Reducing Waste in Dermatologic Surgery: An Evidence-Based Review of Sustainability Strategies

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BACKGROUND Dermatologic surgery generates considerable medical waste due to its high procedural volume, yet specialty-specific guidance on sustainable practices remains limited.

OBJECTIVE To present an evidence-based framework for reducing waste in dermatologic surgery while maintaining safety and efficacy.

MATERIALS AND METHODS A comprehensive search of PubMed was conducted for articles published from 2000 onward using key terms combining predefined waste reducing interventions (e.g. multipack nonsterile gloves, reusable drapes and instruments, longer-acting anesthetics, continuous suturing, simplified dressings) with ("waste reduction" OR "sustainability"). Evidence was graded by Oxford CEBM (1a–5) and GRADE (A–D).

RESULTS Twenty-eight sustainability strategies were identified across the preoperative, intraoperative, and postoperative phases of dermatologic surgery, 15 of which were supported by level 1 to 2 evidence. High-level interventions included the use of nonsterile gloves, longer-acting anesthetics, reusable drapes and instruments, absorbable and continuous suturing techniques, and occlusive dressings.

CONCLUSION This review summarizes evidence-based sustainability strategies shown to reduce environmental impact and provides a practical framework for potential implementation in dermatologic surgery.

The World Health Organization identifies climate change as the greatest threat to global health. Health care contributes 4.4%-5.2% of total global greenhouse gas emissions, with the US sector alone accounting 8.5% of national emissions.[1,2] This contributes to climate change and ozone depletion, which are linked to increasing rates of cutaneous malignancies.[2]

Each dermatologic surgery procedure generates an average of 0.52 kilograms of waste, largely from disposable instruments, personal protective equipment (PPE), and packaging.[3] A 2018 survey reported that Mohs surgeons alone perform an average of 578 procedures annually, although this is likely an underestimate, equating to 300 kilograms of waste per surgeon per year.[4] These estimates exclude sutures, blades, and gauze, indicating that the true burden is greater.

Despite the growing urgency of climate action, there remains no framework guiding sustainability in dermatologic surgery. This review provides the first evidence-based recommendations to reduce waste while maintaining safety and efficacy.

Methods

The authors conducted an intervention-focused literature review of practical waste-reduction strategies in dermatologic surgery. Prespecified interventions included multipack nonsterile gloves, reusable drapes and instruments, longer-acting anesthetics, continuous suturing, and simplified dressings. PubMed was searched (March 2000–February 2025) using terms combining each intervention with environmental and safety outcomes (e.g., gloves AND environmental impact OR waste reduction), and reference lists were reviewed.

Eligible English-language studies included randomized controlled trials, observational studies, reviews, life-cycle assessments, and expert commentaries. Outcomes of interest were environmental metrics, supply reduction, safety, and patient satisfaction. In the absence of direct environmental data, strategies supported by patient safety evidence or expert opinion with plausible environmental benefit included. Evidence was graded using the Oxford CEBM (1a–5) and GRADE (A–D) frameworks.

Preoperative Waste Reduction Strategies

Surgical gloves contribute substantially to preoperative waste. A life-cycle assessment found that sterile latex gloves have a climate impact 11.6 times greater than nonsterile gloves, with most emissions stemming from

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manufacturing.[5] A systematic review of 12,275 outpatient procedures found no significant difference in infection rates between sterile and nonsterile gloves, supporting the routine use of nonsterile gloves.[6]

Antiseptic waste can be reduced by utilizing bulk-pour solutions dispensed into sterilizable basins. Spray or foam-based chlorhexidine offers another low-waste option. In an observational study of obstetric and gynecologic surgery, spray-based 0.5% chlorhexidine in 70% alcohol used only 2.4 mL per patient, compared to greater volumes required with single-use sachets, highlighting its potential utility in dermatologic surgery.[7] Antiseptic use can be further reduced by conservative surgical site preparation. The CDC recommends sterilizing an area large enough to allow for incision extension and/or drain placement. Since drains are rarely utilized in dermatologic surgery, limiting the prepped area can prevent waste. Colored antiseptics such as povidone-iodine provide visual feedback to avoid redundant application; 1 RCT found that colored solutions achieved better field coverage (86.5%) than uncolored ones (73.9%) while preventing overapplication.[8]

Disposable gentian violet surgical markers and associated packaging contribute largely to waste. Reusing surgical markers can offer a solution to this problem. To maintain sterility, surgeons can apply povidone-iodine or isopropyl alcohol to the area marked with gentian violet markers. After 30 seconds of application, a stable complex forms with gentian violet that resists removal during subsequent skin preparation.[9] In addition, some surgeons use reusable ink or blood from the surgical site on a cotton-tip applicator or toothpick to mark lesions and draw repairs.

Another source of avoidable waste is anesthetics. An economic modeling analysis in the Journal of the American Medical Association found that low-dead-space syringes retain just 0.3% of residual volume compared to 3% in high-dead-space syringes, reducing medication waste by nearly tenfold.[10] In addition, using longer-acting anesthetics, such as 0.5% bupivacaine with 1:200,000 epinephrine, has been shown to reduce the need for reinjection. In a prospective RCT of patients undergoing Mohs surgery, adjunctive bupivacaine eliminated the need for repeat anesthetic in all cases compared to 28% requiring reinjection in the lidocaine-only group.[11] In addition, prefilled syringes can be more efficient but often overestimate the amount needed, leading to waste.

Disposable sterile drapes are a major source of procedural waste and environmental burden. Reusable cloth drapes provide a sustainable alternative that maintains barrier integrity, conforms well to anatomic contours, and withstands standard textile sterilization protocols. A prospective study in cardiac surgery found no increase in SSI with reusable drapes compared to disposables, supporting their clinical safety.[12] In dermatologic surgery, a prospective study of 1,000 Mohs cases using a clean technique, without sterile gloves, gowns, or drapes, reported an infection rate of 0.91%, further supporting reduced reliance on single-use sterile barriers in selected cases.[13] Reusable drapes represent a safe and environmentally responsible option. All preoperative waste reduction strategies are summarized in Table 1.

Intraoperative Waste Reduction Strategies

Accurate measurement of surgical defects is essential for surgery and disposable plastic, or paper rulers contribute significantly to procedural waste. A practical alternative is the use of sterilizable metal rulers, calipers, and blade handles (with integrated distance markings), which can be autoclaved between uses. An additional low-waste alternative suggested by Mehta and colleagues[14] involves repurposing graduated syringes, which are already routinely used for local anesthesia. After the plunger is removed, syringe barrels offer visible, standardized markings that can be used to measure elliptical excisions, flap dimensions, or tumor margins. Their mild flexibility allows for accurate measurement on curved surfaces and can be calibrated against a standard ruler once for added precision.

Surgical instruments represent a key opportunity for sustainable intervention through reuse. A life cycle assessment of anterior cruciate ligament repairs in orthopedic surgery found that disposable materials generated 7.55 kg of waste per case compared to 5.19 kg from reusable materials, and that sustainability interventions such as increased instrument reuse reduced total greenhouse gas emissions by up to 42%.[15] Although data specific to dermatologic surgery are limited, adopting the use of reusable instruments is likely to yield meaningful reductions in environmental burden. Proper sterilization and maintenance (e.g., instrument sharpening) extend the lifespan of reusable tools. The same principle applies to suture removal, where prepackaged kits often generate waste by including items already stocked in patient rooms (e.g., gauze), disposable instruments, and additional plastic packaging. A more efficient alternative is to use sterilized reusable forceps with scissors or a disposable No. 11 or 15 blade.[16]

Standardized packs, which bundle only the essential instruments needed for specific procedures, can reduce both instrument and packaging waste. In hand surgery, Van Demark and colleagues[17] reduced waste by 2.3 kg per carpal tunnel case by omitting nonessential items such as extra towel clamps, hemostats, and needle drivers. Across 1,099 procedures, this strategy diverted approximately 2.5 metric tons of waste from landfills.[18] For dermatologic surgery, assembling procedure-specific packs (e.g., smaller kits for cyst excisions vs larger sets for complex repairs) limits unused tools, reduces packaging from individually wrapped instruments, and decreases the environmental burden of sterilizing unused instruments. Waste reduction can also be achieved by preserving the same sterile instrument set for tumor extirpation and reconstruction during a single Mohs case, rather than opening a new set for each stage. In a prospective study of 332 patients, this approach resulted in an SSI rate of only 2.1%.[19]

Suture material provides another opportunity for waste reduction. Delaying the opening of suture packets until

TABLE 1. Strength of Recommendation and Level of Evidence for Preoperative Waste Reduction Strategies in Dermatologic Surgery

Waste Reduction Strategy	Strength of Recommendation	Level of Evidence	References
Use nonsterile gloves from multiglove boxes	A	1a	[5,6]
Use longer-acting anesthetics with epinephrine	A	1b	[11]
Use colored antiseptics such as povidone-iodine	B	1b	[8]
Use spray or foam-based chlorhexidine	B	2b	[7]
Use reusable cloth drapes	B	2b	[12,13]
Use clean technique in select low-risk cases	B	2b	[13]
Reuse gentian violet surgical markers and fix with povidone-iodine or isopropyl alcohol	D	5	[9]
Use low dead space syringes	D	5	[10]
Use bulk-pour antiseptics in sterilizable containers	D	5	Expert opinion

closure begins or a specific suture is needed and using the same suture for both dermal and epidermal layers can minimize unused materials. Absorbable sutures further reduce waste and eliminate the need for suture removal instruments or follow-up visits. A meta-analysis of 19 RCT (1,748 patients) found no significant difference in infection or scar formation between absorbable and nonabsorbable sutures, with subgroup analysis showing improved cosmetic outcomes in the absorbable group.[20] In a survey study of linear repairs, most patients who received absorbable sutures (67.6%) reported they would choose them again to avoid suture-removal visits.[21] Eliminating such visits also reduces travel emissions: in a carbon-footprint analysis of an academic outpatient dermatology clinic in Philadelphia (~30,000 annual visits), patient travel contributed 14.2 metric tons of carbon dioxide equivalent annually (~0.47 kg per in-person visits).[22]

Continuous suture techniques offer material efficiency across various surgical specialties and may provide waste-reducing benefits in dermatologic surgery. In a RCT of episiotomy repairs, continuous nonlocking closure used fewer suture packets than interrupted methods (1.07 vs 1.90).[23] Similarly, a prospective study of cleft palate repairs found that continuous suturing halved suture usage (2.12 vs 4.59 packets) and shortened closure time without increasing complications. In traumatic laceration repairs, continuous techniques reduced the material used to 0.321 packets/cm compared to 0.508 packets/cm for interrupted closure.[24,25] Suture knot technique can also reduce material waste; the Double-Loop Dermal method was found to use only 6.1 cm of suture per knot versus 15.3 cm with conventional hand-tying, without prolonging closure time.[26]

Maintaining a dry wound bed is essential for minimizing complications, but common tools such as sterile gauze contribute substantially to waste. A descriptive study in laparotomy surgeries found that unused single-use supplies accounted for 5.9% of total costs, with sterile gauze representing the largest share at 28.25%.[27] Reusable cotton surgical towels offer a sustainable alternative, with an estimated ten-use lifespan when processed by medical linen services.[12,13] Electrosurgical units, including hyfrecator-style and bipolar devices, often feature reusable handpieces and electrodes that can be sterilized, eliminating the need for plastic sleeves and disposable tips.

Anesthesia also offers an opportunity for waste reduction. A triple-blinded RCT showed that maximal vasoconstriction from lidocaine with epinephrine occurs at approximately 25.9 minutes postinjection, optimizing conditions for reduced bleeding and less need for electrocautery and gauze.[28] In addition, a blinded RCT found that adding tranexamic acid to lidocaine significantly reduced intraoperative bleeding compared to saline, with the most pronounced effect observed in patients on anticoagulants,[29] highlighting a valuable strategy for minimizing waste associated with hemostasis in higher-risk surgical cases. A summary of these intraoperative interventions is provided in Table 2.

Postoperative Waste Reduction Strategies

Conventional dressings (CDs) consist of layered ointment and nonadherent, absorbent, contouring, or compressive materials that reduce infection risk.[30] Although effective, CDs require frequent changes. In contrast, occlusive dressings such as films, hydrocolloids, and alginates use less material and reduce dressing changes. Hydrocolloids have been shown to lower infection rates and improve patient satisfaction compared with CDs.[30] Many occlusive materials are also biodegradable; for example, alginates derived from seaweed and hydrogels naturally degrade over time, reducing environmental impact.[31]

Limiting dressing changes reduces bandage waste and can improve patient adherence. The 24-7 bandage technique, which involves leaving the same dressing in place for

TABLE 2. Strength of Recommendation and Level of Evidence for Intraoperative Waste Reduction Strategies in Dermatologic Surgery

Waste Reduction Strategy	Strength of Recommendation	Level of Evidence	References
Use absorbable sutures to reduce material and follow-up visits	A	1a	21,22
Use continuous suturing techniques	A	1b	23–25
Allow 25 minutes after lidocaine with epinephrine injection for peak vasoconstriction	A	1b	28
Use tranexamic acid as an adjunct to lidocaine	A	1b	29
Reuse the same sterile instrument set for tumor removal and reconstruction in Mohs surgery	B	2b	19
Use reusable instruments for surgery and suture removal	B	2b	15,16
Consider the double-loop dermal for suture knot technique	B	2b	26
Assemble procedure-specific packs	B	3b	17,18
Use reusable cotton surgical towels for hemostasis	C	4	12,13,27
Use sterilizable metal rulers, blade handles, or caliper to measure	D	5	Expert opinion
Repurpose graduated syringe barrels as measuring tools	D	5	14
Maintain instruments through routine sharpening and sterilization	D	5	Expert opinion
Delay opening suture packets until wound closure begins	D	5	Expert opinion
Use electrosurgical units with reusable tips and accessories that can be sterilized	D	5	Expert opinion

7 days, has been proposed as an effective option after dermatologic surgery.[32] In a case series of approximately 200 patients using a layered dressing of mupirocin ointment, bismuth impregnated gauze, a nonadherent layer, and secure wrap, no complications were reported across a range of anatomical sites during follow-up.[32] Similarly, a systematic review of RCTs found no significant differences in infection or adverse events between early dressing removal (≤48 hours) and delayed removal (>48 hours), supporting the safety of limiting dressing changes.[33]

Another strategy to reduce waste is the use of skin substitutes for second intention healing. These substitutes are designed to supply essential components such as matrix materials and healing cells, which are often lacking in granulating or chronic wounds. Skin substitutes are biodegradable and are eventually replaced by the patient's

TABLE 3. Strength of Recommendation and Level of Evidence for Postoperative Waste Reduction Strategies in Dermatologic Surgery

Waste Reduction Strategy	Strength of Recommendation	Level of Evidence	References
Maintain dressings for at least 48 hours postoperatively	C	1b	33
Use occlusive dressings such as films, hydrocolloids, and alginates	B	2b	30,31
Reduce frequency of dressing changes and consider the 24–7 bandage technique	C	5	32
Simplify dressing layers	D	5	Expert opinion
Use biodegradable dressings and skin substitutes	D	5	Expert opinion

tissue. These postoperative waste reduction strategies are outlined in Table 3.

Conclusion

Despite the significant waste generated by dermatologic surgery, specialty-specific sustainability recommendations remain lacking. In this review, the authors present 28 evidence-based strategies to reduce waste, including the use of reusable gowns and gloves, low-dead-space syringes, absorbable sutures, continuous suture techniques, and simplified dressings. By adopting these interventions, dermatologic surgeons can help lead efforts to reduce health care's environmental footprint while maintaining safety and high-quality care.

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