist (MT) who conducted the procedure, along with recommendations for therapy management guided by the ICG-TRANSLATE tool.

Data Analysis

A deductive approach[48] was used with a coding tree developed as a framework to code the extracted therapy plan data related to target lymphedema therapy modalities and their features (Fig. 2). The predetermined coding tree was based on clinical knowledge and principles of lymphedema therapy and was designed to enable comparison of the existing and ICG-L–informed therapy plans. The coding tree included self-management modality selection and features such as MLD technique and sequence, and compression garment limb coverage. Documented pre– and post–ICG-L therapy plan data were coded by one member of the research team (MT). To enhance rigor, a second member of the research team (AP) not involved in the procedure categorized a random selection (n = 5, 20%) independently, blinded by reviewing participant medical chart and abridged ICG report (ie, with

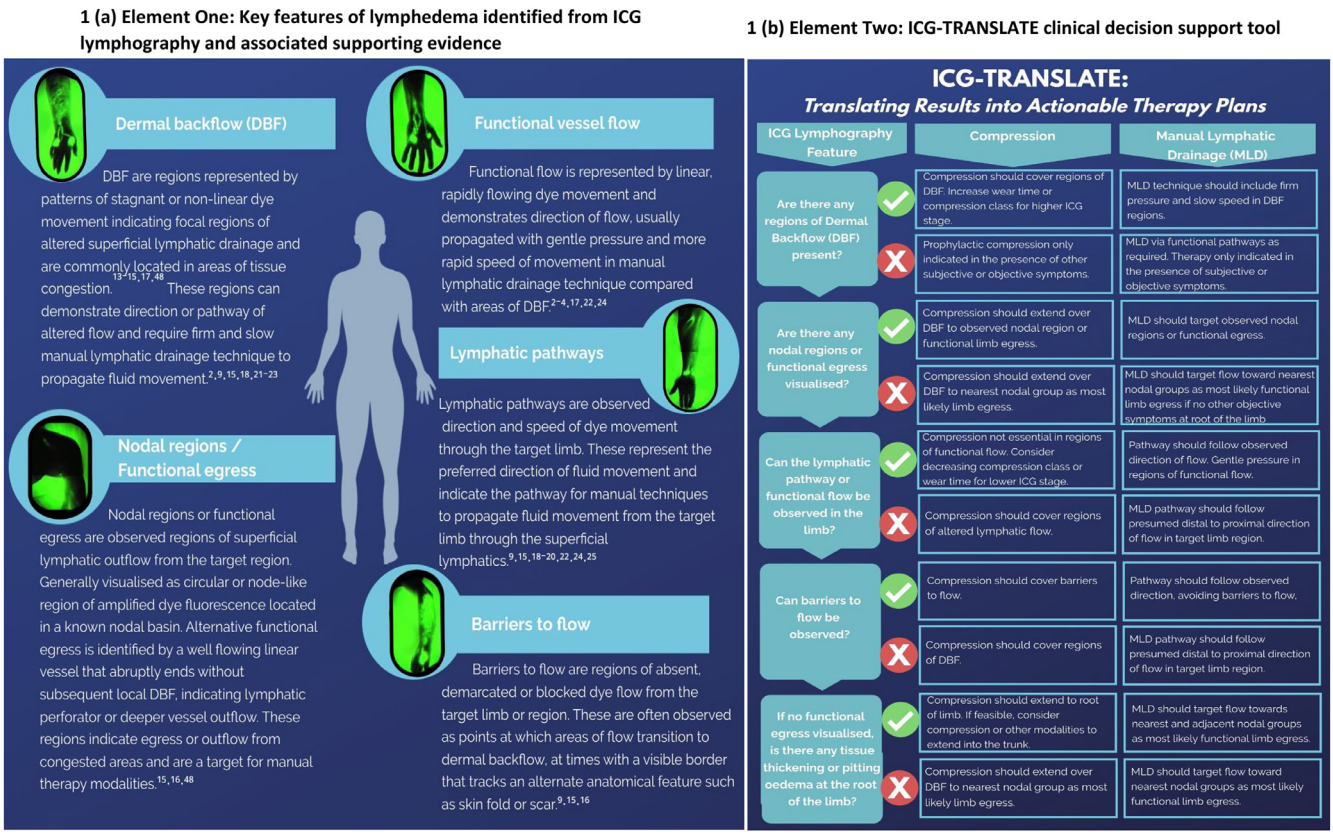

FIG 1. ICG-TRANSLATE tool 1, (a) Element 1: key features of lymphedema identified from ICG lymphography and associated supporting evidence 1. (b) Element 2: ICG-TRANSLATE clinical decision support tool.

findings only) to derive an ICG-L–informed plan through applying the ICG-TRANSLATE tool and extracting therapy recommendation data via the coding tree. Agreement between reviewers for the five independently reviewed participant charts using the coding tree was 95.55%. Differences were resolved during a consensus meeting between the two reviewers (MT and AP). Given the high levels of agreement between reviewers, the remaining participant data were coded by a single reviewer (MT) with ongoing consensus discussion between reviewers (MT and AP) throughout the process.

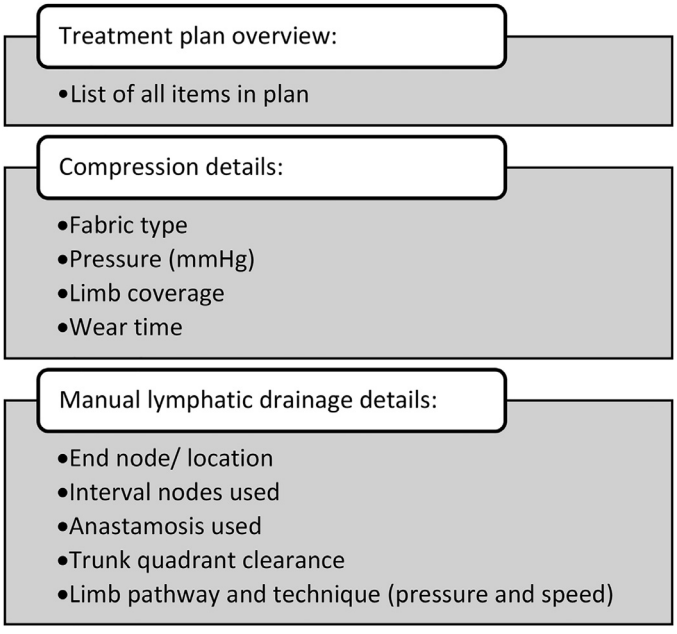

FIG 2. Therapy plan coding tree.

Descriptive statistics (frequencies and central tendencies) were used to describe changes in lymphedema therapy plans. Specifically, coded therapy plan data were tabulated and compared across both time points, with the percentage of change reported for each categorical variable of interest. The frequency of change (%) and most common changes in plan modality features of compression and MLD were reported. Patient demographic data were descriptively reported.[49]

Results

A total of 25 consecutive patients consented to participate in the study, with 16 women and 9 men ranging from in age from 36 to 78 years. Participants primarily had a history of breast cancer (n = 14) or melanoma (n = 8), and all had prior lymph node surgery. Most participants had unilateral upper limb lymphedema (n = 19) compared with lower limb (n = 6). One of the six participants with lower limb lymphedema had bilateral limbs affected. Participant demographics are presented in Table 1.

All participants demonstrated some changes to their existing lymphedema therapy plan post ICG-L and application of the ICG-TRANSLATE tool, with all (100%, n = 25) participants undergoing changes in MLD recommendations and 88% (n = 22) demonstrating changes to compression recommendations. See Table 2 for details of changes to therapy plans.

Some MLD features were changed after ICG-L, including location of end nodes (n = 25), anastomosis used (n = 24), and technique (n = 25). The location of end nodes for 24 cases changed to focus on ipsilateral axilla or groin nodal regions, with some focusing on additional nodal regions such as supraclavicular fossa. One case changed

TABLE 1
Participant Details and Lymphedema Background

	n (%)
Sex assigned at birth	
Female	16 (64)
Male	9 (36)
Age	
Age in years, mean (range)	57 (36-78)
Cancer diagnosis	
Breast	14 (56)
Melanoma	8(32)
Lymphoma	2(8)
Cervical	1(4)
Treatment	
Surgery (any) to lymph nodes	25(100)
Radiotherapy	19 (76)
Chemotherapy	17 (68)
Hormonal therapy	9 (36)
Immunotherapy	3 (12)
Affected limb	
Upper limb	19 (76)
Lower limb	6 (24)*
Bilateral	1 (4)*
ISL staging[b]	
0	3
1	4[a]
2a	13
2b	6[a]
3	0
Lymphedema history	
Lymphedema duration in months (mean(range))	51.1 (5-318)

[a] Bilateral limb lymphedema,
[b] International Society of Lymphology (ISL) staging descriptions: 0 (latent or subclinical); 1 (early, subsides with elevation); 2a (pitting, does not subside with elevation); 2b (possible fibrosis and fatty deposition); 3 (pitting absent, trophic skin changes present),[27]

toward contralateral axillary region alone. The use of lymphatic anastomosis changed in most cases, with 22 participants no longer indicating its use, and two participants altered their use to anterior anastomosis only. The MLD technique recommendations, which changed for all participants, were an increase in firm and slow pressures and altered pathway directions. In five upper limb participants, interval nodes were added to MLD recommendations where they had previously not been included.

The compression feature that most was commonly changed following ICG-L and application of ICG-TRANSLATE was the extent of limb coverage (n = 21), with 89% of upper limb participants (n = 17) and 67% (n = 4) of lower limb participants having compression limb coverage changes. Of the 17 participants with upper limb lymphedema with changes to their therapy plan, 14 were recommended reduction in compression limb coverage such as reduced garment coverage at fingers, hand or the upper arm. In contrast, of the four participants with lower limb lymphedema with suggested changes, three were recommended an increase in coverage. This included increasing garment coverage to include the thigh, pelvis, or toes where they had previously not been included in the limb region covered by compression garments.

TABLE 2
Frequency of Change in Compression and Manual Lymphatic Drainage Lymphedema Therapy Plan Features

	UL (n = 19) (n) %	**LL (n = 6) (n) %**	**Total (N = 25) (n) %**
Change to compression	**17 (89)**	**5 (83)**	**22 (88)**
Fabric type	**4 (21)**	**2 (33)**	**6 (24)**
Increase stiffness	4 (21)	2 (33)	
Decrease stiffness	0 (0)	0 (0)	
Pressure	**5 (26)**	**3 (50)**	**8 (32)**
Increase pressure	2 (11)	3 (50)	
Decrease pressure	3 (16)	0 (0)	
Limb coverage	**17 (89)**	**4 (67)**	**21 (84)**
Increase coverage	3 (16)	3 (50)	
Decrease coverage	14 (74)	1 (17)	
Wear time	**6 (32)**	**1 (17)**	**7 (28)**
Increase time	4 (21)	1 (17)	
Decrease time	2 (11)	0 (0)	
Change to MLD	**19 (100)**	**6 (100)**	**25 (100)**
End nodes	19 (100)	6 (100)	25 (100)
Interval nodes	5 (26)	0 (0)	5 (20)
Anastomosis used	19 (100)	5 (83)	24 (96)
Trunk quadrant clearance	18 (95)	6 (100)	24 (96)
Limb pathway and technique	19 (100)	6 (100)	25 (100)

Discussion

This study aimed to describe the changes to lymphedema therapy plans following participation in ICG-L and application of ICG-TRANSLATE, a novel clinical decision support tool for translating ICG-L findings into actionable therapy plans. Informed by current evidence of altered lymphatic drainage, the ICG-TRANSLATE clinical decision support tool was developed and applied to inform therapy planning after participation in ICG-L. Following application of ICG-TRANSLATE, this study found that all participants experienced changes in their therapy recommendations in one or more of the routine lymphedema therapy modalities examined. These findings underscore the potential significance of ICG-L as a valuable tool in conservative lymphedema management through directly informing individualized therapy plans.

Progressing beyond conventional lymphedema therapy prescription, this study proposed a potential clinical decision support tool (via ICG-TRANSLATE) to apply ICG-L findings in clinical lymphedema therapy practice. Conventional lymphedema care approaches have used identification and assessment of clinical features of an individual's lymphedema presentation to identify therapy components necessary for management.[50,51] However, advancements in lymphatic imaging, specifically those found with ICG-L such as lymphatic pathways and altered drainage nodal regions, have not yet been incorporated routinely in therapy management approaches. Widely accepted uses of ICG-L to identify lymphatic rerouting and regions of dermal backflow for the diagnosis of lymphedema are well described.[1,52,53] However, the mechanisms for applying these individual anatomical findings to inform contemporary lymphedema care are lacking. Koelmeyer et al[9] have reported beyond the use of ICG-L findings for lymphedema staging by describing altered functional pathways observed and implying the use of these observations in adapting MLD to personalize lymphedema therapy management. Our study extends further to describe how individual ICG-L assessment findings and a clinical decision-making approach can guide ICG-L–informed lymphedema therapy planning.

The use of clinical reasoning or decision support tools to inform clinical decision-making can be useful for the translation of evidence to practice and a potential facilitator for implementation success. Decision tools have been successfully applied in many clinical practice areas, including upper limb hypertonicity management,[26] lower back pain,[54] and wound management.[55] Notably, the advantages proposed by decision tool use in these examples includes translation of evidence to practice,[10] consistency of practice[55] and enhanced decision-making for novice clinicians.[56] It is important to highlight that decision support tools do not replace the need for considered clinical reasoning. In this case, lymphedema-trained practitioners still require the knowledge and skill to determine whether and how the tool applies to individual cases,[57] but the ICG-TRANSLATE tool aims to enhance practitioners' application of evidence to practice and guide clinicians to make timely, consistent, evidence-based clinical decisions for individualized patient care. Though there are several clinical practice guidelines indicating lymphedema conservative management recommendations,[58] there is limited guidance in how

clinicians should stratify treatment selection for individualized care.[59] The ICG-TRANSLATE tool is a novel clinical decision support tool, based on the available evidence in the field and the first application of a tool actioning ICG-L–guided clinical reasoning in lymphedema care.

The clinical impact of applying ICG-L–informed changes to therapy may influence the burden of lymphedema care to both the individual and the health service through the targeted stratification of lymphedema therapy management. For example, there is a relative reduction in the time burden and physical demand on the individual performing MLD (or self-MLD) when components of MLD are reduced to focus on the target limb alone and avoid inclusion of likely unnecessary steps (eg, trunk and anastomoses clearance). Similarly, where compression limb coverage is reduced, there is a conceivable reduction in compression costs, along with the potential for improved tolerance from the individual through reduced intrusion into their daily function. Although contrasting outcomes may indicate recommendations for individuals to increase aspects of lymphedema therapy self-management, it may be that the accompanying reported increased knowledge gained through the procedure experience itself[41] assists subjects' acceptance of recommendations. Leading to a hypothesized potential for enhanced lymphedema outcomes, with more targeted modality selection for people so heavily burdened with health-related maintenance tasks. While the clinical utility of ICG-L in conservative lymphedema clinical practice is suggested in this study by demonstrating ICG-L application in lymphedema therapy planning, how useful ICG–L–informed therapy may be to lymphedema outcomes is still not yet known.

Limitations and Directions for Future Research

The authors acknowledge the limitations in this study. First, as is known with before-after studies, validity may be limited by discrepancies between stated therapy plans and actual behavior.[42] This study focused on identifying if change to recommended plans occurred, rather than focusing on the subsequent assumed behavior change. Future prospective studies that extend to exploring impact to lymphedema outcomes following ICG-L–informed therapy plan changes are warranted and should consider methods for monitoring adherence to the proposed therapy changes. Second, the role of the principal investigator as the clinical lead posed an additional challenge, increasing the potential for bias. However, the addition of a second blinded reviewer to apply the proposed clinical reasoning tool and compare therapy plan recommendations enhanced the rigor of the findings reported. Finally, the tool used to apply changes to therapy plan recommendations is not yet validated. We used current available evidence to inform development of the ICG-L clinical decision support tool, ICG-TRANSLATE. However, the emerging nature of ICG-L as a therapy-shaping technique means that the ICG-TRANSLATE tool proposed in this study is expected to change and expand over time as exploration extends to a more detailed understanding of ICG-L impacts on patient outcomes. Further to this, the use of the ICG-TRANSLATE tool still requires lymphedema-trained practitioners with clinical knowledge of lymphedema to support its application to ICG–L–informed practice. Although this current study demonstrates ICG-L–informed change to therapy management modalities of MLD and compression for individuals with lymphedema, further larger studies are needed to understand if this ICG-L–informed change translates to improved lymphedema outcomes for people with lymphedema, along with calculating potential health use cost benefits. Broader exploration of ICG-L impact to other conservative lymphedema therapy modalities is also necessary. Understanding these impacts, along with more detailed analysis of the health resource burden in relation to ICG-L is essential in determining its value in the clinical setting.

Conclusion

This study identified that the use of ICG-L in combination with the ICG-TRANSLATE clinical decision support tool resulted in change to MLD for all participants, including terminal nodes, pathway and technique. For many it also informed change to compression recommendations particularly the reduction or extension of garment limb coverage, highlighting the clinical importance of ICG-L. ICG-TRANSLATE, the novel clinical decision support tool used, may assist lymphedema practitioners with the translation of key ICG-L findings to inform individualized lymphedema therapy management plans. Further exploration is necessary to determine if the subsequent changes informed by ICG-L–guided lymphedema therapy plans translate into improved clinical outcomes for people with lymphedema.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

Megan Trevethan: Writing – original draft, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation. **Emmah Doig:** Writing – review & editing, Methodology, Conceptualization. **Freyr Patterson:** Writing – review & editing, Methodology, Conceptualization. **Amanda Pigott:** Writing – review & editing, Methodology, Formal analysis, Conceptualization.

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Ethics Approval

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Metro South Health Human Research Ethics Committee (HREC/2019/QMS/49709) and The University of Queensland Ethics Committee (2019/HE000868).

Data Availability

The data that support the findings of this study are not openly available due to privacy/ethical restrictions and are available from the corresponding author upon reasonable request.

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