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.

**Misvaluation of Hospital-based Upper Extremity Surgery Across Payment, Relative Value Units, and Operative Time**

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**PURPOSE:** To determine whether differences in estimated operative times between the Centers for Medicare & Medicaid Services (CMS) and the National Surgical Quality Improvement Program (NSQIP) contribute to payment and work relative value unit (wRVU) misvaluation for hospital-based hand and upper extremity procedures.

**METHODS AND METHODS:** Data on wRVUs, payments, and estimated operative times were collected from CMS for 53 procedures. Using regression analysis, we compared relationships between these variables, in addition to actual median operative times as reported in the NSQIP database, from 2011 to 2016. We then determined which procedures may be overvalued or undervalued based on operative time.

**RESULTS:** There was a wide discrepancy between CMS and NSQIP operative times ($R^2 = 0.49$), with 60% of CMS times being longer than NSQIP times. Payments were more strongly correlated with CMS operative times ($R^2 = 0.55$) than with NSQIP operative times ($R^2 = 0.24$). Similarly, wRVUs were more strongly correlated with CMS operative times ($R^2 = 0.84$) than with NSQIP operative times ($R^2 = 0.51$). In general, for trauma-related procedures, any distal radius open reduction internal fixation was considered overvalued, whereas any open reduction internal fixation proximal to the distal radius was considered undervalued in analysis of both databases. Nearly all elective tendon procedures were considered undervalued. Thirty-nine percent of trauma procedures were considered undervalued compared to 70% of elective procedures. Notable compensation differences were found between trapeziectomy versus ligament reconstruction and tendon interposition, epicondyle debridement with tendon repair versus denervation, proximal row carpectomy versus 4 corner fusion, and distal radius open versus percutaneous fixation.

**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**

**Presenter:** Michael K. Boyajian, BA

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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 al1 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 al1). 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
filaments connecting the bones were broken after the silicone set, allowing for realistic simulation of hand joint mobility. Bony structures were exchanged and replaced after use via a palmar incision.

RESULTS: To test durability of the model, 20 K-wire placements were performed. Preliminary trials demonstrated the silicone to be durable, withstanding multiple K-wire passes without breakdown. Additionally, the metacarpal bones were easily replaced for repeat use. Bones were intentionally printed with a linear infill pattern (lattice matrix) to evaluate disruption of the lattices by K-wire passes. Accuracy and proficiency of K-wire placement are assessed by direct visualization of the disrupted matrix compared to conventional assessment with fluoroscopy. Total cost of material for each hand model was $25.00. For reference, the largest bone in the hand (metacarpal) could be replaced for a material cost of $0.50.

CONCLUSIONS: Implementation of 3D printing and silicone casting can be used to produce a cost-effective and reproducible training tool for bony fixation of the hand and wrist. We are currently validating our 3D-printed K-wire placement hand and wrist model for educational utility among plastic surgery residents. Radiation exposure can also be avoided by studying the placement of K-wires through direct visualization of the altered 3D-printed matrix.

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Risk Factors Contributing to Postoperative Infection in Distal Radius Fractures

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INTRODUCTION: Distal radius fracture (DRF) is one of the most common injuries, accounting for one-sixth of all fractures1,2 with an annual incidence of >640,0003 in the United States. In previous studies, several risk factors for postoperative surgical site infection (SSI) in DRF surgery have been identified, but diabetes mellitus (DM) has not been previously demonstrated to be an independent risk factor.4 The purpose of this study was to expand on previous studies to identify risk factors contributing to SSI in patients undergoing surgical treatment of DRFs, focusing on the role of DM and glucose control.

METHODS: This was a single-institution retrospective chart review of patients with operative treatment of DRFs from 2012 to 2017. After excluding patients with incomplete data, 541 patients were included in this study. Patients were divided into 2 groups: those with postoperative SSI and those without. Potential risk factors for infection included surgery length, presence of Kirschner wires (K-wires) or external fixators (ex-fix), diagnosis of DM, uncontrolled DM defined as an HgBA1c >7, open fracture, smoking, osteoporosis, gender, and age. Variables were screened for inclusion in the final model by performing bivariate analysis for each independent variable, with infection as the dependent variable. Variables with a P value <0.10 in the initial screen were included in the final model. Multiple logistic regression was performed to control for confounding variables, using the independent variables selected in the bivariate analyses. A P value of <0.05 was considered statistically significant.

RESULTS: Twenty patients (3.7%) had SSIs, whereas 521 (96.3%) did not. Uncontrolled diabetes mellitus (odds ratio [OR], 7.83; P = 0.002), the presence of an ex-fix or K-wires (OR, 3.73; P = 0.007), and smoking (OR, 3.79; P = 0.007) were statistically significant independent predictors of SSI. Of note, DM alone (as opposed to uncontrolled DM) was not an independent risk factor.

CONCLUSION: The previously identified risk factors for SSI of smoking and the use of K-wires or ex-fix were confirmed in this study. Additionally, this study demonstrates that patients with uncontrolled DM (HgA1c >7) are at increased risk for SSI, independent of other risk factors. Notably, the presence of DM alone is not an independent risk factor, highlighting the importance of glucose control.

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