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SPECIAL TOPIC

Development of a Plastic Surgery Supply Cart: Patient Outcomes and Quality of Care

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Background: Plastic surgeons experience unique quality issues related to the specialty nature of patient procedures. Lack of accessibility to specialty supplies is a rate-limiting variable that impacts treatment efficiency and hospital resources. This study had the following goals: (1) to develop a mobile plastic surgery cart and (2) to assess the impact of a plastic surgery cart on time to treatment of consults.

Methods: Two plastic carts were developed using preexisting hospital supplies. Cart composition was designed and approved by hospital staff. A prospective study was conducted to assess overall time to treatment of patient consults throughout the hospital comparing a plastics cart versus a traditional hunt and gather methodology. One surgeon recorded time to treatment with and without the plastics cart for each consult during on-call duty hours over a 6-month period.

Results: A total of 40 patients were treated for either head or neck (60%) or hand-related (40%) cases. The average time (minutes) to treatment across all procedures with the plastics cart was 3.7 ± 1.9 versus 46.3 ± 60.0 without the plastics cart. The maximum time to treatment was 9.5 minutes with the plastics cart and 3 hours without the plastics cart. Usage of the plastics cart resulted in a significant reduction in total time to treatment of 42.5 ± 60.3 minutes ($P < 0.0001$).

Conclusions: A specialty supplies cart has quality improvement implications for patients, physicians, and hospitals. Increased accessibility of specialty supplies may significantly reduce the time to treatment for plastic surgery patient consults throughout a hospital. *(Plast Reconstr Surg Glob Open 2019;7:e2111; doi: 10.1097/GOX.0000000000002111; Published online 8 February 2019.)*

INTRODUCTION

Over 200,000 patient deaths per year are attributable to system-related hospital deficits.[1] The Institute of Medicine's reports on healthcare delivery identify quality errors as a top health concern in both public and private sectors.[2,3] A majority of hospital admissions experiencing unintended adverse events caused by medical errors are considered preventable.[4,5] Despite low overall mortality rates associated with plastic and reconstructive surgical procedures, this subspecialty is not immune from quality errors that may result in complication and mortality.[6] In fact, recent publications highlight pre-, intra-, and postoperative opportunities for reduction of adverse events within the field of plastic surgery.[7,8] Resource management is 1 key opportunity that directly aligns to the Institute of Medicine aims for reducing quality errors through timely and efficient care.[3]

Plastic surgery is a unique subspecialty that is responsible for treating patients in all hospital locations including the emergency department, general medical floor, and the intensive care unit. Intrinsic to its uniqueness is the need for specific surgical resources to appropriately manage laceration repairs, wound care, and splint application. Often these supplies are not immediately available to plastic surgeons and must be ordered from the surgical center or hospital central supply. Special ordering supplies may lead to delays in patient care, which are often exacerbated by

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miscommunication errors associated with those delivering the supplies. Furthermore, the flow of supplies between departments is regulated and cannot be easily transferred to the patient's room once located. These logistical challenges greatly increase the time between consultation and treatment, and thus result in both lower quality of care and an inefficient use of physician time and resources.

Standardized hospital protocols and supply chain training may improve the delivery of supplies to the correct location, but several key factors are still not addressed. The supply orders are subject to interpretation, the supplies remain in a remote location, and it is difficult to know exactly what the procedure may require beforehand. The logical solution to this problem is a mobile collection of supplies that can be accessed directly by the plastic surgery team. The overall aim of this prospective study was to develop a plastic surgery supply cart and to assess improvements in time to treatment of patients.

METHODS

Two identical mobile plastic surgery supply carts (30" Auto-Locking Cart; Armstrong Medical) were developed at the Spectrum Health Butterworth Hospital in Grand Rapids, Michigan (Fig. 1). Supply carts were designed to provide immediate availability of specialty supplies, multiple sterilized and packaged instrument trays, mobility to various hospital locations, and a system for restocking and resterilizing used trays and cart supplies. Key hospital representatives in Central Supply, Sterile Processing, Pharmacy and Hospital Administration aligned to the development of the cart and provided input on overall cart design. Carts were stocked using preexisting hospital supplies, with the cost of the physical cart being the only financial obligation. A list of a surgical instruments and their prices is provided in Table 1. The organization structure of the supplies throughout the cart is listed in Table 2. Plastic surgery carts were positioned in a fixed and central location in the surgical intensive care unit at Spectrum Health Butterworth Hospital.

After the development of the plastic surgery carts, a prospective study was conducted to compare the time to treatment using the plastic surgery supply cart versus the current "hunt and gather" methodology for each patient procedure. The protocol for treating patients with the plastics cart involved the surgeon retrieving the cart from the surgical intensive care unit and wheeling it to the patient's location. Time to treatment was calculated as the total time (hours:minutes:seconds) it took to leave the patient's room, grab the cart, and return. After each patient encounter, Central Supply was called to retrieve and restock the cart supplies, create an invoice for supplies used, and return the cart to its primary location. The

Figure 1. Plastic surgery supply cart.

Table 1. Plastic Surgery Instrument Tray Composition and Cost

Instrument	Material Number	Quantity	Price ($)
Freer septal elevator	RH750	1	23.24
Adson forceps	NL1400	1	5.12
Adson micro forceps	NL1411	1	21.45
Foerster sponge forceps	GL650	1	16.55
Surgical knife handle	SU1403-001	1	4.66
Straight's single tenaculum	RH1100	2	37.40
Automatic skin retractor	SU3145	1	50.26
Ragnell retractor	OS930	2	37.92
Senn retractor	SU3785	2	19.70
Triple prong micro hook	RH1145-012	1	106.32
Ruskin mini rongeur	AU6784-002	1	261.46
Backhaus towel forceps	SU2900	4	31.92
Halsted mosquito forceps	SU2702	6	49.26
Vital Mayo–Hegar needle holder	SU16060	1	54.19
Webster needle holder	RH2560	2	52.62
Plastic utility scissors (straight)	RH1600	1	28.62
Plastic utility scissors (curved)	RH1610	1	35.01
Operating scissors (straight)	SU1702	1	10.21
Total price			845.91

2 circulating carts were used in tandem such that 1 cart was used for treatment whereas the other cart was being stocked and repositioned. The control treatment, without the plastics cart ("hunt and gather"), required the plastic and reconstructive surgeon to self-collect all supplies and instruments needed for the particular patient case. Time to treatment was thus calculated as the total time taken to leave the patient's room, retrieve all provisions, and return to the patient's location.

Time to treatment was recorded for all consults seen by 1 plastic and reconstructive surgery resident over the course of a 6-month period during on-call duty hours at 1 hospital. All procedural consults seen at the hospital by this resident were included in the study. Procedure types encountered were documented for each patient case and summarized. All statistical analyses were performed using SPSS Version 24 (IBM, Chicago, IL). The minimum, maximum, and mean time to treatment were calculated for each study condition. Mean times were compared for treatment with and without the plastics cart using paired t tests, whereby $P < 0.01$ was deemed significant.

RESULTS

A total of 40 patients were treated during this prospective quality improvement study. A majority of the procedures were head and neck (60%), with the other 40% being hand and upper extremity procedures. Several of the head and neck procedures involved a facial injury (50%), followed by injuries of the lips (21%), eyelids (17%), and scalps (12%). Hand procedures encompassed a range of simple repairs (44%), incision and drainages (37%), and revision amputations (19%). Table 3 provides a summary of the procedure types encountered during the study period.

Average time (minutes) to treatment across all procedures with the plastics cart was 3.7 ± 1.9 versus 46.3 ± 60.0 without the plastics cart. The time to treatment range with the plastics cart was 1.0–9.5 minutes, whereas the range without the plastics cart was 5.0–180 minutes. Overall, usage of the plastics cart resulted in a significant reduction in total time to treatment of 42.5 ± 60.3 ($P < 0.0001$). Table 4 summarizes the mean time to treatment with and without the plastics cart. Further analysis by anatomic area revealed that both head and neck and hand and upper extremity procedures had a statistically significant improvement in time to treatment utilizing the plastics cart, 45.0 ± 64.6 ($P < 0.002$) and 44.4 ± 55.6 ($P < 0.004$), respectively. There was no significant difference in time to treatment with the plastics cart between anatomic areas ($P = 0.11$). Table 5 provides a breakdown of time to treatment by anatomic area with and without the plastics cart.

DISCUSSION

Results reveal that the usage of a plastic cart with specialty supplies significantly reduces the amount of time to treat patients throughout a hospital. The overall

Table 2. Plastic Surgery Cart Composition

Drawer 1: Local anesthetic supplies • 1% lidocaine with 1:100,000 epinephrine (20 ml) • 1% lidocaine (5 ml) • 0.5% bupivacaine (30 ml) • 8.4% sodium bicarbonate (50 ml) • Syringes (10/60 ml) • Hypodermic needles (18/27/30 g)	Drawer 2: Antiseptics and ointment • Alcohol swabs • Betadine bottle (237 ml) • Chlorhexidine sticks (1.5 ml) • Bacitracin ointment	Drawer 3: Sutures and blades • Nylon (4-0/5-0) • Prolene (4-0/5-0/6-0) • Polydioxanone (5-0) • Monocryl (3-0/4-0/5-0) • Vicryl (3-0/4-0) • Ethibond (3-0/4-0) • Chromic (4-0/5-0) • Fast absorbing plain gut (5-0/6-0) • Blades (11/15/21)
Drawer 4: Personal protective equipment and intraoperative supplies • Sterile gloves (6/6.5/7/7.5/8) • Procedural masks • Penrose drains (0.25/0.5 inch) • Finger tournicots (red/green/blue) • Culture swabs • Iodoform packing (0.5/1 inch) • Sterile saline (1 L)	Drawer 5: Dressings • Steri strips (0.5 inch) • Xeroform (small/large/roll) • Kerlix (2/4/6 inch) • Soft roll (2/4/6 inch) • Elastic wraps (2/4/6 inch) • Nasal splints • Fiberglass splints (3/4 inch)	Drawer 6: Other • Sterile basins • Sterile surgical towels • Trauma shears

Table 3. Summary of Patient Consult Procedures

Procedure Area and Type	No. Procedures
Hand and upper extremity	16 (40%)
Irrigation and debridement	6
Revision amputations	3
Simple laceration repairs	7
Head and neck	24 (60%)
Scalp	3
Eyelid	4
Lip	5
Nose	3
Ear	2
Cheek	7
Total	40

Table 4. Time to Treatment With and Without the Plastics Cart

Time to Treatment	With Plastics Cart (N = 40)	Without Plastics Cart (N = 40)
Shortest time to treatment (min)	1.0	5.0
Longest time to treatment (min)	9.5	180.0
Average time to treatment (mean ± SD)	3.7 ± 1.9	46.3 ± 60.0
Average time saved with cart (mean ± SD)	42.5 ± 60.3 ($P < 0.0001$; 95% CI, −61.6 to −23.5)	

Table 5. Time to Treatment by Anatomic Area With and Without the Plastics Cart

Time to Treatment	With Plastics Cart	Without Plastics Cart
Head and neck (N = 24)		
Shortest time to treatment (min)	1.3	5.0
Longest time to treatment (min)	9.5	180.0
Average time to treatment (mean ± SD)	3.3 ± 2.0	48.3 ± 64.1
Average time saved with cart (mean ± SD)	45.0 ± 64.6 ($P < 0.002$; 95% CI, −71.4 to −18.7)	
Hand and upper extremity (N = 17)		
Shortest time to treatment (min)	1.0	7.0
Longest time to treatment (min)	8.5	180.0
Average time to treatment (mean ± SD)	4.3 ± 1.8	48.7 ± 58.9
Average time saved with cart (mean ± SD)	44.4 ± 55.6 ($P < 0.004$; 95% CI, −73.5 to −15.3)	
Average time saved for head and neck versus hand and upper extremity (mean ± SD)	0.6 ± 2.0 ($P = 0.11$; 95% CI, −0.23 to 2.23)	

maximum time to treatment with the plastics cart was 9.5 minutes versus 3 hours without the plastic cart, thus illustrating large gaps in the quality of patient care without accessible resources. Analysis of procedures by anatomic area further demonstrated the benefit from utilizing the plastics cart. Head and neck and hand and upper extremity procedures displayed similar average reductions in the time to treatment. The plastics cart did not benefit procedures in 1 anatomic area more than the other. More data are required to understand the time to treatment differences among subunits in an anatomic area.

The total treatment time saved provides wide-reaching benefits for patients, physicians, and hospital staff. The availability of a plastic cart allows for more efficient patient treatment, better utilizes hospital support staff, and optimizes time available for physicians to complete other on-call tasks. Initial cost–benefit analyses reveal that a plastics cart requires no additional funding beyond the purchase of the physical cart itself. Furthermore, the cart may provide potential cost savings through both improved supply tracking and billing. Humphries et al[9] has shown that specialized instrument trays readily available to plastic surgery residents in the emergency department provided a significant cost savings to institutions. In-depth future cost analyses need to be completed on a plastic surgery cart to definitively quantify the overall financial benefit.

Instituting the development of a plastic cart has broad quality improvement implications. The literature suggests that increased time before laceration closure for plastic surgery cases is an independent risk factor for infection.[10–12] Waseem et al[10] demonstrated that lacerations that eventually became infected were open over twice as long as those that healed without infection. Cost analyses illustrate that higher wound infection rates can increase hospital costs.[11] Interestingly, the most important adverse outcome rated by patients with traumatic lacerations is not infection but rather cosmesis.[13] Thus, less efficient care can lead to both poor clinical and cosmetic outcomes and further underscores the importance of providing plastic surgeons with timely specialty resources in the acute care setting.

The overall utility of a mobile plastic surgery cart varies based on the organizational efficiency of each institution. A mobile cart is most valuable for institutions who lack availability of specialized supplies throughout the hospital. At the hospital included in this prospective study, there are 3 available portable instrument carts in the emergency department. These carts are for use only in the emergency department and do not contain all specialized sutures and dressings needed by plastic surgery residents. Each hospital floor also has their own supply room but do not carry any materials needed for bedside procedures. One could argue for stocking each floor of a hospital with specialized supplies and instruments for plastic surgery procedures; however, this is not cost efficient. Some institutions may equip on-call residents with supply bags for use in procedural consults. This still requires residents to obtain instrument trays, and it may be impractical for a supply bag to contain all the specialty supplies. A mobile cart can hold and transport all trays and supplies necessary for any plastic surgery bedside procedure. This can be easily relocated to any area of a hospital and makes specialized supplies available where surgeons need them. The top of the cart also functions as a mayo onto which supplies can be set up for procedures.

Limitations of this study include the possibility of observer effect on the participating resident. Future studies could blind residents to study inclusion, thus eliminating the impact that timing may have on residents' abilities to collect supplies in both study conditions. Selection bias was minimized in this study as all consults seen during the study period were included for analysis. Including a larger sample size would increase the power of the study and allow for more procedural diversity. The overall generalizability of this study is low due to a lack of literature on the impact of specialty surgical carts on quality improvement outcomes. The development of specialty carts has been described in only a couple of studies in the plastic surgery and otolaryngology literature.[14,15] Thus, it may be difficult for all area hospitals to institute a mobile plastic surgery cart without a standardized methodology. Although the plastics cart was easily implemented in this prospective study, widespread adoption was contingent upon creation of prescriptive development and usage guidelines.

CONCLUSIONS

Plastic surgery consults in the emergency department are complex and require specialty supplies for appropriate management and treatment. Inability to efficiently treat patients in acute care settings can lead to adverse health events and poor utilization of hospital resources. Overall findings suggest that time to treatment was significantly reduced with the introduction of a mobile plastic surgery supply cart in the emergency department. The ultimate value of the cart is widespread because it provides value to patients, physicians, and hospitals. Closing gaps in the quality of patient care lead to better both better clinical outcomes and optimized usage of hospital staff, resources, and finances.

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