

From Cording to Recovery: Timing, Dose, Progression, and Personalization of Exercise-Based Rehabilitation for Axillary Web Syndrome Following Breast Cancer Surgery

(A Systematic Review and Evidence-to-Practice Framework AWS-PReF • FITT-PRO • AWS-CORE)

Waseem Mumtaz Ahamed

DOI: <https://doi.org/10.5281/zenodo.23208881>

Published Date: 07-October-2026

Abstract: Background: Axillary web syndrome (AWS) is a postoperative complication of breast cancer surgery associated with cord-like structures, pain, restricted shoulder movement and impaired upper-limb function. Existing syntheses have largely focused on whether physiotherapy works or which modality performs best; less attention has been given to initiation timing, dose, progression, supervision, adherence and recovery trajectory.

Objective: To evaluate exercise-based and multimodal rehabilitation for AWS, emphasizing timing, therapeutic dose, progression, treatment exposure and recovery trajectory, and to develop an evidence-informed Axillary Web Syndrome Precision Rehabilitation Framework (AWS-PReF).

Methods: The review is designed according to PRISMA 2020. Eligible interventions include therapeutic exercise, active/assisted ROM, stretching, progressive resistance, functional exercise, home/supervised programs and multimodal rehabilitation containing an active physical component. Planned sources are MEDLINE/PubMed, Embase, CINAHL, CENTRAL, Web of Science Core Collection, Scopus and PEDro, supplemented by trial registries and citation searching. FITT-PRO characterizes Frequency, Intensity, Time, Type, Progression, Rehabilitation context and Onset. RoB 2 and GRADE are planned.

Current evidence synthesis: Contemporary randomized evidence supports active rehabilitation as a central component of conservative AWS management. Improvements have been reported in pain, shoulder ROM, disability and recovery trajectory. Selected manual, lymphatic and scar-directed adjuncts may add benefit, but differences in treatment exposure complicate causal attribution. A 2026 network meta-analysis identified 14 RCTs involving 1,007 participants and 11 intervention categories while highlighting sparse networks, heterogeneity and model-dependent findings.

Conclusion: The unresolved question is increasingly not simply whether physiotherapy works, but how AWS rehabilitation should be prescribed. Active progressive rehabilitation appears to form the therapeutic foundation. AWS-PReF provides a hypothesis-generating pathway from symptom-sensitive mobility through capacity restoration and functional reintegration, but requires prospective validation.

Keywords: axillary web syndrome; breast cancer; rehabilitation; physiotherapy; therapeutic exercise; cording; shoulder range of motion; manual lymphatic drainage; functional recovery; systematic review.

1. INTRODUCTION

Axillary web syndrome (AWS), frequently termed axillary cording, is a recognized complication after breast cancer surgery and axillary procedures. It may present as one or more taut, palpable or visible cords extending from the axilla into the medial arm and, in some patients, farther distally. Pain, pulling sensations, restricted shoulder elevation and abduction, movement apprehension and difficulty with activities of daily living may accompany the condition.

The rehabilitation literature has expanded from descriptive reports to controlled trials and systematic reviews. Earlier syntheses suggest that rehabilitation can improve pain, mobility and function, but the evidence remains heterogeneous. The evidence base expanded further in 2026, when a network meta-analysis identified 14 randomized controlled trials involving 1,007 participants and 11 intervention categories.

However, treatment labels do not define a reproducible rehabilitation prescription. Programs classified as exercise or physical therapy may differ substantially in frequency, session duration, total program length, home-exercise exposure, progression criteria, supervision, postoperative timing and adjunctive treatment. Comparisons between exercise and exercise plus an adjunct may also compare different levels of therapist contact or total treatment exposure.

This review therefore reframes AWS management as a rehabilitation-prescription problem. Its central question is how exercise-based rehabilitation should be initiated, dosed, progressed, combined and individualized to optimize meaningful functional recovery after breast cancer surgery.

2. OBJECTIVES

- Evaluate the effectiveness and safety of exercise-based and multimodal rehabilitation for AWS.
- Characterize rehabilitation according to timing, frequency, intensity, duration, type, progression, supervision, home exposure and adherence.
- Interpret adjunctive therapies in the context of total treatment exposure.
- Synthesize symptoms, ROM, function, AWS resolution, participation, safety and time-to-recovery.
- Develop the evidence-informed, hypothesis-generating AWS-PReF framework.

3. METHODS

3.1 Reporting framework

The review is designed according to PRISMA 2020. Final reporting must include the actual databases/platforms searched, exact search dates, complete strategies, selection process, study-level results, risk-of-bias judgments and certainty assessments.

3.2 Eligibility criteria

Domain	Eligibility
Population	Adults ≥ 18 years with clinically diagnosed AWS following breast cancer surgery.
Intervention	Therapeutic exercise; active/assisted ROM; stretching; progressive resistance; functional exercise; home/supervised exercise; manual therapy + exercise; MLD + exercise; scar/soft-tissue interventions; technology-supported or multimodal physical rehabilitation.
Comparator	Usual care, education, no structured rehabilitation, another active intervention or a different dose/combination.
Primary outcomes	Pain; shoulder flexion/abduction ROM; upper-limb disability/function; AWS resolution/severity; time-to-recovery.
Secondary outcomes	QoL, ADLs, participation, strength, exercise capacity, adherence, adverse events and swelling/lymphedema.
Design	RCTs and controlled/prospectively comparative intervention studies for primary effectiveness synthesis; observational intervention evidence may be summarized separately.
Exclusions	Case reports, narrative reviews, editorials, diagnostic-only studies and studies without extractable AWS outcomes.

3.3 Information sources and search architecture

Planned databases: MEDLINE/PubMed, Embase, CINAHL, Cochrane CENTRAL, Web of Science Core Collection, Scopus and PEDro; supplemented by ClinicalTrials.gov, WHO ICTRP where accessible, backward reference searching and forward citation searching.

Draft PubMed strategy:

("axillary web syndrome" OR "axillary cording" OR "lymphatic cording" OR "axillary cord*") AND ("breast cancer" OR "breast neoplasm*" OR mastectom* OR "breast surgery" OR "axillary lymph node dissection" OR "sentinel lymph node biopsy") AND (physiotherap* OR "physical therapy" OR rehabilitation OR exercise OR stretching OR strengthening OR "resistance training" OR mobilization OR "manual therapy" OR "manual lymphatic drainage" OR "range of motion" OR myofascial OR "scar massage")

3.4 Selection, extraction and linked reports

Two reviewers should independently screen records and full texts, with disagreements resolved by consensus or a third reviewer. Full-text exclusion reasons must be recorded. Multiple publications from the same underlying trial should be clustered under a single study identifier to prevent double counting.

3.5 FITT-PRO intervention taxonomy

Element	Meaning	Extraction
F	Frequency	Sessions/day; sessions/week
I	Intensity	Resistance, stretch intensity, symptom/tolerance threshold
T	Time	Session duration; program duration; hold time
T	Type	ROM, stretching, resistance, functional loading, adjuncts
P	Progression	Rules/criteria for advancing treatment
R	Rehabilitation context	Supervised/home/hybrid; therapist exposure; adjuncts
O	Onset	Time from surgery/AWS diagnosis to treatment

3.6 Risk of bias and certainty

Randomized trials will be assessed with Cochrane RoB 2 at the outcome level. GRADE will be applied separately to critical outcomes. Final judgments remain pending the definitive included-study set.

3.7 Synthesis

Random-effects meta-analysis will be undertaken only where clinical and methodological comparability is adequate. Mean differences will be preferred for identical scales/units, standardized mean differences for conceptually comparable constructs measured differently, and risk ratios for dichotomous outcomes. Time-to-event estimates will be synthesized only where compatible data exist.

4. CURRENT EVIDENCE SYNTHESIS

Study/report	Design/sample	Intervention structure	Exposure	Interpretation
Cho et al. (2016)	RCT; 41	PT + MLD vs PT	4 weeks; treatment frequency differed	Potential adjunct benefit, but treatment-exposure confounding limits attribution to MLD alone.
Torres-Lacomba et al. (2022)	Assessor-blinded RCT; 96	MLD + AWS-specific progressive exercise vs standard arm exercise	3 sessions/week × 3 weeks plus home exercise	Supports short/intermediate improvements; balanced visit frequency strengthens comparison.
Stretching ± snapping maneuver (2023)	RCT; 60	Stretching + snapping vs stretching	Weekly supervised ×2; home exercise 3×/day ×1 month	No clear additional 1-month ROM benefit from snapping.
MLD vs soft-tissue mobilization (2023)	RCT; 36	Two adjunctive approaches with common exercise backbone	5 sessions/week ×4 weeks	Between-group effects primarily estimate incremental adjunct effects.
González-Rubino et al. linked reports (2025)	RCT; 48 randomized, 46 analyzed	Stretching + manual therapy + scar massage	15 sessions; linked reports	NCT05115799 publications should be treated as one underlying trial.
2026 network meta-analysis	14 RCTs; 1,007 participants	11 intervention categories	Heterogeneous	Selected multimodal combinations ranked favorably, but sparse network, heterogeneity and model sensitivity limit definitive ranking.

4.1 Treatment-exposure confounding

When groups differ in both treatment content and total exposure, superior outcomes cannot automatically be attributed to the added modality. Therapist contact, exercise exposure, adherence reinforcement and nonspecific treatment effects may contribute.

4.2 Active rehabilitation as the foundation

Exercise is frequently present in both intervention and comparator arms. Many trials therefore estimate the incremental effect of an adjunct rather than exercise versus inactivity. Active progressive rehabilitation should be regarded as the therapeutic backbone.

4.3 Progressive rather than aggressive treatment

Progressive loading should not be confused with aggressive cord manipulation. Current evidence does not establish that increasingly forceful disruption improves meaningful functional recovery.

4.4 Recovery acceleration

Earlier improvement may be clinically meaningful even if groups converge later. Time-to-recovery and recovery trajectory should therefore complement final endpoint status.

5. AWS-CORE OUTCOME ARCHITECTURE

Domain	Constructs	Clinical focus
C - Cording	Presence, severity, extent, resolution	Clinical AWS status
O - Objective mobility	Flexion, abduction, movement restriction	Physical restoration
R - Recovery experience	Pain, pulling, irritability, time-to-recovery	Recovery trajectory
E - Everyday function	DASH, ADLs, participation, work/recreation	Meaningful functional recovery
+ Safety	Swelling/lymphedema, wound issues, exacerbation, discontinuation	Treatment tolerability

AWS-CORE is a proposed synthesis framework, not an established core outcome set.

6. AWS PRECISION REHABILITATION FRAMEWORK (AWS-PReF)

AWS-PReF is evidence-informed and hypothesis-generating; it is not a validated clinical guideline.

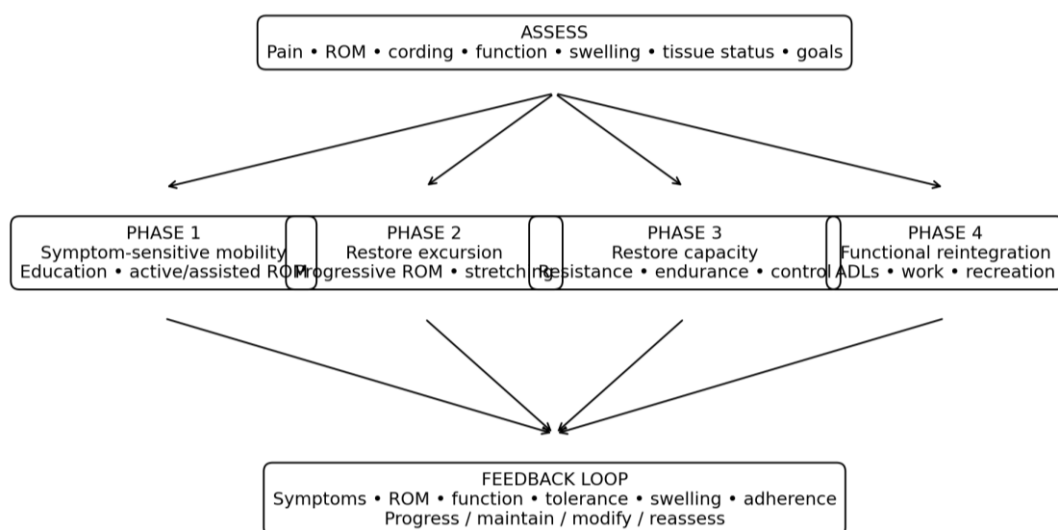


Figure 1. Proposed AWS Precision Rehabilitation Framework (AWS-PReF).

Phase	Target	Example components	Progression considerations
Assessment	Define phenotype and constraints	Pain, ROM, cording, function, swelling, tissue/wound factors, goals	Identify precautions and modifiable limitations.
Phase 1	Symptom-sensitive mobility	Education; active/assisted ROM; movement confidence	Acceptable symptom response and improved movement tolerance.
Phase 2	Restore excursion/ROM	Progressive flexion/abduction; stretching; selected adjuncts	Improving functional ROM and tissue tolerance.
Phase 3	Restore capacity	Progressive resistance; endurance; scapulothoracic control; functional loading	Tolerance of current load and increasing functional demand.
Phase 4	Functional reintegration	ADLs; work; recreation; exercise; self-management	Goal attainment and sustainable independence.



Effectiveness is interpreted as an interaction among patient characteristics, rehabilitation prescription, treatment exposure and adherence - not treatment label alone.

Figure 2. Evidence-to-practice model for prescription-centered AWS rehabilitation.

7. DISCUSSION

The evidence supports a shift from modality-centered thinking toward prescription-centered rehabilitation. Programs bearing the same label can represent very different therapeutic exposures.

The 2026 network meta-analysis substantially expands the randomized evidence base, but sparse comparisons, clinical heterogeneity and sensitivity to model assumptions mean treatment rankings should not be interpreted as definitive clinical hierarchies.

FITT-PRO addresses a translational gap by requiring extraction of the practical components necessary to reproduce rehabilitation. AWS-CORE broadens interpretation beyond cord disappearance toward objective mobility, recovery experience, everyday function and safety.

A patient may retain palpable cording while regaining meaningful movement and participation. Rehabilitation should therefore treat the patient's recovery, not merely the cord.

8. CLINICAL IMPLICATIONS

- Use active, progressive rehabilitation as the central conservative pathway.
- Begin with symptom-sensitive mobility and progress toward ROM restoration, strengthening, endurance and functional loading.
- Use manual, lymphatic or scar-directed approaches as selected adjuncts rather than substitutes for active rehabilitation.
- Do not assume forceful cord disruption is required.
- Monitor symptoms, function, ROM, swelling/lymphatic status, tissue considerations and adherence.
- Judge success using meaningful function and recovery trajectory, not cord appearance alone.

9. RESEARCH AGENDA

- Standardize reporting of rehabilitation dose and progression.
- Separate treatment-content effects from total treatment-exposure effects.
- Measure supervised and home-exercise adherence.
- Prioritize time-to-recovery, participation and patient-centered function.
- Use adequately powered trials with blinded outcome assessment where feasible.
- Prospectively validate AWS-PReF and develop a validated AWS core outcome set.

10. STRENGTHS AND LIMITATIONS

Strengths include the prescription-focused question, explicit attention to treatment-exposure confounding, linked-report handling, recovery-trajectory emphasis and a reproducible intervention taxonomy.

The present assembled manuscript does not yet contain the review team's own finalized multi-database search and record-level screening dataset. Consequently, genuine PRISMA counts, the definitive study set, complete RoB 2 assessments, GRADE profiles and any de novo meta-analysis remain pending. These must not be inferred from previous reviews.

11. CONCLUSION

Exercise-based rehabilitation appears to form the active foundation of conservative treatment for AWS following breast cancer surgery. Structured physiotherapy can improve pain, shoulder mobility and upper-limb function and may accelerate recovery. Selected manual, lymphatic and scar-directed interventions may provide additional benefits, but heterogeneity in frequency, duration, progression and comparator exposure prevents identification of a universally optimal prescription. Future research should prioritize treatment dose, initiation timing, progression criteria, adherence, functional recovery and time-to-recovery. AWS-PReF provides an evidence-informed model but requires prospective validation.

12. DECLARATIONS

Ethics approval and consent to participate: Not applicable; this systematic review uses published evidence.

Consent for publication: Not applicable.

Funding: Author confirmation required. Suggested statement if applicable: No specific funding was received for this work.

Competing interests: Author confirmation required. Suggested statement if applicable: The author(s) declare no competing interests.

Author contributions: Complete according to the final author team and target journal's CRediT requirements. Screening, extraction, RoB 2 and analysis contributions must be attributed to the people who actually perform them.

Data availability: The final extraction dataset, search strategies, risk-of-bias judgments and analytic materials should be supplied as supplementary files or deposited according to journal policy.

Protocol/registration: Insert an actual registry and identifier only if one exists. Do not imply prospective registration if it did not occur.

AI-assisted writing disclosure: Adapt to the target journal's policy. AI cannot be an author; all scientific content, references and conclusions require human verification.

REFERENCES

- [1] Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*. 2021;372:n71. doi:10.1136/bmj.n71.
- [2] Cho Y, Do J, Jung S, Kwon O, Jeon JY. Effects of a physical therapy program combined with manual lymphatic drainage in breast cancer patients with axillary web syndrome following axillary dissection. *Support Care Cancer*. 2016. PMID:26542271.
- [3] Torres-Lacombe M, et al. Effectiveness of physical therapy in axillary web syndrome after breast cancer: a randomized, single-blind, controlled trial. *Phys Ther*. 2022;102(3):pzab314. PMID:35079831.

- [4] Agostini F, et al. Rehabilitation of axillary web syndrome after breast cancer surgery: systematic review. 2022. PMID:35807124.
- [5] Systematic review and meta-analysis of physical therapy for axillary web syndrome following breast cancer surgery. Support Care Cancer. 2023. PMID:37043039.
- [6] Randomized controlled trial of stretching with or without a snapping manual maneuver for axillary web syndrome. 2023. PMID:37750301.
- [7] Randomized trial comparing manual lymphatic drainage and soft-tissue mobilization within exercise-based rehabilitation for axillary web syndrome. 2023. PMID:37950230.
- [8] Exercise-based interventions with and without adjunct therapies for axillary web syndrome: systematic review. 2024. J-STAGE.
- [9] González-Rubino JB, et al. Randomized clinical trial report addressing pain, range of motion and recovery in axillary web syndrome. 2025. PMID:40153020. NCT05115799.
- [10] González-Rubino JB, et al. Linked randomized trial report addressing function, exercise capacity and quality of life. 2025. PMID:40810787. NCT05115799.
- [11] Comparative Effectiveness of Different Physical Therapies for Axillary Web Syndrome after Breast Cancer Surgery: A Network Meta-Analysis of Randomized Controlled Trials. Physiotherapy. Published online 2026 Sep 8. doi:10.1016/j.physio.2026.102381.

Reference verification note: All bibliographic fields must be checked against the original publications and reformatted to the selected journal before submission.

Supplementary Materials

Supplement S1. Search Log

Database/platform	Date searched	Coverage	Full strategy status	Records
MEDLINE/PubMed	PENDING	Inception to final date	PENDING final execution	PENDING
Embase	PENDING	Inception to final date	PENDING final execution	PENDING
CINAHL	PENDING	Inception to final date	PENDING final execution	PENDING
CENTRAL	PENDING	Inception to final date	PENDING final execution	PENDING
Web of Science Core Collection	PENDING	Inception to final date	PENDING final execution	PENDING
Scopus	PENDING	Inception to final date	PENDING final execution	PENDING
PEdro	PENDING	Inception to final date	PENDING final execution	PENDING
ClinicalTrials.gov	PENDING	Inception to final date	PENDING final execution	PENDING
WHO ICTRP	PENDING	Inception to final date	PENDING final execution	PENDING

Supplement S2. PRISMA Flow Data Sheet

Item	Value
Records identified	PENDING - populate from actual review workflow
Duplicates removed	PENDING - populate from actual review workflow
Records screened	PENDING - populate from actual review workflow
Title/abstract exclusions	PENDING - populate from actual review workflow
Reports sought	PENDING - populate from actual review workflow
Full texts assessed	PENDING - populate from actual review workflow
Full-text exclusions with reasons	PENDING - populate from actual review workflow
Unique studies included	PENDING - populate from actual review workflow
Reports of included studies	PENDING - populate from actual review workflow
Studies in quantitative synthesis	PENDING - populate from actual review workflow

Supplement S3. FITT-PRO Extraction Form

Field	Entry
Study ID/linked reports	
Country/design	
Sample randomized/analyzed	
Surgery/axillary procedure	
AWS criteria	
Time from surgery/AWS onset	
Frequency	
Intensity	
Session duration	
Program duration	
Exercise type	
Sets/reps/hold time	
Progression rule	
Supervised/home context	
Adjuncts	
Home-exercise exposure	
Adherence	
Comparator exposure	
Pain	
ROM	
Function/disability	
AWS resolution	
Time-to-recovery	
QoL/participation	
Safety	
Funding/conflicts	

Supplement S4. RoB 2 Template

Domain	Judgment	Support
Randomization process	PENDING	Complete per critical outcome
Deviations from intended interventions	PENDING	Complete per critical outcome
Missing outcome data	PENDING	Complete per critical outcome
Measurement of outcome	PENDING	Complete per critical outcome
Selection of reported result	PENDING	Complete per critical outcome
Overall risk of bias	PENDING	Complete per critical outcome

Supplement S5. GRADE Template

Outcome	Studies	Risk of bias	Inconsistency	Indirectness	Imprecision	Certainty
Pain	PENDING	PENDING	PENDING	PENDING	PENDING	PENDING
Shoulder flexion ROM	PENDING	PENDING	PENDING	PENDING	PENDING	PENDING
Shoulder abduction ROM	PENDING	PENDING	PENDING	PENDING	PENDING	PENDING
Upper-limb disability/function	PENDING	PENDING	PENDING	PENDING	PENDING	PENDING
AWS resolution/severity	PENDING	PENDING	PENDING	PENDING	PENDING	PENDING
Time-to-recovery	PENDING	PENDING	PENDING	PENDING	PENDING	PENDING
Safety/adverse events	PENDING	PENDING	PENDING	PENDING	PENDING	PENDING

Supplement S6. Planned Synthesis Matrix

Outcome	Effect measure	Time points	Pooling rule
Pain	MD/SMD	Short/intermediate/long	Only clinically comparable measures/time points
ROM	MD in degrees	Short/intermediate/long	Flexion and abduction separately
Function	MD/SMD	As reported	Avoid conceptually dissimilar scales
AWS resolution	Risk ratio	As reported	Consistent resolution definitions where possible
Time-to-recovery	Time-to-event metric if available	Trajectory	Narrative if definitions incompatible
Safety	RR or narrative	Entire intervention	Report adverse events/discontinuations

Supplement S7. PRISMA 2020 Submission Audit

Requirement	Status
Systematic review identified in title	Complete
Structured abstract	Draft complete; update after final dataset
Rationale/objectives	Complete
Eligibility criteria	Complete
All information sources and exact dates	Pending
Full strategy for every database/register	Pending; PubMed architecture drafted
Independent selection process	Specified; execution pending
Data collection process	Specified; execution pending
Risk of bias	Method specified; judgments pending
Effect measures/synthesis methods	Specified
PRISMA flow diagram	Pending genuine counts
Definitive study characteristics	Pending final study set
Individual numerical results	Pending complete extraction
Synthesis/meta-analysis	Pending comparability assessment
GRADE	Pending
Discussion/limitations	Draft complete
Registration	Confirm actual status
Declarations/data availability	Drafted; author confirmation required

Supplement S8. Submission Readiness Gate

- Complete all database searches through the declared final date.
- Deduplicate and independently screen records.
- Lock the unique-study/linked-report map.
- Generate genuine PRISMA flow counts and exclusion reasons.
- Complete full numerical extraction.
- Complete outcome-specific RoB 2 and GRADE.
- Perform meta-analysis only if justified.
- Verify every reference against the original source.
- Update abstract/results/conclusion with final evidence.
- Format manuscript and supplements to the selected journal.