Minimal Custom Pack Design and Wide-Awake Hand Surgery: Reducing Waste and Spending in the Orthopedic Operating Room

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Cassandra L. Thiel¹, Rafaela Fiorin Carvalho², Lindsay Hess³,
Joelle Tighe², Vincent Laurence², Melissa M. Bilec², and Mark Baratz²

Abstract

Background: The US health care sector has substantial financial and environmental footprints. As literature continues to study the differences between wide-awake hand surgery (WAHS) and the more traditional hand surgery with sedation & local anesthesia, we sought to explore the opportunities to enhance the sustainability of WAHS through analysis of the respective costs and waste generation of the 2 techniques. **Methods:** We created a “minimal” custom pack of disposable surgical supplies expressly for small hand surgery procedures and then measured the waste from 178 small hand surgeries performed using either the “minimal pack” or the “standard pack,” depending on physician pack choice. Patients were also asked to complete a postoperative survey on their experience. Data were analyzed using 1- and 2-way ANOVAs, 2-sample *t* tests, and Fisher exact tests. **Results:** As expected, WAHS with the minimal pack produced 0.3 kg (13%) less waste and cost \$125 (55%) less in supplies per case than sedation & local with the standard pack. Pack size was found to be the driving factor in waste generation. Patients who underwent WAHS reported slightly greater pain and anxiety levels during their surgery, but also reported greater satisfaction with their anesthetic choice, which could be tied to the enthusiasm of the physician performing WAHS. **Conclusions:** Surgical waste and spending can be reduced by minimizing the materials brought into the operating room in disposable packs. WAHS, as a nascent technique, may provide an opportunity to drive sustainability by paring back what is considered necessary in these packs. Moreover, despite some initial anxiety, many patients report greater satisfaction with WAHS. All told, our study suggests a potentially broader role for WAHS, with its concomitant emphases on patient satisfaction and the efficient use of time and resources.

Keywords: anesthesia, sustainability, waste, wide-awake, surgery, costs, preferences, trash

Introduction

Spending on health care in the United States is increasing at an unsustainable rate. In one estimate, spending is expected to rise from 18% of the Gross Domestic Product in 2013, to 26% by 2040.^{11,14} Growing health care expenditures pose problems for federal and state budgets, diverting government funds from other important sectors, while also creating added burden on patients.^{1,15} Likewise, the health care sector has a large environmental footprint, accounting for 10% of the United States’ total greenhouse gas emissions and 9% of criteria air pollutants.^{3,6,9,13,20,22,23} This spending and associated emissions is the result of material and resource consumption. Comparing health care–related solid waste generation rates globally, the United States leads all other nations for which data are available, producing

approximately 5 to 7 kg/bed/day in 2011; Portugal (3.8), Italy (3–5), Japan (2.05), Jordan (1.88–3.49), and Turkey (2.35), among others, generate far less.¹⁰

Operating rooms (ORs) generate about 25% to 35% of a hospital’s total waste volume.¹² Furthermore, typical ORs consume, on average, 56% of total hospital supply expenses.¹⁹

¹New York University School of Medicine, New York City, USA

²University of Pittsburgh, PA, USA

³Robert Morris University, Moon Township, PA, USA

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Corresponding Author:

Melissa M. Bilec, Department of Civil and Environmental Engineering, University of Pittsburgh, 153 Benedum Hall, 3700 O’Hara Street, Pittsburgh, PA 15261, USA.
Email: mbilec@pitt.edu

Table 1. Number and Percent of Respondents by Metric, Analyzed by Physician and Anesthetic Choice.

Metric	Number (% of metric, % of all cases in study)			
	Waste data	Survey, general	Survey, fear/anxiety /pain	Survey, satisfaction
Total cases	178 (100)	73 (41)	43 (24)	95 (53)
Physician 1, Pack S	80 (45)	30 (41, 17)	0 (0, 0)	47 (49, 26)
Physician 2, Pack M	98 (55)	43 (59, 24)	43 (100, 24)	48 (51, 27)
WAHS	87 (49)	37 (51, 21)	38 (88, 21)	42 (44, 24)
Sedation & local	91 (51)	36 (49, 20)	5 (12, 3)	53 (56, 30)

Note. Pack S = standard disposable-material custom pack for hand surgeries; Pack M = minimized hand custom pack; WAHS = wide-awake hand surgery (local-only).

A majority of the materials used in surgery are single use and disposable, and many supplies enter the OR in a disposable custom pack of sterile supplies packaged together for a single procedure. Custom packs minimize contamination risk and optimize the surgery; however, once opened, all materials in the custom pack are considered unsterile—even items not utilized—and everything must be thrown out.^{4,22}

Within medicine, the orthopedic specialty is considered one of the largest waste generators. The materials contained in custom packs used in orthopedics can be decreased by different strategies.⁴ Traditionally, hand procedures have required the patient to be sedated. Recently, the use of local-only anesthesia in hand surgery has been studied as an alternative to sedation & local anesthesia.^{2,8} This local-only or wide-awake hand surgery (WAHS) method has been used in a variety of hand procedures, including carpal tunnel release (CTR), trigger finger release (TFR), and cyst/mass excision, and the number of procedures for which it is deemed viable continues to grow.¹⁶

Though the literature on the WAHS approach is limited, existing studies suggest several benefits for both surgeon and patient. It is presumed that this method reduces the need for subsequent revision surgeries; the patient can actively move the hand or finger, demonstrating that the surgical intervention achieved the desired effect.¹⁷ Wide-awake hand surgery also offers the potential for cost savings; studies have shown that WAHS can be performed more quickly and with fewer assistants, and can be performed safely in an office with field sterility, rather than necessarily in an OR with full sterility.^{5,17,18} Previous studies have also found that patients prefer WAHS: Patients report that it is more comfortable, due to the absence of a tourniquet,²¹ and at least one study has demonstrated that patients experience less preoperative anxiety than sedated patients.⁷ We could identify no previous studies, however, that evaluated the relative materials' cost or waste generation associated with WAHS as compared with the more traditional local & sedation technique. To address this dearth of information, and to help reduce costs and improve sustainability, we conducted a pilot-stage comparative analysis of WAHS versus local & sedation.

Materials and Methods

This study analyzed the waste generation, costs, and patient experience associated with WAHS as compared with local & sedation. Cases included predominantly CTR, TFR, and benign cyst/mass excisions; a small number of other types of cases were also performed, with details provided below. Data were collected from 178 patients undergoing these surgeries with one of 2 physicians in ORs at a single surgery center within the University of Pittsburgh Medical Center (UPMC) between May 2014 and July 2015. Independent of this study, patients were scheduled for either a sedation-and-local anesthetic option (sedation & local) or a local-only option (WAHS), based on discussions with their physician. As this was deemed a quality-improvement project, the project did not need Institutional Review Board approval, and we did not collect demographic information on patients.

Prior to the start of the study, we analyzed the contents of the standard hand surgery custom pack (Pack S) and eliminated all items deemed unnecessary or redundant, creating a *minimal* custom pack (Pack M), which includes a small drape that covers only the surgical site. Draping in Pack S covers the entire patient. The price of both custom packs, and any additional items from the physician's preference card or "pick list," was obtained from UPMC's supply ordering system. The contents and prices of both packs can be found in Table 1 of the Supporting Information. Physician 1 used pack S and Physician 2 used pack M, exclusively, for all surgeries included in this study, regardless of anesthetic approach. The OR staff was also aware of Physician 2's preference to minimize surgical waste.

Following each surgery, we weighed the total biohazardous (red-bag) and nonbiohazardous waste using a small floor scale, accurate to one-tenth of a pound. At the 2-week postsurgical checkup, patients were asked to provide information about their experience, including time spent for preoperative testing; need for a driver or a caretaker for dependents; ability to hear surgical sounds; whether they experienced any nausea or vomiting postoperatively; what they remembered from their postoperative discussion with

the surgeon; degree of fear, anxiety, and pain during surgery; and their overall experience with the surgery and anesthesia. Responses could not be collected from all patients; however, as a member of the research team was not always able to be present at the postoperative surgical checkup. The list of survey questions can be found in the Supplemental Information section.

Data were analyzed using 2 methods of grouping; first we compared differences in metrics by physician, and second we compared differences based on anesthetic approach. Two-sample *t* tests with a 95% confidence interval were used to compare the continuous data, such as waste generation and experience rankings, and Fisher exact tests were used to compare categorical data, such as ability to hear surgical sounds or remember postoperative discussions. A 2-way ANOVA tested the relative effects of physician and anesthetic approach on the waste generation. A 1-way ANOVA analyzed the relative influence of procedure type (CTR, TFR, cyst excision) on waste generation with a 95% confidence interval.

Results

Eighty procedures (45%) were performed by Physician 1 using the standard hand custom pack (Pack S); 98 (55%) were performed by Physician 2, using the new minimal hand custom pack (Pack M), as shown in Table 1. Eighty-seven patients (49%) underwent WAHS procedures, with Physician 1 performing 1 WAHS (1% of all cases) and Physician 2 performing 86 WAHS (48%). Physician 1 performed 79 sedation & local procedures (44% of all cases). Physician 2 performed 12 sedation & local procedures (7%) for a total of 91 cases (51%) performed using sedation. The surgeries were divided into 4 categories: 80 (45%) were for CTR, 39 (22%) were for TFR, 32 (18%) were for cyst/mass excision, and 27 (15%) were designated as “other,” a category that included de Quervain release, Dupuytren contracture treatments, nailbed or nerve repairs, and any time multiple procedures were performed during a single surgical visit.

Seventy-three patients (41%) answered general survey questions. Physician 1 was the surgeon for 30 of those cases (41% of general survey respondents, 17% of all cases in the study), and Physician 2 was the surgeon for 43 cases (59% and 24%, respectively). Responses were split almost evenly between patients undergoing WAHS (49%) and those who received both sedation & local (51%). Forty-three patients (24% of cases) answered questions related to fear, anxiety, or pain during the surgery. All of these responses came from Physician 2's cases, and 38 cases (88% of survey responses, 21% of all cases in the study) were WAHS; 5 (12%, 3%) used sedation & local. Ninety-five patients (53%) responded to questions regarding anesthetic and overall surgical satisfaction. Responses were evenly split between physicians,

with 42 (44% of satisfaction responses, 24% of all cases in the study) respondents undergoing WAHS and 53 (56%, 30%) using sedation & local.

There were no statistically significant differences between the various categories, or types, of surgery (CTR, TFR, excisions, and “other”) in terms of number of preoperative visits ($P = .333$), time spent in preoperative testing ($P = .903$), patient satisfaction with anesthetics ($P = .177$), or overall satisfaction ($P = .300$, 1-way ANOVA). Waste generation while comparable between CTR, TFR, and excision of lesions ($P = .812$, 1-way ANOVA) was significantly greater for the “other” procedures ($P = .002$, 1-way ANOVA). There were no reported complications in any of the cases.

The average waste generated per surgery was 2.4 kg (standard deviation [SD], ± 0.5 kg) for the CTR, TFR, and excision procedures and 2.8 kg (SD, ± 0.4 kg) for the “other” procedures (see Figure 1). For sedation & local, pack size was significantly correlated with waste generation for CTR, TFR, and excision procedures, with Physician 1 (Pack S) averaging 2.6 kg of waste per surgery ($n = 72$, SD = 0.5) and Physician 2 (Pack M) averaging 2.2 kg waste ($n = 79$; SD = 0.5), for a reduction of 0.3 kg (13%) per case (2-sample *t* test, $P < .005$). The difference in waste generation for procedures in the “other” category was not significant between physicians (therefore, pack size), with means for both of 2.8 kg per case (2-sample *t* test, $P = .950$).

Local-only, or WAHS, procedures generated 2.2 kg waste per case ($n = 70$; SD = 0.5); procedures using sedation & local generated 2.5 kg per case ($n = 81$; SD = 0.5), or 0.3 kg (12%) more waste for sedation & local than for WAHS (2-sample *t* test, $P < .005$). For the “other” procedures, however, there was no statistical difference in waste generation with WAHS generating 2.7 kg per case ($n = 17$, SD = 0.5) and sedation & local generating 2.9 kg per case ($n = 10$, SD = 0.4) (2-sample *t* test, $p = .253$).

For CTR, TFR, and excision procedures, waste generation was tied more to the pack size ($P = .034$) than to type of anesthesia ($P = .394$) or a combined physician/anesthesia factor ($P = .108$, 2-way ANOVA). For the “other” procedures, neither physician/pack size ($P = .101$, 2-way ANOVA) nor anesthesia ($P = .051$) was statistically significant. Physician 1 conducted only 1 WAHS procedure, however, so these results are likely not generalizable.

The minimal pack, Pack M, costs the surgery center \$17.60, while the standard pack, Pack S, costs \$47.33. When Pack M is used in WAHS, the total estimated cost of all disposable surgical materials (pack plus pick list) is \$104.69. When Pack S is used with sedation & local cases, the total estimated cost of all disposable surgical materials more than doubles, rising to \$230.13. In addition, although costs were not calculated for each case, because patients undergoing WAHS do not require anesthesia clearance, preoperative testing and its associated costs are reduced or eliminated.

Figure 1. Waste generation by procedure, physician, and anesthetic choice.

Note. WAHS = wide-awake hand surgery (local-only); CTR = carpal tunnel release; TFR = trigger finger release; other = de Quervain release, Dupuytren contracture treatment, nailed or nerve repair, and multiple procedures; Avg = average; SHS = small hand surgeries (combination of CTR, TFR, and excision); Sedation = sedation & local; Pack S = standard disposable custom pack; Pack M = minimized disposable custom pack.

*Physician 1 performed a single WAHS for CTR (3.2 kg); therefore, the limited data were not included.

General Survey Metrics Show Little Difference Between Anesthetic Approaches Except the Patients' Transportation Methods

Patients undergoing WAHS were significantly less likely to have a driver on the day of their surgery ($P < .005$, Fisher exact test). Patients undergoing sedation & local are required to have a driver, and all 37 respondents (100%) reported having one.

The average time patients estimated they spent in preparation for the surgery was about 1 hour ($N = 62$), which did not vary significantly either by physician ($P = .292$, 2-sample t test) or by anesthetic approach ($P = .127$). The WAHS patients did not require preoperative testing, so this result suggests the need to refine the survey question. Neither anesthetic choice nor the physician was significantly correlated with the patient's ability to recall the postoperative discussion with their physician (Fisher exact test, $P = .511$ for physician, $P = 1.000$ for anesthetic choice). Though there was one instance of nausea reported in the WAHS group ($n = 37$), there was no statistical difference between the groups ($P = 1.000$, Fisher exact test).

Potentially Greater Anxiety and Pain in WAHS Group

The portions of the questionnaires related to pain, anxiety, fear, and noise or talking in the OR were only answered by Physician 2's patients. Furthermore, 38 of the 43 responses (88%) were from patients undergoing WAHS and only 5

(12%) from those who received sedation & local. Conclusions are limited by the small sample size in the sedation category.

Patients reported greater anxiety levels during WAHS (mean = 1.9 out of 5, $n = 38$) than they did in sedation & local cases (mean = 1.2, $n = 5$, $P = .0378$, 2-sample t test). Pain was also statistically greater in the WAHS group (mean = 1.8 out of 5; $P < .005$) than for those who received sedation & local (mean = 1.0). Though WAHS patients reported more fear (mean = 1.6 out of 5; $n = 38$) than did the sedation & local patients (mean = 1.2), this difference was not found to be statistically significant ($P = .145$, 2-sample t test). Of note, these findings, which are limited by the small sample size of the sedation & local arm, differ from previous findings, which found less anxiety and/or fear in WAHS patients.⁸ None of the surveyed patients reported being bothered by surgical sounds or talking during their WAHS ($n = 41$).

Patients Express Preference for WAHS and Greater Satisfaction With WAHS

Thirty-five patients self-reported their previous use of either sedation or local-only surgeries (see Figure 2). Of the 22 patients (63% of respondents) who had previously undergone surgery via local-only and sedation, 8 (36%) reported preferring local-only, 0 preferred sedation over local-only, 2 (9%) had no preference, and the remainder had either unclear (3, 14%) or no responses (9, 41%).

When asked to rate their satisfaction, on a scale of 1 to 10, with the anesthesia used for their procedure, WAHS patients reported greater satisfaction (mean = 9.7, $n = 40$) than patients with sedation & local (mean = 9.3, $n = 53$,

Figure 2. Patient preference for anesthetic choice based on previous experiences.

Note. N = number of respondents.

$P = .011$, 2-sample t test). Overall satisfaction with the surgical experience was not significantly different between the WAHS (mean = 9.8, $n = 42$) and sedation & local groups (mean = 9.7, $n = 53$, $P = .397$, 2-sample t test). Neither the physician ($P = .674$) nor the anesthesia ($P = .445$, 2-way ANOVA) achieved statistical significance.

Discussion

When implemented together, a minimal custom pack design and WAHS appear to halve surgical material costs for at least some of the most commonly performed hand surgeries (CTR, TFR, excision of benign cysts/masses) and reduce surgical waste by 13% (0.3 kg) per case. Waste reduction is largely due to minimizing the disposable custom pack, a practice which could be replicated at all surgical facilities using custom packs.⁴ The savings resulting exclusively from WAHS may not be fully captured in this study, as costs and waste for preoperative testing were not comprehensively analyzed, and the measured (weighed) OR wastes did not include sharps; though likely minimal, there would obviously be more sharps generated by the sedation & local arm.

This study adds to the literature examining the differences between anesthetic approaches to minor hand procedures. Patients undergoing WAHS experience greater independence, with only 32% of survey respondents using a driver on the day of surgery. Though WAHS patients can hear their surgery, none were bothered by talking or other sounds. The sedation & local group reported lower levels of pain and anxiety during surgery; however, the sample size of the sedation group who responded to these questions ($n = 5$) was small and may not be

representative. Patients who had previously undergone surgeries with both types of anesthesia prefer WAHS to sedation & local. There were no reported differences in surgical complications, infection rate, or recovery time between patients undergoing WAHS procedures and those who received sedation & local. In summary, these data suggest that WAHS should be used more broadly in hand surgery and considered for other procedures in the field of orthopedics.

In this study, WAHS patients also expressed greater satisfaction with anesthetic choice than did sedation & local patients, but this trend did not carry into overall surgical satisfaction. Both groups were equally satisfied with their overall surgical experience. This result seems to be tied to the physician. Physician 2, who performed a majority of the WAHS cases, is very enthusiastic about this approach. This enthusiasm has perhaps encouraged the WAHS patients to feel that the anesthetic approach is inherently better, which might also suggest that a physician's attitude can influence a patient's satisfaction with his or her experience.

The main limitations of our study was its narrow focus on two physicians at a single surgery center, with each physician preferring a specific type of anesthesia and using a different size sterile custom pack. Though we were able to demonstrate significance in terms of the reduction in waste generation and materials' cost as a function of pack size, we were not able to find statistical significance with respect to choice of anesthesia. An additional limitation, though likely of minimal significance, is that the waste measured did not include sharps, more of which would necessarily be generated in a case with a patient receiving sedation. It may be interesting in future studies either to analyze a larger

number of physicians or to conduct a longitudinal, interventional study on individual physicians as they transition from a predominantly sedation & local approach to WAHS. In addition, our study's postoperative survey suffered from a low-response rate and incomplete responses. Future studies should include a better mechanism for capturing patient feedback.

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Ethical Approval

This study was approved by our institutional review board.

Statement of Human and Animal Rights

This article does not contain any studies with animal subjects. All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008 (5).

Statement of Informed Consent

Informed consent was obtained from all patients for being included in the study.

Declaration of Conflicting Interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: MB reports personal fees from Integra and Elizur; editorial board positions with the *Journal of Bone and Joint Surgery*, the *American and European Journal of Shoulder and Elbow Surgery*, the *Journal of Hand Surgery*, and *HAND*; position as president elect for the American Association for Hand Surgery; membership on the board of trustees for the American Foundation for Surgery of the Hand, outside the submitted work. All other authors declare that they have no conflict of interest.

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