Moving the needle: a narrative review of enhanced recovery protocols in breast reconstruction

Robert Craig Clark, Alexandra Alving-Trinh, Miriam Becker, Garrison A. Leach, Amanda Gosman, Chris M. Reid

Division of Plastic Surgery, UC San Diego School of Medicine, La Jolla, CA, USA

Contributions: (I) Conception and design: CM Reid, A Gosman, RC Clark, A Alving-Trinh; (II) Administrative support: CM Reid, A Gosman; (III) Provision of study materials or patients: None; (IV) Collection and assembly of data: RC Clark, A Alving-Trinh, GA Leach, M Becker; (V) Data analysis and interpretation: RC Clark, GA Leach, M Becker; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Chris M. Reid, MD. Division of Plastic Surgery, UC San Diego Health, 200 West Arbor Drive MC 8890, La Jolla, CA 92103-8890, USA. Email: chreid@ucsd.edu.

Background and Objective: After a relatively late introduction to the literature in 2015, enhanced recovery protocols for breast reconstruction have flourished into a wealth of reports. Many have since described unique methodologies making improved offerings with superior outcomes attainable. This is a particularly interesting procedure for the study of enhanced recovery as it encompasses two dissident approaches. Compared to implant-based reconstruction, autologous free-flap reconstruction has demonstrated superiority in a range of long-term metrics at the expense of historically increased peri-operative morbidity. This narrative review collates reports of recovery protocols for both approaches and examines methodologies surrounding the key pieces of a comprehensive pathway.

Methods: All primary clinical reports specifically describing enhanced recovery protocols for implant-based and autologous breast reconstruction through 2022 were identified by systematic review of PubMed and Embase libraries. Twenty-five reports meeting criteria were identified, with ten additional reports included for narrative purpose. Included studies were examined for facets of innovation from the pre-hospital setting through outpatient follow-up. Notable findings were described in the context of a comprehensive framework with attention paid to clinical and basic scientific background. Considerations for implementation were additionally discussed.

Key Content and Findings: Of 35 included studies, 29 regarded autologous reconstruction with majority focus on reduction of peri-operative opioid requirements and length of stay. Six regarded implant-based reconstruction with most discussing pathways towards ambulatory procedures. Eighty percent of included studies were published after the 2017 consensus guidelines with many described innovations to this baseline. Pathways included considerations for pre-hospital, pre-operative, intra-operative, inpatient, and outpatient settings. Implant-based studies demonstrated that safe ambulatory care is accessible. Autologous studies demonstrated a trend towards discharge before post-operative day three and peri-operative opioid requirements equivalent to those of implant-based reconstructions.

Conclusions: Study of enhanced recovery after breast reconstruction has inspired paradigm shift and pushed limits previously not thought to be attainable. These protocols should encompass a longitudinal care pathway with optimization through patient-centered approaches and multidisciplinary collaboration. This framework should represent standard of care and will serve to expand availability of all methods of breast reconstruction.

Keywords: Enhanced recovery; breast reconstruction; outcomes; enhanced recovery after surgery (ERAS); length of stay

Submitted Apr 11, 2023. Accepted for publication Jul 07, 2023. Published online Jul 24, 2023.
doi: 10.21037/atm-23-1509
View this article at: https://dx.doi.org/10.21037/atm-23-1509

Introduction

Early reports discussing surgical physiology and its relationship with post-operative morbidity founded the introduction of "fast-track" surgery protocols in the early 2000's (1-3). Research has since blossomed into enhanced recovery after surgery (ERAS), a field of itself, with numerous publications spanning most surgical subspecialties. These methods, aimed at optimizing the physiologic response to operation and anesthesia, have demonstrated reductions in factors including morbidity, length of stay, and costs (4). As of 2023, the international ERAS® Society has collated 30 current consensus guidelines in 17 specialties, with focus on pre-operative optimization, anesthesia, opioid-sparing analgesia, and post-operative care (5).

Plastic surgery had a relatively late introduction to enhanced recovery, with Fayezizadeh *et al.* describing a protocol for abdominal wall reconstruction in 2014 (6). Research quickly saw exponential growth, particularly in breast surgery and head and neck reconstruction, leading to publication of consensus ERAS® guidelines for each in 2017 (7,8). Breast reconstruction is a particularly interesting service for the study of enhanced recovery as it encompasses two dissident techniques, namely implant-based (alloplastic) and free-flap (autologous) reconstruction.

Alloplastic methods are of comparatively lower technical demand with significantly shorter operative times and historically lower immediate perioperative morbidity and post-operative length of stay. Thus, they are currently employed in approximately 75% of reconstructions (9). Meanwhile, less-frequently-offered autologous reconstructions have demonstrated long-term superiority in metrics ranging from complication rates, costs and quality of life (10-14). The goals of operative and recovery protocols should thus be two-fold; improving alloplastic outcomes and enhancing autologous offerings.

Since 2019, the authors' group has worked to build on the consensus guidelines and enhanced recovery literature at-large to create a comprehensive and interdisciplinary pathway targeting these goals. Herein is a narrative review researching recovery after surgery for breast reconstruction with systematic description of reports and dissection into the facets of a comprehensive pathway. Each facet is described, with attention to available evidence, and discussed through the lens of the authors' experience. We present this article in accordance with the Narrative Review reporting checklist (available at https://atm.amegroups.com/article/view/10.21037/atm-23-1509/rc).

Methods

Following Preferred Reporting in Systematic Meta Analysis guidelines, the authors identified reports describing enhanced recovery protocols in alloplastic and autologous reconstructions (*Figure 1*, Table S1). The PubMed and Embase databases were queried with various search terms, and titles and abstracts were screened for inclusion by two independent blinded reviewers followed by retrieval and assessment of the full text. Initially included reports were those containing primary clinical research and focused on ERAS or improved outcomes with protocol description. Reviews and studies focusing on one specific protocol facet were initially excluded.

Initial inclusion criteria yielded 25 studies. Five were focused on alloplastic reconstruction with year of publication ranging from 2017–2020 (15-19). Twenty were focused on autologous reconstruction with publication ranging from 2015–2022 (20-39). Study characteristics, descriptions, and conclusions are provided (*Tables 1*,*2*). Ten reports outside of the initial criteria were additionally included to enhance the narrative (40-49). Descriptions and reasoning for inclusion are provided (*Table 3*).

The narrative review is divided into sections on pre-hospital, pre-operative, intra-operative, inpatient, and outpatient care. Both alloplastic and autologous reconstruction are included, but significant attention is given to autologous as the literature is significantly denser. Special topics including costs and protocol adoption are ultimately discussed, and the key pieces of a compressive protocol are outlined.

Discussion

Pre-hospital

Enhanced recovery protocols in breast reconstruction often start in the clinic, with patient selection, education, expectation setting, and surgical optimization.

Selection criteria

As much of the literature focuses on expedited discharge, selection often hinges on safe outpatient care. In the alloplastic literature, reported criteria included well-controlled comorbidities, American Society of Anesthesiologists (ASA) class I or II (excluding patients with severe systemic disease), BMI <35 kg/m^2, and metastatic cancer (16-19). Notably, two studies by Dumestre *et al.*, which were focused on a protocol for same-day discharge,

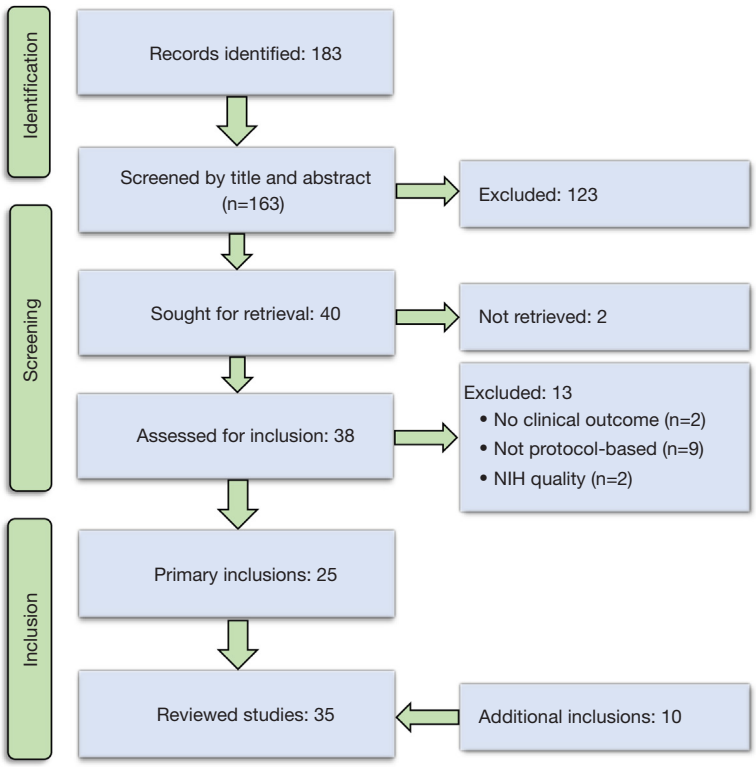

Figure 1 PRISMA flowchart of study identification and selection.

also described the importance of home support. Patients were only enrolled into the pathway if they had another capable adult at home and lived within an hour of the institution (18,19). Generally, autologous reports described similar criteria, with additional exclusions for age >70 years, contra-indication to local anesthetic, current smoking, chronic opioid use, narcotic abuse history, chronic pain syndromes, and sleep apnea (28,32,43,46,49). Otherwise, many studies reported that all patients were enrolled without exclusions. The authors' program enrolls all patients, but attention is paid to the criteria described and elements are tailored to the individual when indicated.

Education and expectations

Patient-centered education and expectation setting played a major role in many reports. Notable examples include provision of pamphlets (17), figure-based discussions (25,37), and classes with specialized nurses (27,42). Two autologous studies describe the specific power of expectations and norms by demonstrating significantly reduced length of stay after simply shortening that expected by patients, surgeons, and staff (40,47). These reports show profound simplicity in that all the authors modified was set an expectation ahead of surgery and tell the patients and staff it was possible. With just this, they were able to reduce the length of stay by at least a day. These findings emphasize the importance of patient expectation management as part of an enhanced recovery protocol. The psychological component of patient expectations and concerns must be considered, as it can constitute a barrier to optimal recovery. It appears that this aspect is easily addressed by timely and adequate patient education.

Interestingly, while the 2017 ERAS® consensus guidelines provided a strong recommendation for pre-hospital counseling and education, there is no mention of expectation-setting and a paucity of research on specific education elements or delivery (7). The authors have had success with a short, nurse-created video detailing inpatient and outpatient recovery and surgeon directed expectation setting at initial consultation. These goals set early, serve as a foundation for achievement after surgery.

Optimization

The consensus guidelines likewise provide a strong

Table 1 Summary of alloplastic reconstruction protocol studies meeting inclusion criteria

Study	Journal	Country	Study type	ERAS patients (n)	Traditional patients (n)	Synopsis	Conclusions
Dumestre *et al.*, 2017	*Plast Reconstr Surg*	Canada	Prospective comparative	29	29	Assessed length of stay, ED visits/ readmissions, and pain requirements in traditional, hybrid, and full ERAS cohorts for alloplastic reconstruction	ERAS protocol offered reduced pain without increase in complications for alloplastic reconstruction
Dumestre *et al.*, 2017	*Plast Surg (Oakv)*	Canada	Retrospective comparative	78	78	Updated larger cohort with longer follow-up for above study	ERAS protocol resulted in decreased length of stay without increased readmissions or ED visits
Chiu *et al.*, 2018	*BMC Anesthesiol*	United States	Retrospective comparative	96	276	Assessed pain requirements and post-operative nausea/emesis in patients undergoing mastectomy with immediate alloplastic reconstruction. All patients (traditional and ERAS) had planned 23 h admission	ERAS protocol including multimodal pain control and regional anesthesia blocks yielded decreased rates of opioid consumption and nausea/ emesis
McGugin *et al.*, 2019	*Ann Surg Oncol*	United States	Retrospective comparative	611	188	Did not articulate exact protocol, but assessed length of stay and IV opioid use after implementation of ERAS protocol	Institution of formal protocol yielded significant reduction in overall IV opioid use, percentage of patients requiring opiates, and time to last IV use
Hammond *et al.*, 2021	*Ann Plast Surg*	United States	Retrospective comparative	151	212	Assessment of the feasibility of same-day alloplastic reconstruction after mastectomy in the presence of ERAS. Significant reduction in overall complications at 90-day follow-up	ERAS allowed for same day discharge of mastectomy patients without increased risk of overall complications

ERAS, enhanced recovery after surgery; ED, Emergency Department; IV, intravenous.

recommendation for pre-hospital patient optimization including varying levels of evidence supporting glycemic control, BMI reduction, smoking cessation, and alcohol abstinence (7). Unfortunately, the timeline of breast reconstruction makes optimal surgical candidacy challenging and the arguably non-elective nature of the procedure limits patient selection for many surgeons. In the current literature, optimization counseling/encouragement includes smoking cessation, alcohol reduction or abstinence, exercise, and healthy diet (23,24,31,32,43,46).

Three reports specifically discussed nutritional optimization. Sindali *et al.* noted this to be of particular importance but did not provide detail, Shin *et al.* described employed protein supplementation for 1 week, and Bamba *et al.* provided high-calorie nutritional beverages for 5 days pre-operatively (31,40,42). While pre-operative nutrition may have potential value, the concept is presently understudied with sparse evidence across all fields (50-52).

Fasting

The final piece of the pre-hospital recovery foundation is departing from the pre-operative fast, rooted in many years of tradition, for evidence-based practices including limited fasts, clears-only diets, and immediate pre-operative oral carbohydrate solutions (53). This principle was given strong recommendations in the consensus guidelines, namely a clears-only to 2 hours before the operation and an oral carbohydrate & electrolyte solution. But, this can be a challenging piece to enact as it requires interdisciplinary discussion and collaboration (7). Of included studies, 63% directly indicated limited fasting and 25% also described administering an oral solution. As these interventions were

Table 2 Summary of autologous reconstruction protocol studies meeting inclusion criteria

Study	Journal	Country	Study type	ERAS patients (n)	Traditional patients (n)	Synopsis	Conclusions
Batford *et al.*, 2015	*J Plast Recontr Aesthet Surg*	United States	Retrospective comparative	49	51	First published study analyzing ERAS in autologous reconstruction. Comparing a comprehensive protocol to a traditional cohort	ERAS in microsurgical breast reconstruction showed significant decreases in both length of stay and opioid intake with no increase in surgical morbidity and readmission rates
Bonde *et al.*, 2015	*J Plast Surg Hand Surg*	Denmark	Retrospective comparative	177	292	5-year retrospective assessment of implemented ERAS protocol compared to previous methodology	Reduction of length of stay by at least 1 day with no increased rate of complications
Bonde *et al.*, 2016	*Plast Reconstr Surg*	Denmark	Prospective non-comparative	16	0	Developed a 7 milestone criteria to fast-track discharge with goal of reducing length of stay in ERAS patients. Follow-up study to above	Length of stay after autologous breast reconstruction reliably reduced to 3 days post-operatively
Afonso *et al.*, 2017	*Plast Reconstr Surg*	United States	Retrospective comparative	42	49	Multidisciplinary designed ERAS pathway. Performed retrospective comparison to historical cohort with assessment of 30-day outcomes	Multidisciplinary organized ERAS protocol reduced length of stay and opioid use
Astanehe *et al.*, 2018	*Plast Reconstr Surg Glob Open*	Canada	Retrospective comparative	72	258	30-day outcomes assessment of opioid use, pain scale, and LOS in traditional approaches compared to hybrid and ERAS pathways	Reduced opioid use while maintaining same opioid pain scores, decreased length of stay, and increased early ambulation without difference in complication rates
Kaoutzanis *et al.*, 2018	*Plast Reconstr Surg*	United States	Retrospective comparative	50	50	Assessed outcomes at 45 days post op regarding length of stay, analgesic requirements and cost savings in traditional *vs.* ERAS pathways	Decreased opioid use and length of stay which decreased cost by $4,400 per patient
Sharif-Askary *et al.*, 2019	*J Surg Res*	United States	Retrospective comparative	138	138	Inpatient opiate intake (significantly decreased at 48 h post op), pain scores, LOS, and postoperative complications compared with pre-ERAS cohort	Large single-institution cohort with decreased postoperative opioid requirements with no increase in complications and a slight reduction in pain scores in the early postoperative period
Sindali *et al.*, 2019	*JPRAS open*	United Kingdom	Retrospective comparative	66	72	Assessed length of stay, time to ambulation, opioid use, removal of PCA and removal of drain in ERAS *vs.* traditional protocols	First study showing decreased complication rate in ERAS group, did not show decrease in length of stay
Stein *et al.*, 2019	*J Plast Recontr Aesthet Surg*	Canada	Prospective comparative	20	58	ERAS *vs.* traditional protocols comparing LOS, complication rate, and cost in latissimus dorsi recon	ERAS protocol effective in all 20 patients receiving latissimus dorsi based recon with regard to quality of life
DelMauro *et al.*, 2019	*J Reconstr Microsurg*	United States	Retrospective non-comparative	161	0	Retrospective cohort assessing "fast-track" ERAS protocol to expedite discharge	Length of stay of 3.3±1.2 days with only one flap loss in 161 patients
Rendon *et al.*, 2020	*Plast Reconstr Surg*	United States	Retrospective comparative	59	46	Compared ERAS *vs.* traditional cohort for abdominal autologous. Examined opioid usage inpatient and outpatient, as well as pain scores. Reduction in outpatient usage even with decreased inpatient time (3.1 *vs.* 4.4 days)	ERAS led to decreased outpatient opioid use and shorter length of stay even with similar pain scores and complication rates
O'Neill *et al.*, 2020	*J Plast Recontr Aesthet Surg*	Canada	Retrospective comparative	198	183	Compared results pre and post ERAS. Showed improvement in length of stay to 3.6 days and ~$1,000 less per case. No difference in rates of minor complication, major complication, or readmission	ERAS effectively reduced both length of stay and patient care costs following DIEP flap breast reconstruction without compromising patient safety
Martinez *et al.*, 2020	*Plast Reconstr Surg Glob Open*	United States	Retrospective non-comparative	92	0	Assessing ERAS protocol to achieve outpatient DIEP flap. One return to OR postop within same hospital stay for congestion	Outpatient autologous breast reconstruction is possible without significant increase in complications
Højvig *et al.*, 2021	*J Plast Recontr Aesthet Surg*	Denmark	Retrospective comparative	18	12	Assessing use of previously published ERAS protocol for Latissimus Dorsi, improved LOS over the TRAS cohort and historical DIEP cohort	Length of stay in LD breast reconstruction can safely be reduced to around 3 days
Gort *et al.*, 2021	*Breast*	The Netherlands	Retrospective comparative	73	79	Compared traditional *vs.* ERAS protocol in DIEP patients, examining hospital stay, post-op pain scores and complication rate	ERAS led to decreased length of stay (5 *vs.* 6 days) and postop pain score (1.73 *vs.* 2.17) with no difference in complication
Haddock *et al.*, 2021	*Plast Reconstr Surg*	United States	Retrospective comparative	139	117	Assessed the effect of chemotherapy on ERAS outcomes in DIEP patients	Hypothesized chemotherapy induced peripheral neuropathy causing increased opioid usage in patient population; addition of gabapentin to ERAS protocol mitigated opioid use
Haddock *et al.*, 2021	*J Reconstr Microsurg*	United States	Retrospective comparative	139	67	Compared traditional versus implemented ERAS protocols specifically assessing compliance with ERAS protocol	Took one full year for ERAS implementation and compliance gaps still remained years later with 7 of 13 compliance metrics met
Ochoa *et al.*, 2022	*Plast Reconstr Surg*	United States	Retrospective comparative	204	205	Analyzed outcomes in implantation of ERAS protocol in private practice group. Compared to previous non-ERAS patients from same group	ERAS led to decreased length of stay and opioid usage intraop and postop, with longer operative time associated with higher rates of postop opioid usage
Linder *et al.*, 2022	*J Pers Med*	Switzerland	Retrospective comparative	42	37	Two center study comparing one group which implemented ERAS and another which used traditional pain control methods (ERAS center also employed rib sparing vessel exposure). Outcomes were length of stay and readmissions	ERAS center had significantly decreased hospital stays; operative time appeared to be a factor as no difference in bilateral group with longer operative times but significant difference in unilateral DIEPs
Bonde *et al.*, 2022	*J Plast Recontr Aesthet Surg*	Denmark	Retrospective non-comparative	147	0	Retrospective study assessing group previously published protocol and ability to achieve earlier discharge	Using group's previously published ERP, 80% unilateral abdominally based free flaps were able to be discharged by POD3

ERAS, enhanced recovery after surgery; LOS, length of stay; DIEP, deep inferior epigastric perforator flap; OR, operating room; TRAS, traditional recovery after surgery; LD, Latissimus Dorsi flap; PCA, patient controlled (opioid) analgesia; ERP, enhanced recovery pathway; POD, postoperative day.

Table 3 Summary of additional included studies

Study	Journal	Country	Study type	Reconstruction	Subject	Synopsis	Conclusions
Jablonka *et al.*, 2017	*Plast Reconstr Surg*	United States	Retrospective	Autologous	Blocks	Comparison of ERAS protocol with intra-operative catheter-infusion TAP block *vs.* single-injection TAP block *vs.* TRAS. Noted exceptionally low inpatient opioid requirements for both ERAS cohorts (<10 mg IVMME/48 h), with single-injection TAP subjects discharged on mean POD 2.7	ERAS with single-injection TAP blocks may allow for rapid recovery and discharge without increased complication rates
Oh *et al.*, 2018	*J Plast Recontr Aesthet Surg*	United States	Retrospective	Autologous	Costs	Assessment of costs in autologous breast reconstruction and comparison of cost between ERAS and TRAS. Based on linear modeling with defined clinical cost variables, predicted ERAS to decrease costs by $2,500 to $6,400 USD per case	ERAS pathway implementation may allow for reduced autologous reconstruction procedure-associated costs and bringing them closer to that of alloplastic approaches
Rochlin *et al.*, 2019	*Ann Plast Surg*	United States	Retrospective	Autologous	Expectations	Revised autologous reconstruction pathway, including patient and surgeon expectations, for discharge on POD 3. Mean length of stay significantly improved to 3.5 days for both unilateral and bilateral reconstruction cases	The revised pathway demonstrated the power of simply changing patient and surgeon expectations and allowed shorter length of stay without notable negative consequences
Mercili *et al.*, 2020	*J Am Coll Surg*	United States	Review	Autologous	Costs	Meta-Analysis modeling for cost utility adjusted for LOS, additional consulting, medications, and 30-day outcomes. Found ERAS to be clinically and economically superior to TRAS, estimating that an ERAS-based LOS reduction of 1.5 days saved ~$750 USD per patient	ERAS is an economically dominant option, with length of stay primarily contributing to savings
Anolik *et al.*, 2020	*Plast Reconstr Surg*	United States	Retrospective	Autologous	Concerns	Comparison of rates of symptomatic hypotension between ERAS and TRAS cohorts. ERAS patients received significantly fewer intraoperative fluids and had significantly higher rates of symptomatic hypotension (22% *vs.* 4%). No notable predictors of the complication were identified	Research in intra-operative and post-operative fluid management in ERAS protocols is warranted
Oxley *et al.*, 2020	*J Plast Recontr Aesthet Surg*	Canada	Retrospective	Alloplastic	Predictors	Univariate regression for predictors of unplanned admission in a large cohort of alloplastic reconstruction patients with planned same-day discharge. Unplanned admission was much more common in the hospital than the outpatient center (35% *vs.* 4%) with the majority secondary to oversedation	Same-day discharge after mastectomy and alloplastic reconstruction is demonstrated in a large cohort of patients, but training and education of staff is necessary
Haddock *et al.*, 2021	*Plast Reconstr Surg*	United States	Retrospective	Autologous	Blocks	Comparison of ERAS protocol with blocks using liposomal bupivicaine *vs.* without *vs.* TRAS. Inpatient opioid requirements were significantly fewer and length of stay was significantly reduced to 2.6 days with the addition of liposomal bupivicaine	Blocks with liposomal bupivicaine are effective when used in conjunction with ERAS protocols and multimodal opioid sparing analgesia
Shin *et al.*, 2021	*J Plast Recontr Aesthet Surg*	United States	Retrospective	Autologous	Predictors	Subgroup analysis of the effect of obesity class on length of stay in the setting of ERAS and TRAS. Found no difference in length of stay between ERAS and TRAS for patient with BMI <30, but significantly shorter length of stay with ERAS with BMI >30 kg/m^2 (4.4 *vs.* 5.2 days)	ERAS improves speed of discharge, particularly in patients with obesity, without increased risk of postoperative complications
Martinez *et al.*, 2022	*Plast Reconstr Surg*	United States	Retrospective	Autologous	Innovation	Novel description of bilateral DIEP flaps for cosmetic abdominoplasty and breast augmentation utilizing ERAS protocol. Successful in eleven patients with all discharged within 24 hours and no complications at 4-month follow-up	ERAS may allow for same-day discharge after free flap breast reconstruction with a morbidity profile allowing purely cosmetic offerings
Bamba *et al.*, 2022	*J Reconstr Microsurg*	United States	Prospective	Autologous	Expectations	ERAS patients were divided into an experimental cohort in which expectations were set for 1–2 days length of stay and a control cohort in which length of stay was discussed as usual. Length of stay was significantly reduced for both unilateral (2.9 days) and bilateral (3.5 days) reconstructions in the experimental cohort	Expectations of earlier discharge lead to earlier discharge without other changes to the protocol, thus patient expectations are an important aspect of consideration

ERAS, enhanced recovery after surgery; TAP, transverse abdominis plane; POD, postoperative day; TRAS, traditional recovery after surgery; LOS, length of stay; BMI, body mass index; DIEP, deep inferior epigastric perforator flap.

given moderate and low level of evidence respectively by consensus guidelines, further research into their efficacy may be warranted.

Pre-operative

Preemptive interventions may allow stronger control of intraoperative anesthesia and analgesia, ultimately leading to faster recovery and improved outcomes (54). Interventions can include opioid-sparing analgesia, anti-emetics, and local anesthesia. While the 2017 consensus guidelines also indicate prophylactic antibiotics and thromboprophylaxis, these represent the current standard of care and will not be discussed (7).

Analgesia

Theoretically, analgesics given to take effect prior to the operation could prevent postoperative pain through reducing nociceptor sensitization and partially mitigating local inflammatory and central pain responses (55,56). While this has good physiological backing, clinical evidence has not definitively proven efficacy, likely because of the complexity of pain pathways (57). Nonetheless, pre-operative analgesics were recommended in the 2017 consensus review under the umbrella of multimodal pain control, and were mentioned in 57% of studies included in this review (7). Most common was acetaminophen in various combinations with or without celecoxib and pregabalin or gabapentin. Additionally, five reports described administering opioids (19,28,32,34,46), one aspirin and ketorolac (40), and one Naprosyn (32). The use of non-steroidal anti-inflammatories (NSAIDs) is a particularly contentious and debated topic in surgery due to concerns of bleeding risk, but supporting evidence illustrates this is not a concern (58,59). While pre-operative analgesics don't have proven benefit in post-operative pain control, it is arguable that they allow for fewer opioids and lower sedation intra-operatively. Although preoperative analgesia is not an essential component of ERAS protocols, it appears to be widely used. The potential benefits regarding reduction in opioid use and shorter hospital stays indicate it may be premature to dismiss it entirely. This goal-directed anesthesia is a key pillar, particularly in lengthy autologous reconstructions, which will be later discussed.

Anti-emetics

A 2020 Cochrane review demonstrated strong evidence for prophylactic post-operative nausea and vomiting prevention, particularly in combination and at multiple peri-operative time points. Those most commonly described for pre-operative administration were aprepitant, casopitant, ondansetron, rolapitant, and scopolamine (60). Pre-operative and intra-operative prophylaxis were additionally given a strong recommendation in the 2017 consensus review for breast reconstruction (7). Of included studies, 31% mentioned pre-operative administration of scopolamine patches or aprepitant, with one alloplastic and one autologous study noting administration based on risk assessment (15,35).

Regional anesthesia

Pre-operative regional anesthesia, in the form of peripheral nerve blocks, has demonstrated outstanding efficacy in limiting acute post-operative pain. Additionally, there is some evidence that these blocks may reduce incidence and severity of chronic post-operative pain through a mechanism similar to that described above (61-64). Pre-operative blocks are not specifically mentioned in the 2017 ERAS® consensus, but methods such as transverse abdominis plane (TAP) blocks, which can be intraoperative or preoperative, are favorably reviewed (7). In this review, three groups employed pre-operative TAP blocks, and one group paravertebral or more-peripheral blocks, for autologous reconstruction (30,35,40,49). For alloplastic reconstruction, two groups employed paravertebral anesthesia, but Chiu *et al.* described preference for intra-operative ultrasound-guided pectoralis blocks (16,17).

The authors' institution considers pre-intervention peripheral nerve blocks (primarily paravertebral) to be a cornerstone of recovery after breast reconstruction, wherein all not-contraindicated patients receive unilateral or bilateral upper thoracic block(s) and autologous patients receive bilateral lower thoracic blocks. This is made possible through tight-knit collaboration with a fellowship-trained anesthesiology service.

When enacting a block protocol, particularly one with the rigor allowed by partnership with specialists, an important consideration is whether single injection or continuous catheter is warranted (65). As regionals such as bupivacaine can maintain effect for multiple days and single injections can be given with enhanced accuracy, the authors' group has evolved to avoid catheter implantation for both alloplastic and autologous reconstruction (63,66). In line with the authors' experience, Jablonka *et al.* compared between TAP block with liposomal bupivacaine by injection or catheter, in autologous reconstruction, and

found injection to be superior in peri-operative opioid requirements and length of stay (49).

Intra-operative

Collaboration across the curtain is key for optimal outcomes. Attention must be paid to maintaining physiologic norms, minimizing sedation and anesthetic load, and preemptively targeting post-operative hurdles. Goal-directed intra-operative practices can include tight thermic and volumetric control, regional anesthesia, sedation-sparing systemic analgesia and anesthesia, and minimizing time in the operating room.

Surgical physiology

The importance of physiologic core temperature during surgery or intervention has been discussed for decades, with literature-demonstrated benefit including superior wound healing and reduced complication rates (67,68). This is because hypothermia leads to peripheral vasoconstriction, lowers systemic pH through multifactorial mechanisms, and pathologically alters coagulative and immunologic cascades (69). Interestingly, the importance of maintaining normothermia was specifically mentioned in less than 20% of the captured studies. Presumably, this was selectively omitted by many as it has become standard care for most surgical teams.

Physiologic volume control is a more contentious topic in surgery with a long-reaching history. Rising popularity of fluid resuscitation from the early 20th century led to potentially overzealous fluid provisions and subsequent reversal to fluid restrictions in by the early 21st century (69,70). While fluid balance deserves further study in most surgical subspecialties, normovolemia is the current evidence-based standard for most recovery pathways and strict vitals-based control was recommended in the 2017 consensus review for breast reconstruction (7). When reported, the majority of included studies echoed the recommendations, with monitoring by urine production or cardiac output. Just two groups prescribed to fluid restriction, with Hammond *et al.* noting "judicious" fluid provisions in their alloplastic pathway and Linder *et al.* limiting fluids to 100 mL/h in autologous reconstructions (15,21). Notably, there is evidence that more-restrictive fluid administration is associated with improved peri-operative morbidity profiles in autologous reconstruction, particularly reduced incidence of abdominal wound complications (71,72).

Analgesia and anesthesia

Evidence of value for regional anesthesia was detailed above. While blocks could theoretically be of reduced efficacy if administered in the operating room, intra-procedural timing is commonly reported and has benefit in instances where an interventionist is not available, or the patient cannot tolerate a pre-operative block. More than half of included studies described some form of surgeon-administered intra-operative local anesthesia, most commonly TAP and/or pectoral and pre-incisional. The literature reflects variation in the type of blocks administered, both pre and intraoperatively. This to some extent appears to be a function of surgeon/institutional preference. The authors' preference is for pre-operative blocks, but much of the literature reports equivalent success with employment intraoperatively.

In a 2021 National Surgery Quality Improvement Program (NSQIP) database study, Kotha *et al.* showed significant correlation between length of autologous reconstructive operation and length of inpatient stay (73). While the causes of this relationship are complex and multifactorial, prolonged anesthetic and opioid administration undoubtedly plays a role in perioperative morbidity (74,75). This demonstrates the importance of minimally sedative, minimally volatile, and opioid-sparing anesthesia protocols, particularly in prolonged cases such as bilateral autologous reconstructions.

The concept is partially reflected in the 2017 consensus review, which recommends total intravenous anesthesia (TIVA) for mitigation of postoperative nausea and vomiting (7). As anesthetic selection is often outside of the scope of the plastic surgeon, just 34% of included studies specifically mentioned these protocols. Notably, two studies described use of TIVA (17,34), and eight employed systemic ketamine and/or lidocaine (15,23,24,28,32,35,43,46). Additional analgesics included intravenous administration of non-opioids such as acetaminophen or ketorolac.

Antiemetics and additional considerations

The common use of antiemetics for enhanced recovery was discussed above. However, it should be again noted that provision of antiemetics in combination and multiple time points has demonstrated efficacy. In the 2020 Cochrane review, aprepitant given within 24 hours postoperatively demonstrated a relative risk of postoperative nausea and vomiting (PONV) of 0.26. Dexamethasone, which has shown additional efficacy in mitigation of postoperative inflammation and pain, demonstrated a relative risk

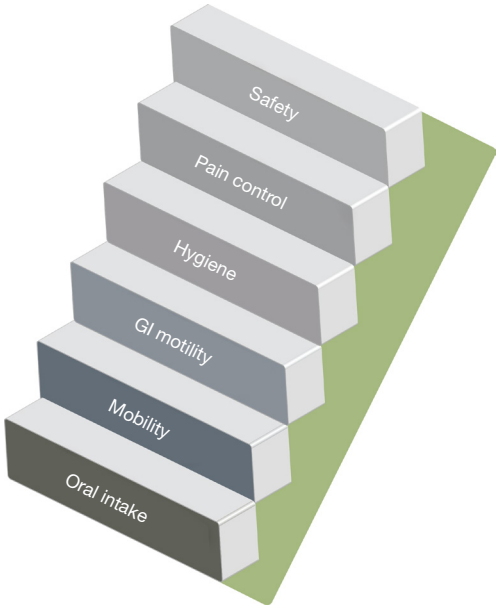

Figure 2 Staircase diagram depicting milestones for discharge. GI, gastrointestinal.

for PONV of 0.51 (60,76). This is the intraoperative combination employed at the author's institution, and was mentioned frequently in included studies.

Speed and efficiency

As important as minimizing the adverse effects of anesthesia and optimizing intraoperative physiology is limiting the patient's exposure to these challenges. While alloplastic reconstructions can commonly take fewer than 3 hours, unilateral and bilateral microsurgical cases take approximately 6 and 10 hours respectively (73). Although it isn't necessarily a component of ERAS protocols, safely maximizing speed and efficiency in the operating room should be an important consideration of the surgeon. In 2019, Sharma *et al.* reported reduction of unilateral autologous operating time by approximately 1 hour by instituting a '100 step' process-mapped protocol (77). This was followed by Haddock and Teotia in 2021 who instituted a process-mapped co-surgeon protocol allowing for an average operative time of just under 4 hours in 50 consecutive bilateral reconstructions (78). While the variability and surgical training inherent to academic institutions likely makes such a feat impossible, process-mapping should be instituted in some form. The author's academic institution has had success with implementation, when possible, of efficiency protocols. Although optimal efficiency may be difficult to achieve while teaching, in the authors' experience training is not incompatible with protocols for operative-time reduction.

Post-operative

Protocols for inpatient recovery should optimize rehabilitation with focus on quickly preparing the patient for safe disposition.

Discharge goals

The steps to discharge can be visualized as a ladder including oral intake, mobility, gastrointestinal function, hygiene, pain control, and safety (*Figure 2*). This concept is well described in two early autologous studies by Bonde *et al.* which employed process mapping for identification of barriers to discharge on postoperative day (POD) 3 (37,38). Meanwhile, alloplastic protocols demonstrated focus on same-day discharge, as demonstrated by a 2020 report by Oxley *et al.* which attempted to retrospectively identify predictors of unanticipated admissions (44).

The ultimate goal should be a pathway allowing discharge of autologous patients on POD 1. To date, this has only been consistently demonstrated in a specialized setting by Martinez and Boutros (29). Furthermore, concern for microvascular failure makes expedited discharge a topic of contention (79). This, and optimal reported outcomes will be later discussed.

Disposition

Though not directly mentioned in the 2017 consensus review, the authors believe that immediate transfer from post-anesthesia care to a dedicated floor with protocol-driven care from specialized staff is invaluable (7). Similar disposition protocols after autologous reconstructions were mentioned by Batdorf *et al.* in 2015 and DelMauro *et al.* in 2019 (33,39). While maintenance of a dedicated unit may not be possible, ensuring appropriate training and understanding of staff is vital for optimal outcomes. This also affords the opportunity to avoid intensive care unit (ICU) admission, which is typically standard for hourly flap checks at the majority of institutions. The cost savings of avoiding ICU admission may be a valuable bargaining chip when propositioning health systems.

Many alloplastic protocols focus on reconstructions in the outpatient setting or with early POD 1 discharge. While it may not be possible to ensure ambulatory patients have reached the top of the ladder shown in *Figure 2*,

methodologies for determining readiness and investigations into pitfalls are described. A protocol for same-day discharge was first described by Dumestre *et al.* in two 2017 studies (18,19). While these reports solely referenced 'standard day-surgery criteria,' they included important selection factors: patients followed the full ERAS protocol, ASA class <III, another capable adult at home, residence within 1 hour of the hospital, and booking as first or second surgery of the day. In 2021, Hammond *et al.* retrospectively demonstrated a same-day discharge rate of 52% in 151 patients and found nerve block to be a significant predictor. They further demonstrated unanticipated admission necessitated by pain in 15%, PONV in 14%, surgeon or patient request in 14%, and complication in 12%, with the majority of these being directly related to incomplete recovery protocol adoption (15). This once again shows the importance of norms, for providers and patients, as affirmed by Oxley *et al*. who demonstrated 35% of patients requiring unplanned admission in the primary hospital, most commonly secondary to oversedation, versus 4% in the ambulatory center (44).

Independence

Eating, drinking, and walking are obvious fundamentals to discharge which are naturally followed by gastrointestinal motility and hygiene. These milestones should be integral to any recovery pathway, included in preoperative education, and encouraged at every visit. With appropriate preparation and coaching, it is not unreasonable to expect many to reach a level of independence on post-operative day 1. As emphasized by Astanahe *et al.*, early foley removal and early ambulation are key factors in achieving these goals (34). The 2017 consensus review gives strong recommendations to diet advancement and mobilization within 24 hours (7). Most included studies aligned or surpassed recommendations for ambulation with seven indicating initiation on POD 0 and/or no restrictions (21,28,35,39,40,42,49). Of notable importance, when applicable, is ensuring integrity of the abdominal wound through a moderately kyphotic position. Likewise, a knowledgeable physical therapist should be present, particularly during early baby steps.

Of included autologous studies, 41% indicated encouraging an immediate unrestricted or minimally restricted diet with most others indicating immediate clears-only diet and/or advancement by postoperative day 1. The latter option may be advisable in case of necessary re-operation. An interesting dogma which is at present maintained by the authors' protocol, and was mentioned by Bamba *et al.*, is abstinence from caffeine due to concern for contribution to vasospasm (40,80). A delve into the literature shows that this may not have much basic or clinical backing, with some evidence that supplementation may actually improve analgesia, motility, and recovery (81,82).

The controversy surrounding caffeine consumption and surgery appears to be a long standing, if unfounded one. Its effect on the microsurgeon was addressed by Dr. Acland decades ago in his *Practice Manual for Microvascular Surgery* (83). He notes that for the surgeon, abrupt changes in caffeine consumption are more deleterious than maintaining an established habit. Most research indicates that this principle is likely equally applicable to patients and their recovery. Provision of gum, with hope to stimulate motility through the gastro-colic reflex, was another described facet without particularly satisfying clinical evidence (84-86).

Fluids and lines

Adjacent to the above steps towards independence is weaning of intravenous fluids and, ultimately, removing all lines that can't be brought home. Protocols for fluid discontinuation were mentioned, with various intricacies and limits, in 40% of included studies. Most focused-on discontinuation with adequate oral intake or within the first 48 hours. The necessity of other lines should be weighed against respective barriers to discharge. This was demonstrated by Jablonka *et al.* who achieved shorter length of stay and opioid use with regional anesthesia by single injection rather than catheter, and by Bonde *et al.* who found that scheduled removal of vacuum-assisted drains was necessary to achieve discharge goals (37,49).

Pain

The multifactorial benefit of regional anesthesia was previously detailed and represents a key foundation of peri-operative pain control and expedited recovery. While blocks inherently lose efficacy 2–3 days after administration, they are present to blockade the critical acute postoperative pain thus limiting sedative and opioid administration. This not only allows for more-immediate and steady rehabilitation, but mitigates adverse effects of traditional analgesics such as PONV, anorexia, and constipation.

Further, the authors recommend a protocolized scheduling of non-opioid analgesics such as acetaminophen, celecoxib, pregabalin, and NSAIDs in an appropriate

combination. Some variation of this was reported in nearly every included study. Equally mentioned was the sparing use of PRN opioids for breakthrough pain, as these are valuable adjuncts that should not be dismissed entirely. While the ideal would be adequate pain-control without narcotics, a more realistic goal should be limiting administration to the extent that adverse effects are absent. Four included reports described administration of opioids by patient-controlled analgesia pump, but advocated for expedited removal (26,31,33,47). Given the body of evidence, these should probably be avoided entirely. Notably, Kaoutzanis *et al.* reported administration of intravenous lidocaine for 24 hours post-operatively (35). While there is evidence that this, through poorly understood mechanisms, may improve short-term recovery outcomes in some operations, it hasn't demonstrated efficacy in breast surgery (87).

The authors' group is fortunate to have strong collaboration between surgery and anesthesiology which includes peri-operative pain management by a dedicated anesthesiologist-driven acute pain service. While this is not a luxury available to all, collaborative planning of a multimodal analgesia protocol, including careful attention to indications and contraindications, should be pursued.

Safety

The ultimate consideration is patient safety, both inpatient recovery and after discharge. Employment of the methods described above assist the recovering patient in gaining independence and competence, thus providing the majority foundation for safe discharge. Specialized nurses, experienced staff, and protocolized care undoubtedly play a major role. Most pertinent to breast reconstruction is careful monitoring for microvascular compromise after flap-based reconstruction, a dreaded complication effecting approximately five percent of reconstructions (88). If identified within the first 24 hours, salvage rates are as high as 80%, but exponentially decline thereafter (89,90).

Several methods of monitoring were described in included studies. Most common was visual inspection and employment of a handheld doppler device. This was described in just 25% of autologous studies, with variable step-downs from hourly to every 4 hours, but is presumably the methodology used by most groups that didn't provide specifics. Adjunctive use of a tissue oxygenation sensor was reported in five autologous studies (22,32,33,40,46). These devices provide valuable quantitative data, but have been recently demonstrated to have unfavorable cost-effectiveness (91).

As study and adoption of ERAS evolves, the potential for discharge of autologous patients on post-operative day 1 becomes increasingly feasible. This has been demonstrated in unpublished data at the authors' institution and is reflected by Martinez and Boutros who, in addition to reporting consistent <24-hour discharge in 2020, are the first to describe employment of autologous flaps for "outpatient" cosmetic breast augmentations (29,41). Given consensus guidelines recommending flap monitoring for a minimum of 3 days, and a recent cost-effectiveness analysis by Mericli *et al.* concluding 3-day inpatient stay to be optimal, movement towards discharge on post-operative day 1 will undoubtedly be met with contention (7,79). By the authors' approximation, given available data, discharge at 24 hours would theoretically lead to avoidable failure in an additional three to ten patients per thousand (79,88-90). This increase in risk should be discussed with the patient during pre-operative counseling, and advancement is necessary to mitigate the theoretical 100% failure rate if compromise occurs in the outpatient setting (79). Of note, the authors' experience moving towards discharge on postoperative day 1 for all autologous reconstructions and without flap monitoring is yet to see microvascular compromise or flap failure in the outpatient setting. Akin to this, it may be reasonable to discontinue monitoring, after 24 hours, during inpatient stay. Complete discontinuation is controversial, but many authors note conversion to every-4- or every-8-hour checks.

Outpatient

Enhanced recovery pathways should not end in the inpatient setting, as described in the 2017 consensus review which gave strong recommendation to post-discharge care including physiotherapy programs, and support in the form of nurse-driven visits and provider availability by phone or app (7). Additional attention should be given to outpatient analgesia, clinical follow-up, and early identification of complications. In the authors' experience, outpatient care can be greatly enhanced by patient-driven education both pre-operatively and during inpatient recovery. Interestingly, there was a relative paucity of follow-up description within the reports examined.

Discharge analgesia

The importance of opioid-sparing outpatient analgesia in preventing complications, including addiction, is well-

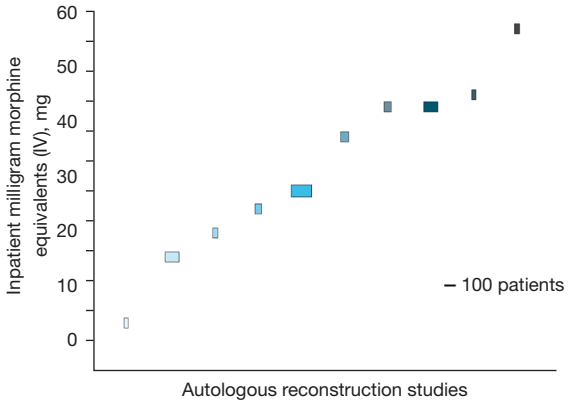

Figure 3 Inpatient IV MME reported in autologous reconstruction protocol studies. Width indicates number of subjects included in the study. From left to right: Jablonka *et al.* 2017 (49), Sharif-Askary *et al.* 2019 (32), Kaoutzanis *et al.* 2018 (35), Sindali *et al.* 2019 (31), Ochoa *et al.* 2022 (22), Haddock *et al.* 2021 (23), Haddock *et al.* 2021 (24), Astanehe *et al.* 2018 (34), Afonso *et al.* 2017 (36), Batdorf *et al.* 2015 (39). IV, intravenous; MME, milligram morphine equivalents.

known. Surprisingly, only a single included study, by Rendon *et al.*, reported a metric of outpatient opioid requirements or made comparison with pre-pathway requirements. They demonstrated a significant and notable decreased opioid use of more than 300 oral morphine equivalents in the first postoperative month, but did not describe on the outpatient methods used for the achievement (28,92,93). Just four examined studies reported on discharge analgesia protocols, with O'Niell *et al.* prescribing 1-week scheduled acetaminophen & celecoxib & gabapentin, Stein *et al.* prescribing the same combination for 3 days, Dumestre *et al.* celecoxib & gabapentin for 2 days, and Jablonka *et al.* acetaminophen and ketorolac for 1 week (18,27,30,49). The authors' have had success with a significantly more aggressive protocol which includes up to 1 month of scheduled acetaminophen and NSAID +/– gabapentin with an initial as-needed 50–100 mg oxycodone.

Follow-up

Reports including specific follow-up protocols were equally sparse. For outpatient alloplastic reconstructions, the protocol described Dumestre *et al.* described providing a 24-hour access telephone line to specialized nursing, with referral to surgeon as needed, and scheduled telephone follow-ups with a surgeon on POD 1 and 2. This accompanied strict safety-oriented selection criteria which are described above (18,19). Jablonka *et al.* noted scheduled clinical follow-up on postoperative day five which included surgical drain removal (49). These were, surprisingly, the only examined studies providing any detail. This leaves something to be desired, and potential for further exploration. It appears that further improvements could be made by many through adoption of literature-supported methods (94-96).

Outcomes

While detailed examination of outcomes respective to specific facets of recovery protocols, the following is an overview of outcomes described in the included studies. When enacting or evaluating a pathway, primary concerns should include opioid requirements at intra-operative, inpatient, and follow-up time points, length of inpatient stay, and adverse events. Patient-reported pain scores are another potential metric, but are infrequently reported due to their subjective and stochastic nature. Secondary considerations, which will be later discussed, should include cost-benefit analysis and implementation.

Opioid requirements

As previously discussed, opioid-sparing anesthesia can mitigate post-operative barriers including PONV and sedation. In yet unpublished research, the authors found employment of the methods herein to allow intraoperatively administered opioids to be significantly fewer than those in much-shorter alloplastic procedures using traditional anesthesia protocols. Of included studies, just one alloplastic and two autologous studies reported on this metric. Chiu *et al.* reported mean administration of ~25 mg intravenous morphine requirements (IV ME) in alloplastic cases (17). Meanwhile, in autologous studies, Ochoa *et al.* reported significant decrease with pathway enaction to mean 32 mg IV MME (milligram morphine equivalents) and Afonso *et al.* reported administration of just 22 mg IV ME.

Nine studies, focused on autologous reconstruction, reported on inpatient opioid requirements which ranged from approximately 10 to 60 mg IV ME (*Figure 3*). There was variability in length of stay and reporting, but these values can be generally approximated to represent post-operative day zero through three. Jablonka *et al.*, whose 2017 study focused on the benefits of pre-operative regional anesthesia, reported the lowest mean requirement in a relatively small cohort of 54 patients (49). The largest study, consisting of 204 subjects, reported of mean of

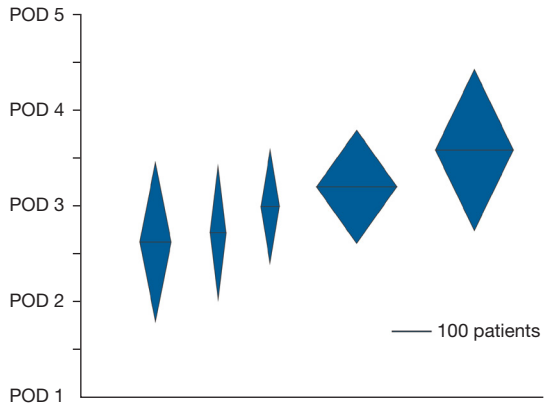

Figure 4 Postoperative length of stay reported in autologous reconstruction protocol studies. Y-axis depicts POD. Width indicates number of subjects included in study. Height indicates standard deviation in length of stay (days). Includes three studies reporting optimal results and the two largest included studies which reported results. From left to right: Haddock *et al.* 2021 (43), Jablonka *et al.* 2017 (49), Kaoutzanis *et al.* 2018 (35), Ochoa *et al.* 2018 (22), O'Neil *et al.* 2020 (27). POD, postoperative day.

approximately 30 mg IV ME (22). The two next-largest studies, consisting of 138 and 139 subjects respectively, reported mean requirements of 19 and 44 mg respectively (24,32). In examining *Figure 3*, one can identify a relatively symmetric distribution of reports centered around a requirement of 30 mg IV ME. For reference, this approximates to 150 mg of oral oxycodone.

Discharge

Most included alloplastic studies demonstrated that safe ambulatory reconstruction is feasible. In the earliest report, Dumestre *et al.* showed successful postoperative outpatient discharge in 72% of patients without significant difference in readmission, and with significantly improved patient reported outcomes, versus traditional and transitional cohorts (18,19). Later, Hammond *et al.* demonstrated a 52% same-day discharge rate, and Oxley *et al.* demonstrated 96% and 65% rates for planned ambulatory patients at their outpatient center and primary hospital respectively (15,44).

For autologous reconstructions, many pathways target discharge on postoperative day 3 as opposed to inpatient stays approaching 1 week in traditional literature. The ultimate goal should be safe and appropriate discharge on postoperative day 1, but to date this has only been consistently demonstrated in a highly specialized non-academic environment by Martinez and Boutros (29,41). As earlier discussed, the risk of flap-threatening complication is relatively elevated in the first 24 hours, thus true outpatient autologous reconstruction is not presently feasible. Besides the aforementioned outlier reports, 78% of examined studies reported on mean or median day of discharge, with a general range from mean day 2.6 to 4.5 and an outlier of day 6.2 from the 2015 seminal report by Bonde and colleagues (38). Just three studies, each with cohorts fewer than 100 patients, reported discharge before mean post-operative day 3 (35,43,49) while the two largest, including 204 and 198 subjects respectively, reported discharge at mean 3.2 and 3.6 days post-operatively (22,27) (*Figure 4*).

Complications

An in-depth discussion of rates of adverse events after breast reconstruction and any associations with ERAS pathways is well-beyond the scope of this review. That stated, many included studies reported some metric of adverse events either inpatient or during outpatient follow-up with the majority of these showing non-significant difference between ERAS and traditional cohorts. There were three exceptions to this rule. One study, by Rochlin *et al.* reported significantly fewer minor complications after autologous reconstruction in the ERAS cohort and concluded that the finding may be secondary to self-resolution of issues that may have otherwise been identified during traditionally longer inpatient stays (47). Two studies reported potential concerns, with Batdorf *et al.* reporting significantly higher infection rates for undetermined reasons and Anolik *et al.* reporting significantly higher rates of symptomatic hypotension potentially secondary to under-resuscitation intraoperatively (39,46). These studies were relative outliers, and synthesis at the literature at-large demonstrates comparable outcomes at follow-up.

Considerations for implementation

The implementation of enhanced recovery protocols presents challenges consistent with previously identified barriers to compliance with medical guidelines: lack of knowledge, lack of agreement, or external factors, including institutional support and patient attitudes (97). However, there are additional unique considerations, as ERAS relies on the cooperation of various stakeholders, including surgeons, anesthesiologists, nurses, administrators and insurance providers. Kehlet *et al.* identified several key considerations in accounting for the multidisciplinary,

multimodal, and team-based nature of ERAS. These include building multidisciplinary teams to strategize, train and implement protocols, as well as a long-term framework for feedback and assessment (98).

Multidisciplinary education and buy-in

Consistent, comprehensive education of all stakeholders has proven useful in addressing the major barriers (99-101). Emphasizing the evidence-based benefits of the protocols and aligning them when possible with existing evidence-based methodologies has resulted in greater acceptance by surgeons and anesthesiologists (102). Eliciting and incorporating feedback prior to protocol implementation facilitates understanding and addressing of perceived obstacles, resulting in more efficient implementation (103). Clear communication and networking within teams and across institutions is associated with successful outcomes, while lack of communication has been identified as one of the greatest obstacles to success (99). People tend to resist change, and in fields where ERAS represents a departure from the establishment, the presence of respected individuals across disciplines (surgeons, anesthesiologists, nurses) who are trained and invested in the protocols, helps to promote buy-in at the organizational and individual level (104-106).

Institutional support

In addition to educating stakeholders, external factors must also be considered. Securing institutional support is essential to enable successful execution of the protocols (105,107). ERAS protocols have been associated with cost optimization in terms of shorter hospital stays and fewer complications. Ensuring these financial benefits are effectively communicated to relevant stakeholders can provide a powerful incentive for their support (3,48).

Patient perspectives

Patient acceptance and perception of protocols is another consideration. Agreement has been found between patient goals and ERAS recommendations, implying that protocols should help patients achieve their preferred outcomes (108,109). Patient education regarding ERAS can provide reassurance that treatment plans align with patients' interests and help to manage expectations accordingly. Patients have indicated the importance of consistent information and communication, with patient education and expectation setting associated with shorter hospital stays and reduced pain during recovery (40,47,101,110). Providing education in accordance with ERAS may necessitate increased time for surgical consultations, emphasizing the importance of cooperation at an institutional and individual practice level (111).

Assessment and evaluation

Finally, a structured method of evaluation and feedback is necessary to objectively assess whether goals are being met and to identify barriers and opportunities (112). Training visits and audits are an effective method for such strategic assessment (105,113,114). Programs such as the ERAS Interactive Audit System (EIAS), provide standardized data regarding outcomes across institutions, contributing to understanding the greater impact of these protocols (113).

Successful implementation of enhanced recovery protocols requires consideration of challenges to include multidisciplinary coordination and collaboration, commitment and buy-in from stakeholders, and institutional capacity and willingness to support. Proactively identifying and accounting for challenges is the first step to developing an effective ERAS implementation strategy (115).

Conclusions

There is an expansive body of literature regarding ERAS for breast reconstruction with many advancements being reported for autologous reconstruction. Implementation of effective ERAS protocols is possible and should not be viewed as excessively challenging. Moreover, enhanced recovery methods should be thought of as part of a comprehensive pathway of subsequent protocols and with multiple collaborators and stakeholders. This should include attention to optimizations from well-preoperatively to well-postoperatively with weaving of individual facets into a multimodal network (*Figure 5*). Of key importance throughout, is collaborative effort between specialties, staff, and hospital systems with additional emphasis on patient centered care.

Enhanced recovery after breast reconstruction has inspired innovation in the field and pushed limits previously not thought to be attainable. Enhanced recovery protocols should be considered standard of care and will serve to expand access to breast reconstruction. This is particularly true for autologous reconstructions, as these pathways are quickly moving the needle toward peri-operative outcomes consummate to those of alloplastic approaches and thus will facilitate offering of the superior approach.

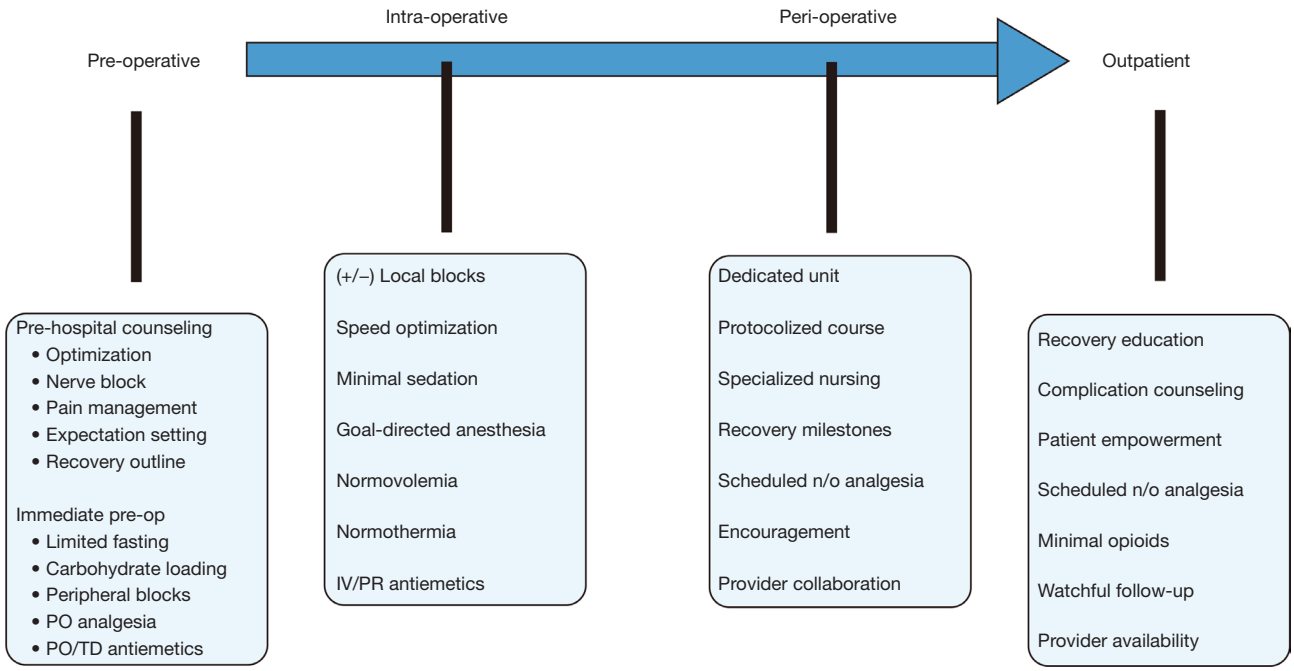

Figure 5 A comprehensive enhanced recovery protocol for breast reconstruction. PO, per os; TD, transdermal; IV, intravenous; PR, per rectum; n/o, non-opioid.

Acknowledgments

Funding: None.

Footnote

Provenance and Peer Review: This article was commissioned by the Guest Editor (Oscar J. Manrique) for the series "Breast Reconstruction" published in *Annals of Translational Medicine*. The article has undergone external peer review.

Reporting Checklist: The authors have completed the Narrative Review reporting checklist. Available at https://atm.amegroups.com/article/view/10.21037/atm-23-1509/rc

Peer Review File: Available at https://atm.amegroups.com/article/view/10.21037/atm-23-1509/prf

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://atm.amegroups.com/article/view/10.21037/atm-23-1509/coif). The series "Breast Reconstruction" was commissioned by the editorial office without any funding or sponsorship. C.M.R. is a consultant for W.L Gore and Associates. A.G. serves on the board of directors of the American Board of Plastic Surgery, the California Society of Plastic Surgery, and the American Council of Academic Plastic Surgeons. The authors have no other conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

References

1. Kehlet H. Multimodal approach to control postoperative pathophysiology and rehabilitation. Br J Anaesth

1997;78:606-17.
2. Kehlet H, Moesgaard F. Prophylaxis against postoperative complications in gastroenterology. Scand J Gastroenterol Suppl 1996;216:218-24.
3. Wilmore DW, Kehlet H. Management of patients in fast track surgery. BMJ 2001;322:473-6.
4. Zhang X, Yang J, Chen X, et al. Enhanced recovery after surgery on multiple clinical outcomes: Umbrella review of systematic reviews and meta-analyses. Medicine (Baltimore) 2020;99:e20983.
5. Home [Internet]. ERAS® Society. [cited 2023 Mar 10]. Available online: https://erassociety.org/
6. Fayezizadeh M, Petro CC, Rosen MJ, et al. Enhanced recovery after surgery pathway for abdominal wall reconstruction: pilot study and preliminary outcomes. Plast Reconstr Surg 2014;134:151S-9S.
7. Temple-Oberle C, Shea-Budgell MA, Tan M, et al. Consensus Review of Optimal Perioperative Care in Breast Reconstruction: Enhanced Recovery after Surgery (ERAS) Society Recommendations. Plast Reconstr Surg 2017;139:1056e-71e.
8. Dort JC, Farwell DG, Findlay M, et al. Optimal Perioperative Care in Major Head and Neck Cancer Surgery With Free Flap Reconstruction: A Consensus Review and Recommendations From the Enhanced Recovery After Surgery Society. JAMA Otolaryngol Head Neck Surg 2017;143:292-303.
9. Plastic Surgery Statistics Report 2015-2020 [Internet]. American Society of Plastic Surgeons. [cited 2023 Jan 19]. Available online: https://www.plasticsurgery.org/news/plastic-surgery-statistics
10. Reinders FCJ, Young-Afat DA, Batenburg MCT, et al. Higher reconstruction failure and less patient-reported satisfaction after post mastectomy radiotherapy with immediate implant-based breast reconstruction compared to immediate autologous breast reconstruction. Breast Cancer 2020;27:435-44.
11. ElAbd R, Prabhu N, Alibrahim A, et al. Autologous Versus Alloplastic Reconstruction for Patients with Obesity: A Systematic Review and Meta-analysis. Aesthetic Plast Surg 2022;46:597-609.
12. Eltahir Y, Krabbe-Timmerman IS, Sadok N, et al. Outcome of Quality of Life for Women Undergoing Autologous versus Alloplastic Breast Reconstruction following Mastectomy: A Systematic Review and Meta-Analysis. Plast Reconstr Surg 2020;145:1109-23.
13. Voineskos SH, Olaiya OR, Tsangaris E, et al. Comparing Breast Sensation between Alloplastic and Autologous Breast Reconstruction Patients Using the BREAST-Q Sensation Module. Plast Reconstr Surg 2022;150:1202e-13e.
14. Santosa KB, Qi J, Kim HM, et al. Long-term Patient-Reported Outcomes in Postmastectomy Breast Reconstruction. JAMA Surg 2018;153:891-9.
15. Hammond JB, Thomas O, Jogerst K, et al. Same-day Discharge Is Safe and Effective After Implant-Based Breast Reconstruction. Ann Plast Surg 2021;87:144-9.
16. McGugin CJ, Coopey SB, Smith BL, et al. Enhanced Recovery Minimizes Opioid Use and Hospital Stay for Patients Undergoing Mastectomy with Reconstruction. Ann Surg Oncol 2019;26:3464-71.
17. Chiu C, Aleshi P, Esserman LJ, et al. Improved analgesia and reduced post-operative nausea and vomiting after implementation of an enhanced recovery after surgery (ERAS) pathway for total mastectomy. BMC Anesthesiol 2018;18:41.
18. Dumestre DO, Redwood J, Webb CE, et al. Enhanced Recovery After Surgery (ERAS) Protocol Enables Safe Same-Day Discharge After Alloplastic Breast Reconstruction. Plast Surg (Oakv) 2017;25:249-54.
19. Dumestre DO, Webb CE, Temple-Oberle C. Improved Recovery Experience Achieved for Women Undergoing Implant-Based Breast Reconstruction Using an Enhanced Recovery after Surgery Model. Plast Reconstr Surg 2017;139:550-9.
20. Bonde CT, Højvig JB, Jensen LT, et al. Long-term results of a standardized enhanced recovery protocol in unilateral, secondary autologous breast reconstructions using an abdominal free flap. J Plast Reconstr Aesthet Surg 2022;75:1117-22.
21. Linder S, Walle L, Loucas M, et al. Enhanced Recovery after Surgery (ERAS) in DIEP-Flap Breast Reconstructions-A Comparison of Two Reconstructive Centers with and without ERAS-Protocol. J Pers Med 2022;12:347.
22. Ochoa O, Rajan M, Garza R 3rd, et al. Enhanced Recovery Pathway Reduces Hospital Stay and Opioid Use in Microsurgical Breast Reconstruction: A Single-Center, Private Practice Experience. Plast Reconstr Surg 2022;150:13e-21e.
23. Haddock NT, Garza R, Boyle CE, et al. Observations from Implementation of the ERAS Protocol after DIEP Flap Breast Reconstruction. J Reconstr Microsurg 2022;38:506-10.
24. Haddock NT, Garza R, Boyle CE, et al. Implications of Instituting an Enhanced Recovery after Surgery Pathway in

Patients Receiving Chemotherapy in Microsurgical Breast Reconstruction. Plast Reconstr Surg 2021;147:7e-15e.
25. Højvig JH, Kehlet H, Bonde CT. Enhanced recovery after breast reconstruction with a pedicled Latissimus Dorsi flap-A prospective clinical study. J Plast Reconstr Aesthet Surg 2021;74:1725-30.
26. Gort N, van Gaal BGI, Tielemans HJP, et al. Positive effects of the enhanced recovery after surgery (ERAS) protocol in DIEP flap breast reconstruction. Breast 2021;60:53-7.
27. O'Neill AC, Mughal M, Saggaf MM, et al. A structured pathway for accelerated postoperative recovery reduces hospital stay and cost of care following microvascular breast reconstruction without increased complications. J Plast Reconstr Aesthet Surg 2020;73:19-26.
28. Rendon JL, Hodson T, Skoracki RJ, et al. Enhanced Recovery after Surgery Protocols Decrease Outpatient Opioid Use in Patients Undergoing Abdominally Based Microsurgical Breast Reconstruction. Plast Reconstr Surg 2020;145:645-51.
29. Martinez CA, Boutros SG. Outpatient Microsurgical Breast Reconstruction. Plast Reconstr Surg Glob Open 2020;8:e3109.
30. Stein MJ, Frank SG, Lui A, et al. Ambulatory latissimus dorsi flap breast reconstruction: A prospective cohort study of an enhanced recovery after surgery (ERAS) protocol. J Plast Reconstr Aesthet Surg 2019;72:1950-5.
31. Sindali K, Harries V, Borges A, et al. Improved patient outcomes using the enhanced recovery pathway in breast microsurgical reconstruction: a UK experience. JPRAS Open 2019;19:24-34.
32. Sharif-Askary B, Hompe E, Broadwater G, et al. The Effect of Enhanced Recovery after Surgery Pathway Implementation on Abdominal-Based Microvascular Breast Reconstruction. J Surg Res 2019;242:276-85.
33. DelMauro MA, Chen K, Keller A. Reducing Length of Stay after Microsurgical Breast Reconstruction with a Standardized Postoperative Protocol. J Reconstr Microsurg 2019;35:557-67.
34. Astanehe A, Temple-Oberle C, Nielsen M, et al. An Enhanced Recovery after Surgery Pathway for Microvascular Breast Reconstruction Is Safe and Effective. Plast Reconstr Surg Glob Open 2018;6:e1634.
35. Kaoutzanis C, Ganesh Kumar N, O'Neill D, et al. Enhanced Recovery Pathway in Microvascular Autologous Tissue-Based Breast Reconstruction: Should It Become the Standard of Care? Plast Reconstr Surg 2018;141:841-51.
36. Afonso A, Oskar S, Tan KS, et al. Is Enhanced Recovery the New Standard of Care in Microsurgical Breast Reconstruction? Plast Reconstr Surg 2017;139:1053-61.
37. Bonde CT, Khorasani H, Elberg J, et al. Perioperative Optimization of Autologous Breast Reconstruction. Plast Reconstr Surg 2016;137:411-4.
38. Bonde C, Khorasani H, Eriksen K, et al. Introducing the fast track surgery principles can reduce length of stay after autologous breast reconstruction using free flaps: A case control study. J Plast Surg Hand Surg 2015;49:367-71.
39. Batdorf NJ, Lemaine V, Lovely JK, et al. Enhanced recovery after surgery in microvascular breast reconstruction. J Plast Reconstr Aesthet Surg 2015;68:395-402.
40. Bamba R, Wiebe JE, Ingersol CA, et al. Do Patient Expectations of Discharge Affect Length of Stay after Deep Inferior Epigastric Perforator Flap for Breast Reconstruction? J Reconstr Microsurg 2022;38:34-40.
41. Martinez CA, Boutros SG. Abdominoplasty and Breast Augmentation with Outpatient Cosmetic Deep Inferior Epigastric Perforator Flaps. Plast Reconstr Surg 2023;151:234e-40e.
42. Shin HD, Rodriguez AM, Abraham JT, et al. "Does ERAS benefit higher BMI patients? A single institutional review". J Plast Reconstr Aesthet Surg 2021;74:475-9.
43. Haddock NT, Garza R, Boyle CE, et al. Defining Enhanced Recovery Pathway with or without Liposomal Bupivacaine in DIEP Flap Breast Reconstruction. Plast Reconstr Surg 2021;148:948-57.
44. Oxley PJ, McNeely C, Janzen R, et al. Successful same day discharge after immediate post-mastectomy alloplastic breast reconstruction: A single tertiary centre retrospective audit. J Plast Reconstr Aesthet Surg 2020;73:1068-74.
45. Mericli AF, McHugh T, Kruse B, et al. Time-Driven Activity-Based Costing to Model Cost Utility of Enhanced Recovery after Surgery Pathways in Microvascular Breast Reconstruction. J Am Coll Surg 2020;230:784-94.e3.
46. Anolik RA, Sharif-Askary B, Hompe E, et al. Occurrence of Symptomatic Hypotension in Patients Undergoing Breast Free Flaps: Is Enhanced Recovery after Surgery to Blame? Plast Reconstr Surg 2020;145:606-16.
47. Rochlin DH, Leon DS, Yu C, et al. The Power of Patient Norms: Postoperative Pathway Associated With Shorter Hospital Stay After Free Autologous Breast Reconstruction. Ann Plast Surg 2019;82:S320-4.
48. Oh C, Moriarty J, Borah BJ, et al. Cost analysis of enhanced recovery after surgery in microvascular breast reconstruction. J Plast Reconstr Aesthet Surg

2018;71:819-26.
49. Jablonka EM, Lamelas AM, Kim JN, et al. Transversus Abdominis Plane Blocks with Single-Dose Liposomal Bupivacaine in Conjunction with a Nonnarcotic Pain Regimen Help Reduce Length of Stay following Abdominally Based Microsurgical Breast Reconstruction. Plast Reconstr Surg 2017;140:240-51.
50. Martin L, Gillis C, Ljungqvist O. Preoperative nutrition care in Enhanced Recovery After Surgery programs: are we missing an opportunity? Curr Opin Clin Nutr Metab Care 2021;24:453-63.
51. Huckleberry Y. Nutritional support and the surgical patient. Am J Health Syst Pharm 2004;61:671-82; quiz 683-4.
52. Hirsch KR, Wolfe RR, Ferrando AA. Pre- and Post-Surgical Nutrition for Preservation of Muscle Mass, Strength, and Functionality Following Orthopedic Surgery. Nutrients 2021;13:1675.
53. Fawcett WJ, Thomas M. Pre-operative fasting in adults and children: clinical practice and guidelines. Anaesthesia 2019;74:83-8.
54. Beverly A, Kaye AD, Ljungqvist O, et al. Essential Elements of Multimodal Analgesia in Enhanced Recovery After Surgery (ERAS) Guidelines. Anesthesiol Clin 2017;35:e115-43.
55. Dahl JB, Møiniche S. Pre-emptive analgesia. Br Med Bull 2004;71:13-27.
56. Rosero EB, Joshi GP. Preemptive, preventive, multimodal analgesia: what do they really mean? Plast Reconstr Surg 2014;134:85S-93S.
57. Vadivelu N, Mitra S, Schermer E, et al. Preventive analgesia for postoperative pain control: a broader concept. Local Reg Anesth 2014;7:17-22.
58. Bongiovanni T, Lancaster E, Ledesma Y, et al. Systematic Review and Meta-Analysis of the Association Between Non-Steroidal Anti-Inflammatory Drugs and Operative Bleeding in the Perioperative Period. J Am Coll Surg 2021;232:765-790.e1.
59. Nonsteroidal Anti-Inflammatory Drugs Do Not Affect Postoperative Bleeding [Internet]. [cited 2023 Mar 16]. Available online: https://www.jwatch.org/na53689/2021/06/10/nonsteroidal-anti-inflammatory-drugs-do-not-affect
60. Weibel S, Rücker G, Eberhart LH, et al. Drugs for preventing postoperative nausea and vomiting in adults after general anaesthesia: a network meta-analysis. Cochrane Database of Systematic Reviews [Internet]. 2020 [cited 2023 Mar 16];(10). Available online: https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD012859.pub2/full
61. Andreae MH, Andreae DA. Regional anaesthesia to prevent chronic pain after surgery: a Cochrane systematic review and meta-analysis. Br J Anaesth 2013;111:711-20.
62. Richardson J, Lönnqvist PA, Naja Z. Bilateral thoracic paravertebral block: potential and practice. Br J Anaesth 2011;106:164-71.
63. Fenten MG, Schoenmakers KP, Heesterbeek PJ, et al. Effect of local anesthetic concentration, dose and volume on the duration of single-injection ultrasound-guided axillary brachial plexus block with mepivacaine: a randomized controlled trial. BMC Anesthesiol 2015;15:130.
64. Heesen M, Klimek M, Rossaint R, et al. Paravertebral block and persistent postoperative pain after breast surgery: meta-analysis and trial sequential analysis. Anaesthesia 2016;71:1471-81.
65. Merritt CK, Mariano ER, Kaye AD, et al. Peripheral nerve catheters and local anesthetic infiltration in perioperative analgesia. Best Pract Res Clin Anaesthesiol 2014;28:41-57.
66. Fujii T, Shibata Y, Ban Y, et al. A single paravertebral injection via a needle vs. a catheter for the spreading to multiple intercostal levels: a randomized controlled trial. J Anesth 2020;34:72-8.
67. Kurz A, Sessler DI, Lenhardt R. Perioperative normothermia to reduce the incidence of surgical-wound infection and shorten hospitalization. Study of Wound Infection and Temperature Group. N Engl J Med 1996;334:1209-15.
68. Arsalani-Zadeh R, ElFadl D, Yassin N, et al. Evidence-based review of enhancing postoperative recovery after breast surgery. Br J Surg 2011;98:181-96.
69. Esnaola NF, Cole DJ. Perioperative normothermia during major surgery: is it important? Adv Surg 2011;45:249-63.
70. Srinivasa S, Hill AG. Perioperative fluid administration: historical highlights and implications for practice. Ann Surg 2012;256:1113-8.
71. Karamanos E, Walker R, Wang HT, et al. Perioperative Fluid Resuscitation in Free Flap Breast Reconstruction: When Is Enough Enough? Plast Reconstr Surg Glob Open 2020;8:e2662.
72. Sjöberg T, Numan A, de Weerd L. Liberal versus Modified Intraoperative Fluid Management in Abdominal-flap Breast Reconstructions. A Clinical Study. Plast Reconstr Surg Glob Open 2021;9:e3830.
73. Kotha VS, Abadeer AI, Amdur RL, et al. A Critical Examination of Length of Stay in Autologous Breast

Reconstruction: A National Surgical Quality Improvement Program Analysis. Plast Reconstr Surg 2021;147:24-33.
74. Kehlet H, Dahl JB. Anaesthesia, surgery, and challenges in postoperative recovery. Lancet 2003;362:1921-8.
75. Guay J, Nishimori M, Kopp SL. Epidural Local Anesthetics Versus Opioid-Based Analgesic Regimens for Postoperative Gastrointestinal Paralysis, Vomiting, and Pain After Abdominal Surgery: A Cochrane Review. Anesth Analg 2016;123:1591-602.
76. Turan A, Sessler DI. Steroids to ameliorate postoperative pain. Anesthesiology 2011;115:457-9.
77. Sharma HR, Rozen WM, Mathur B, et al. 100 Steps of a DIEP Flap-A Prospective Comparative Cohort Series Demonstrating the Successful Implementation of Process Mapping in Microsurgery. Plast Reconstr Surg Glob Open 2019;7:e2016.
78. Haddock NT, Teotia SS. Efficient DIEP Flap: Bilateral Breast Reconstruction in Less Than Four Hours. Plast Reconstr Surg Glob Open 2021;9:e3801.
79. Mericli AF, Selber JC, Largo RD, et al. The Optimal Length of Stay after Microvascular Breast Reconstruction: A Cost-Utility Analysis. Plast Reconstr Surg 2022;150:279e-89e.
80. Hendel PM, Lilien DL, Buncke HJ. A study of the pharmacologic control of blood flow to acute skin flaps using xenon washout. Part I. Plast Reconstr Surg 1983;71:387-98.
81. Zelken JA, Berli JU. Coffee, tea, and chocolate after microsurgery: why not? Ann Plast Surg 2015;74:139.
82. Derry S, Wiffen PJ, Moore RA. Single dose oral ibuprofen plus caffeine for acute postoperative pain in adults. Cochrane Database Syst Rev 2015;2015:CD011509.
83. Acland RD, Russell RC. Practice Manual for Microvascular Surgery. Plastic and Reconstructive Surgery 1990;85:475.
84. Roslan F, Kushairi A, Cappuyns L, et al. The Impact of Sham Feeding with Chewing Gum on Postoperative Ileus Following Colorectal Surgery: a Meta-Analysis of Randomised Controlled Trials. J Gastrointest Surg 2020;24:2643-53.
85. Su'a BU, Pollock TT, Lemanu DP, et al. Chewing gum and postoperative ileus in adults: a systematic literature review and meta-analysis. Int J Surg 2015;14:49-55.
86. Ge W, Chen G, Ding YT. Effect of chewing gum on the postoperative recovery of gastrointestinal function. Int J Clin Exp Med 2015;8:11936-42.
87. Dunn LK, Durieux ME. Perioperative Use of Intravenous Lidocaine. Anesthesiology 2017;126:729-37.
88. Largo RD, Selber JC, Garvey PB, et al. Outcome Analysis of Free Flap Salvage in Outpatients Presenting with Microvascular Compromise. Plast Reconstr Surg 2018;141:20e-7e.
89. Kroll SS, Schusterman MA, Reece GP, et al. Timing of pedicle thrombosis and flap loss after free-tissue transfer. Plast Reconstr Surg 1996;98:1230-3.
90. Chang EI, Chang EI, Soto-Miranda MA, et al. Comprehensive Evaluation of Risk Factors and Management of Impending Flap Loss in 2138 Breast Free Flaps. Ann Plast Surg 2016;77:67-71.
91. Schoenbrunner A, Hackenberger PN, DeSanto M, et al. Cost-Effectiveness of Vioptix versus Clinical Examination for Flap Monitoring of Autologous Free Tissue Breast Reconstruction. Plast Reconstr Surg 2021;148:185e-9e.
92. Marcusa DP, Mann RA, Cron DC, et al. Prescription Opioid Use among Opioid-Naive Women Undergoing Immediate Breast Reconstruction. Plast Reconstr Surg 2017;140:1081-90.
93. Hah JM, Bateman BT, Ratliff J, et al. Chronic Opioid Use After Surgery: Implications for Perioperative Management in the Face of the Opioid Epidemic. Anesth Analg 2017;125:1733-40.
94. Cho HS, Davis GC, Paek JE, et al. A randomised trial of nursing interventions supporting recovery of the postmastectomy patient. J Clin Nurs 2013;22:919-29.
95. Scaffidi M, Vulpiani MC, Vetrano M, et al. Early rehabilitation reduces the onset of complications in the upper limb following breast cancer surgery. Eur J Phys Rehabil Med 2012;48:601-11.
96. Testa A, Iannace C, Di Libero L. Strengths of early physical rehabilitation programs in surgical breast cancer patients: results of a randomized controlled study. Eur J Phys Rehabil Med 2014;50:275-84.
97. Cabana MD, Rand CS, Powe NR, et al. Why don't physicians follow clinical practice guidelines? A framework for improvement. JAMA 1999;282:1458-65.
98. Kehlet H, Wilmore DW. Evidence-based surgical care and the evolution of fast-track surgery. Ann Surg 2008;248:189-98.
99. Lyon A, Solomon MJ, Harrison JD. A qualitative study assessing the barriers to implementation of enhanced recovery after surgery. World J Surg 2014;38:1374-80.
100. Patil S, Cornett EM, Jesunathadas J, et al. Implementing enhanced recovery pathways to improve surgical outcomes. J Anaesthesiol Clin Pharmacol 2019;35:S24-8.
101. Sibbern T, Bull Sellevold V, Steindal SA, et al. Patients' experiences of enhanced recovery after surgery: a systematic review of qualitative studies. J Clin Nurs

2017;26:1172-88.
102. Herbert G, Sutton E, Burden S, et al. Healthcare professionals' views of the enhanced recovery after surgery programme: a qualitative investigation. BMC Health Serv Res 2017;17:617.
103. Pearsall EA, Meghji Z, Pitzul KB, et al. A qualitative study to understand the barriers and enablers in implementing an enhanced recovery after surgery program. Ann Surg 2015;261:92-6.
104. Lam JY, Howlett A, McLuckie D, et al. Developing implementation strategies to adopt Enhanced Recovery After Surgery (ERAS®) guidelines. BJS Open 2021;5:zraa011.
105. Gotlib Conn L, McKenzie M, Pearsall EA, et al. Successful implementation of an enhanced recovery after surgery programme for elective colorectal surgery: a process evaluation of champions' experiences. Implement Sci. 2015 Jul 17;10:99.
106. Grol R, Grimshaw J. From best evidence to best practice: effective implementation of change in patients' care. Lancet 2003;362:1225-30.
107. Liu VX, Rosas E, Hwang J, et al. Enhanced Recovery After Surgery Program Implementation in 2 Surgical Populations in an Integrated Health Care Delivery System. JAMA Surg 2017;152:e171032.
108. Fearon KC, Ljungqvist O, Von Meyenfeldt M, et al. Enhanced recovery after surgery: a consensus review of clinical care for patients undergoing colonic resection. Clin Nutr 2005;24:466-77.
109. Hughes M, Coolsen MM, Aahlin EK, et al. Attitudes of patients and care providers to enhanced recovery after surgery programs after major abdominal surgery. J Surg Res 2015;193:102-10.
110. Egbert LD, Battit GE, Welch CE, et al. Reduction of postoperative pain by encouragement and instruction of patients. a study of doctor-patient rapport. N Engl J Med 1964 Apr 16;270:825-7.
111. Kahokehr A, Sammour T, Zargar-Shoshtari K, et al. Implementation of ERAS and how to overcome the barriers. Int J Surg 2009;7:16-9.
112. Gramlich LM, Sheppard CE, Wasylak T, et al. Implementation of Enhanced Recovery After Surgery: a strategy to transform surgical care across a health system. Implement Sci 2017;12:67.
113. Pickens RC, Cochran AR, Lyman WB, et al. Impact of Multidisciplinary Audit of Enhanced Recovery After Surgery (ERAS)® Programs at a Single Institution. World J Surg 2021;45:23-32.
114. Altman AD, Helpman L, McGee J, et al. Enhanced recovery after surgery: implementing a new standard of surgical care. CMAJ 2019;191:E469-75.
115. Grol R. Personal paper. Beliefs and evidence in changing clinical practice. BMJ 1997;315:418-21.

Cite this article as: Clark RC, Alving-Trinh A, Becker M, Leach GA, Gosman A, Reid CM. Moving the needle: a narrative review of enhanced recovery protocols in breast reconstruction. Ann Transl Med 2023;11(12):414. doi: 10.21037/atm-23-1509

Supplementary

Table S1 The search strategy summary

Items	Specification
Date of search	December, 2022
Databases and other sources searched	PubMed, Embase, Citations of Included Studies, Citations of Included Studies, Citations of Identified Reviews and Guidelines
Search Terms Used	ERAS, Enhanced Recovery, Improved Recovery, Opioid Sparing, Surgery, Procedure, Breast Reconstruction, Breast Implant, Mastectomy
Timeframe	Through December 2022
Inclusion criteria	Primary Clinical Research, Focused on Enhanced Recovery or Improved Peri-Operative Outcomes, Focused on Breast Reconstruction, Includes Discussion of Protocol Elements
Exclusion criteria	Full Text Not in English, No Clinical Outcomes, Solely Comparing Individual Facets of a Protocol.
Selection process	Selection Following Preferred Reporting Items for Systematic Reviews and Meta-Analysis Guidelines. Independent Blinded Review with Screening by Agreement and Collaborative Discussion of Disagreements
Additional considerations	Ten Studies Not Meeting Initial Criteria were Additionally Included at The Authors' Discretion

https://dx.doi.org/10.21037/atm-23-1509