level I trauma centers. The aim of this study was to describe the characteristics of patients transferred to a level I trauma center for hand and upper extremity injuries and to investigate the accuracy of the provided diagnosis at the time of referral.

**METHODS:** All adult patients transferred from outside facilities to our level I trauma center for care of hand and upper extremity injuries were prospectively included in this study. Patient and injury-related information was collected at the time of referral before patient transfer, and again following diagnostic evaluation by a hand surgeon at our institution.

**RESULTS:** Sixty-three patients were transferred to our hand surgery service from outside facilities. Most patients were referred by emergency medicine physicians (76%; n = 47), followed by midlevel emergency department providers (PA or NP) (19%; n = 12) or hand surgeons (5%; n = 3). The median distance from a referring hospital to our center was 31 miles. Twenty-three (37%) of transferred patients were closer in proximity to another level I trauma center. Six patients were transferred directly from a level I trauma center. Twenty-one (33%) of transferred patients had an inaccurate diagnosis at the time of referral. Factors associated with an inaccurate diagnosis included trauma level of the referring hospital and diagnoses of infection or dysvascularity. Seventy-five percent (n = 48) of patients underwent surgical intervention. Of these, 90% (n = 43) underwent operative treatment during their initial hospital stay and 10% (n = 5) patients underwent elective surgery at a later date. Twenty-seven percent (n = 17) of all patients underwent microsurgical procedures. Seventy-five percent (10/15) of patients who did not undergo surgery had a bedside procedure performed as definitive treatment.

**CONCLUSIONS:** Diagnosis of hand pathology at the time of patient transfer was inaccurate in 33% of patients referred to our institution for hand surgery evaluation. Twenty-five percent of patients transferred to our institution did not ultimately undergo surgical intervention. Improvement of diagnostic accuracy before patient transfer may save healthcare costs and facilitate more expeditious, definitive care for patients with hand injuries and other pathology.

**Free Fascial Flaps Versus Bilaminate Synthetic Dermal Matrix: A Cost-Effectiveness Comparison for Full-Thickness Hand Reconstruction**

**Presenter:** Travis J. Miller, MD

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**BACKGROUND:** Soft tissue injuries of the hand with exposure of bone and tendon require durable soft tissue coverage to preserve tendon gliding and hand motion. Two common means of reconstructing these defects include free fascial flaps and bilaminate synthetic dermal matrices (Integra; Integra LifeSciences, Plainsboro, N.J.). In the era of value-based care, payers, providers, and patients desire the reconstructive option with the best outcome at the lowest cost. We aim to investigate the cost-effectiveness of hand resurfacing comparing free fascial flap reconstruction versus bilaminate synthetic dermal matrices. We hypothesize that microsurgical reconstruction will be cost-effective at standard willingness to pay thresholds.

**METHODS:** A decision tree was constructed comparing free fascial flaps to Integra using the rollback method. Probabilities for successful reconstruction were based on a systematic literature review identifying outcomes in free fascial flaps and Integra for hand reconstruction. The base case included a full-thickness hand wound 40cm². Flap-based reconstruction occurred in a single hospitalization, whereas Integra reconstruction occurred in a staged fashion using negative-pressure wound therapy between initial placement and skin grafting. Total active range of motion was modeled as the common outcome variable. Costing was performed from a payer perspective using national Medicare reimbursement rates–based Current Procedural Terminology codes and Medical Severity Diagnosis Related Group codes for facility fees. The willingness to pay threshold was determined by worker’s compensation payout for hand disability. Probabilistic sensitivity analysis was conducted for range of motion outcomes and costs using 10,000 Monte Carlo simulations. Modeling was performed using 2019 US currency.

**RESULTS:** The average cost of free fascial flap reconstruction was $14,201.24 compared to $13,674.20 for Integra, yielding an incremental cost difference of $527.04. Incremental range of motion improvement was 18.0 degrees with free fascial flaps, yielding an incremental cost effectiveness ratio of $29.3 per degree of motion. Assuming willingness to pay thresholds of $557.00 per degree of motion based on current worker’s compensation disability payouts, free fascial flaps were highly cost effective. On probabilistic sensitivity analysis, free fascial flaps were dominant (ie, improved outcomes and lower cost) in 25.5% of simulations and cost-effective in 32.1% of simulations. Thus, microsurgical reconstruction was the economically sound technique in 57.5% of scenarios.

**CONCLUSIONS:** Free fascial flap reconstruction of complex hand wounds was marginally more expensive than Integra and yielded incrementally better outcomes.
Microsurgical techniques were cost-effective in the base case, and this was confirmed with robust sensitivity analysis. Patients should not be discouraged to undergo microsurgical reconstruction for concerns of cost.

Conclusions: CMS may misvalue payment and wRVU rates of hospital-based hand procedures due to inaccurate operative time estimates. By revising CMS operative times for certain procedures, associated changes in payment may improve physician compensation models, correct misvaluation-based incentives, and serve as a catalyst to improve the quality and value of elective and trauma-related hand surgery.

A Novel 3-dimensional–Printed Hand Model to Simulate Bony Fixation With Kirschner Wires Without Fluoroscopy

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Purpose: Simulation has become a mainstay in medical training. The field of 3-dimensional (3D) printing offers additional benefits to medical simulation, allowing for the development of affordable, custom anatomic models. Surgical subspecialties, like plastic surgery and orthopedics, can reap significant benefits from this technology. Specifically, developing the art of operative planning and mastering unique procedural skills are essential to the armamentarium of the plastic surgeon. One skill that is particularly difficult to master in early training is the use of Kirschner wires (K-wires) for bony fixation of the hand and wrist. Brichacek et al have used 3D printing for this specific training purpose, but their construct of silicone and iron-based bones requires fluoroscopy for evaluation of metacarpal K-wire placement, involving more than minimal risk of radiation exposure to trainees (Brichacek et al). Herein, the purpose of this project is to develop a 3D-printed hand and wrist model that serves as a training and evaluation tool for K-wire placement that is novel, cost-effective, durable, and does not require fluoroscopy.

Methods: This novel hand model utilizes 3D printing technology and silicone molding. Data obtained from a computed tomography scan of a healthy hand and wrist were used to 3D print a reusable mold for the fabrication of the silicone-based “soft tissue.” Computed tomography scan data were also used to print out the bony structures of the hand and wrist (carpal bones, metacarpals, and phalanges) from ABS Filament on a UPrint SE+ 3D printer (Stratasys; Eden Prairie, Minn.). Three-dimensional–printed bones were placed in the 3D-printed mold and sealed with silicone to recreate the surrounding soft tissue. Thin