gel concentrations. Mechanical tests were carried out with an indentation test, and the deformation distance of the gel construct was used as an indicator of relative gel stiffness. A total of 5 different concentrations were used with relative stiffness including: <1, 5, 9, 18 and 25 kPa. The 3D gels were cultured as a single droplet on a 48-well suspension cell culture plate with exchange of fresh media and 100ng/mL of VEGF-A/C every 2–3 days. The gels were directly observed daily under the light microscope and recorded.

CONCLUSIONS: The 3D hydrogel served as the interstitial substrate to support LEC tube formation under different mechanical properties. Our experimental results showed a high density of tube formation in LECs cultured in ~18 kPa Col-Tgels beginning as early as 48 hours after plating. Shorter and early stages of tubule structure formation was also visible in the ~9 kPa gel. Col-Tgels with stiffness lesser than 9 kPa or greater than 18 kPa were not conducive to lymphatic tube formation. Lymphatic tube formation was similarly seen in the 18 kPa gels cultured with LEC media alone without soluble cytokines, but only after a 72–96 hour lag compared to the gels with cytokine treatment (images not shown). Our results show that the 3D environment plays an integral role in both cell-cell and cell-extracellular matrix (ECM) interactions. LECs respond not only to soluble factors associated with the ECM, but also the biomechanical cues for tubulogenesis.

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Surgical Factors Associated with Prolonged Hospitalization After Reconstructive Spinal Surgery

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PURPOSE: Posterior trunk reconstruction following oncological resection is increasingly possible as a result of advances in spinal instrumentation, reconstructive approaches, and perioperative critical care. Extensive cases often require a muscle flap or complex closure to obliterate dead space. Postsurgical wound complications and subsequent reoperations can lead to neural injury, higher hospital costs, and longer hospitalizations. We aim to identify risk factors that are associated with increased length of stay (LOS) for patients receiving flaps to close a spinal defect.

METHODS: A single institution, retrospective cohort study was performed on all patients from 2002–2014 who received a muscle flap to close a spinal defect. Medical and perioperative variables that were significantly associated with LOS (p<0.05) in univariate analysis were included in a stepwise regression model.

RESULTS: A total of 288 cases were included in this study. In terms of tumor etiology, 34.3% of the cohort had primary spinal tumors, 22.6% had metastatic spinal tumors, 28.5% underwent hardware revision or spinal fusion, and the rest had benign lesions or other rare tumors. Presence of instrumentation, pre-operative chemotherapy, wound dehiscence, CSF leak, partial/total flap loss, and medical morbidity occurrence were all independently associated with increased LOS in a combined multivariate model (p<0.02 for each of the six variables). Importantly, Kaplan-Meier analysis demonstrated that post-operative wound dehiscence increased length of stay by twelve days (median LOS 11 [95% CI 9–14] versus 23 [95% CI 14–28]).

CONCLUSIONS: Spine tumor resections often create large cavitary defects that necessitate the use of muscle flaps for closure. Patients who have received adjuvant chemotherapy, require instrumentation, or those who develop specific wound-related or medical complications are at an increased risk for prolonged hospitalization following spinal reconstruction. Thus, with knowledge of the effects of these complications, simple interventions can be employed to enhance the safety of the post-operative period and reduce the financial burden associated with unnecessarily long post-operative admissions.

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Validation of Vectra 3D Imaging for Quantitative Volumetric Measurement of Upper Extremity Lymphedema

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BACKGROUND: Secondary lymphedema of the arm is a complication of lymph node removal in cancer surgery. Limb volume measurements are considered the gold standard in evaluating outcomes in upper limb lymphedema. However, current techniques for volume measurement are limited by a lack of sensitivity to localized changes. The aim of this study was to
determine whether the Vectra 3D imaging system could feasibly achieve accurate volume measurements of the upper limb.

METHODS: A feasibility study was performed in 10 patients with lymphedema of the upper limb. Vectra 3D software was used to generate images and calculate volume of the hand, forearm, and upper arm. These measurements were compared to circumference (tape) and water displacement measurements.

RESULTS: Ten patients with lymphedema of the arm were enrolled for volume measurement. Arm volumes ranged from 1517 to 4050 cc. The Vectra 3D provided precise volume measurements (average standard deviation +/- 0.8%). Measurements of the forearm and upper arm correlated with circumference measurements ($R^2 = 0.991$) and were in good agreement, with the mean difference between measurement techniques being $2.8 \pm 2.0\%$. Three dimensional measurements of hand, forearm, and upper arm also correlated with water measurements ($R^2 = 0.994$) and had a mean difference between measurement techniques of $2.2 \pm 1.8\%$.

CONCLUSIONS: The Vectra 3D provides accurate and precise data comparable to the most commonly used technique to estimate limb volume (tape measurement) and gold-standard water volume measurement. Three dimensional imaging also offers several advantages, including time efficiency and obtaining localized measurements.

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Variation in Transfusion Practice and Associated Postoperative Complications in Abdominally-Based Autologous Breast Reconstruction Surgery

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PURPOSE: Blood transfusion is the most frequently performed procedure in US hospitals. Despite its life-saving potential when clinically indicated, evidence shows that transfusion in some cases does not provide a significant clinical benefit to patients and thus does not justify its associated costs and risks. Increasing emphasis has been placed on reducing these potentially unnecessary transfusions, demonstrated by recently published guidelines from the American Association of Blood Banks (AABB) recommending restrictive hemoglobin thresholds for transfusion ($\leq 7$ g/dL). In plastic and reconstructive surgery, free flap procedures are associated with high utilization of blood transfusion, reported in the literature to be as high as 42%. The high volume of flap-based breast reconstructions makes this procedure an ideal target for quality improvement interventions related to blood transfusion practices. In this study, we assessed variation in transfusion practice and its associated clinical outcomes in a large cohort of breast reconstruction patients to identify potential targets for quality improvement.

METHODS: After obtaining IRB approval, we extracted perioperative blood utilization data and hemoglobin transfusion triggers from two prospectively-collected anesthesia and blood management databases (Metavision and IMPACT Online) for all patients who underwent abdominally-based autologous breast reconstruction at the Johns Hopkins Hospital between 2009 and 2015. We defined hemoglobin transfusion triggers as the lowest measured hemoglobin level preceding a blood transfusion. We used ANOVA, Chi-squared, and linear regression to examine patient-level and surgeon-level variation in the use of overall blood transfusions, potentially unnecessary blood transfusions, and hemoglobin transfusion triggers.

RESULTS: Of 653 patients, 65 (10%) received perioperative blood transfusions. Risk factors for increased blood utilization were higher ASA class (OR: 2.4; $p=0.015$) and younger age (OR: 1.2 for every 5-year decrease in age; $p=0.008$), with a trend for the presence of rheumatic comorbidities (OR: 3.7; $p=0.098$). Use of perioperative blood transfusions varied by surgeon (range: 5% to 24%; $p=0.001$), suggesting the presence of variation in transfusion practices. Mean hemoglobin trigger was 6.6 g/dL (±0.83 g/dL; range 3.4–8.2 g/dL). Hemoglobin triggers varied by surgeon (range: 6 g/dL to 7.5 g/dL; $p=0.001$) and patient age ($p=0.031$), with a trend for Charlson comorbidity index ($p=0.093$). Of the 65 patients that received blood transfusions, 16 patients (25%) had potentially unnecessary transfusions (hemoglobin triggers ≥7g/dL). Potentially unnecessary utilization of blood transfusion did not vary by surgeon (range: 1% to 4%; $p=0.142$), but was higher in TRAM flap reconstructions (OR: 9; $p=0.001$) and showed a trend for higher ASA class (OR: 3; $p=0.076$). Patients who received blood transfusions experienced worse clinical outcomes in terms of postoperative infections ($p=0.006$), *Clostridium difficile* infection ($p=0.003$), sepsis ($p=0.001$), and 30-day readmission ($p=0.001$).