

**ΔDo Postoperative Prophylactic Antibiotics Decrease the Risk of Postoperative Infection After ORIF?--A Prospective Double-Blinded Randomized Placebo-Controlled Trial**

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**Purpose:** To determine if postoperative prophylactic cefazolin for 23 hours postoperatively decreases the risk of infection after fracture ORIF. The benefit of preoperative prophylactic antibiotics has been established, but the benefit of postoperative antibiotics has not been justified but has become part of the SCIP initiative.

**Methods:** After IRB approval, patients undergoing ORIF of closed fractures that had a planned postoperative stay of at least 23 hours were randomized to either receiving 23 hours of cefazolin or a placebo. Both groups received preoperative cefazolin, based on weight, and intra-operative re-dosing at 3-hour intervals until surgery completion. The primary endpoint was infection. Patients were clinically followed until bony union.

**Results:** 229 patients were randomized to either receiving postoperative cefazolin or placebo, and 146 patients completed clinical follow-up to bony union. There were 75 patients in the cefazolin group and 71 in the placebo group. Infections occurred in 4 (1 superficial and 3 deep) patients in the cefazolin group and 9 (8 superficial and 1 deep) in the placebo group ( $p=0.12$ ). Risk factors that significantly increased the rate of infection included diabetes ( $p=0.038$ ) and surgery  $>3$  hours ( $p=0.049$ ).

**Conclusions:** In a randomized double-blinded placebo-controlled prospective trial, postoperative prophylactic cefazolin did not significantly decrease the risk of postoperative infection in patients undergoing ORIF for closed limb fractures. 23 hours of postoperative antibiotics should still be considered for patients with diabetes mellitus and patients where the operative time is greater than 3 hours. This still complies with the SCIP initiative.

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**Regional and Seasonal Variations in Posttraumatic Infections After Open Fracture****H. Claude Sagi, MD<sup>1</sup>; Seth Cooper, MD<sup>1</sup>; David Donohue, MD<sup>1</sup>;****David P. Barei, MD, FRCS(C)<sup>2</sup>; Justin C. Siebler, MD<sup>3</sup>; Michael T. Archdeacon, MD<sup>4</sup>;****Marcus F. Sciadini, MD<sup>5</sup>; Michelle Romeo, MD<sup>5</sup>; Patrick F. Bergin, MD<sup>6</sup>;****Thomas F. Higgins, MD<sup>7</sup>;**<sup>1</sup>Orthopaedic Trauma Service, Florida Orthopaedic Institute, Tampa, Florida, USA;<sup>2</sup>Harborview Medical Center, University of Washington, Seattle, Washington, USA;<sup>3</sup>Creighton University, Omaha, Nebraska, USA;<sup>4</sup>University of Cincinnati, Cincinnati, Ohio, USA;<sup>5</sup>R Adams Cowley Shock Trauma Center, Department of Orthopaedics, University of Maryland School of Medicine, Baltimore, Maryland, USA;<sup>6</sup>University of Mississippi, Jackson, Mississippi, USA;<sup>7</sup>University of Utah, Salt Lake City, Utah, USA

**Purpose:** The purpose of this study was to determine if either the incidence of posttraumatic infection or the causative organism varies with season of the year or geographic region in which an open fracture occurred.

**Methods:** A representative Level I trauma center from each of the seven climatic regions of the United States (Northwest, High Plains, Midwest/Ohio Valley, New England/Mid-Atlantic, Southeast, South, and Southwest) took part in this study. A retrospective review of all skeletally mature patients sustaining an open fracture of either the upper or lower extremity between 2007 and 2012 was undertaken. Charts were analyzed to extract information regarding date of injury, Gustilo-Anderson grade of open fracture, any subsequent treatment for a posttraumatic wound infection, and the causative organisms. Patients from each region were placed into one of four groups based on the time of year that the injury occurred: spring (March-May), summer (June-August), fall (September-November), and winter (December – February).  $\chi^2$  analysis was used to assess whether any observed differences were of statistical significance.

**Results:** A total of 4149 patients were included in the analysis. The overall incidence of infection for all open fractures across the US was 8.9% (368 patients) and this did not vary significantly by season (spring 10.1%, summer 8.0%, fall 9.1%, winter 8.5%). There were, however, significant differences in overall infection rates between the climatic regions: Southeast 5.1%, Northwest 6.7% ( $P = 0.1077$ ), Southwest 8.1% ( $P = 0.0008$ ). Midwest/Ohio Valley 10.1% ( $P < 0.0001$ ), High Plains 14.6% ( $P < 0.0001$ ), and South 15.1% ( $P < 0.0001$ ). Additionally, some climatic regions showed a significant seasonal variation in the incidence of infection. The Northwest region was lowest in spring and highest in winter (5.0% vs. 10.6%,  $P = 0.0066$ ), the Southwest was lowest in summer and highest in fall (4.4% vs. 12.0%,  $P < 0.0001$ ), the High Plains region was lowest in summer and highest in fall (6.5% vs. 21.4%,  $P = 0.0033$ ), and the Southeast was lowest in fall and highest in spring (3.8% vs. 6.7%,  $P = 0.0057$ ). The Midwest/Ohio Valley and the South did not demonstrate a seasonal variation in infection rates. The most common causative organism varied not only by region, but peak season as well. The regions with the highest rate of infection in the spring (South, Southeast, and Midwest/Ohio Valley) reported methicillin-resistant *Staphylococcus*

*aureus* (MRSA) as the most common causative organism, while the regions with the highest infection rates in the fall and winter (High Plains, Southwest, and Northwest) reported methicillin-sensitive *S. aureus* (MSSA). Within the individual regions, seasonal variations existed with respect to the causative organism as well.

**Conclusion:** A significant seasonal and regional variation exists regarding both the incidence of infection as well as the causative organisms for posttraumatic wound infection following open fractures. We recommend that surgeons consult with their infectious disease colleagues to better understand these variations for their individual hospital, and adjust their treatment regimens accordingly.

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## The Effect of Acute High-Dose Vitamin D Supplementation on Fracture Union in Patients With Hypovitaminosis D: A Pilot Study

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**Purpose:** Vitamin D deficiency has been implicated as a potential etiology of nonunion. Recent studies suggest that hypovitaminosis D occurs in more than two-thirds of orthopaedic trauma patients. Despite its frequency, little information exists on the rate of nonunion after fracture in vitamin D-deficient patients. The purpose of this study is to determine the rate of nonunion in vitamin D-deficient patients with long bone fractures and to evaluate the feasibility of utilizing acute high-dose vitamin D supplementation in patients with hypovitaminosis D.

**Methods:** 102 adult patients with long bone fractures (humerus, tibia, and femur), presenting to a tertiary Level I trauma center between July 2011 and July 2013, enrolled in an IRB-approved prospective, randomized double-blind placebo-controlled trial to study the effect of acute vitamin D supplementation on fracture union. Serum vitamin D levels were measured for all 102 patients: 89 patients demonstrated vitamin D deficiency (<30 ng/mL) and were randomized to receive either a single dose of 100,000 IU of vitamin D orally within the first 2 weeks following injury (treatment group [TG], N = 44), or a placebo (control group [CG], N = 45). Demographics, fracture location and treatment, vitamin D levels, time to fracture union, and complications including vitamin D toxicity were recorded. Outcomes included healed, nonunion, fixation failure, and lost to follow-up. Nonunion was defined as the absence of bridging bone on 2/4 cortices with a stable implant at 6 months or fixation failure after 6 months. Fixation failure prior to 6 months fell into the fixation failure group. Patients without an outcome and no follow-up for 2 months or more were deemed lost to follow-up. *t*-test and cross tabulations were used to compare groups and verify adequacy of randomization. An intention-to-treat analysis was carried out to build a multivariate model.

**Results:** Hypovitaminosis D occurred in 87% of enrolled patients (89/102). There were 43 femur fractures (48.3%), 33 tibia fractures (37.1%), and 13 humerus fractures (14.6%). Time to outcomes averaged 5 months for all patients, with a range of 6 weeks to 15 months. TG and CG demonstrated similar demographic and injury characteristics ( $P > 0.05$  for all comparisons). Initial vitamin D levels were 16.3 and 16.7 ng/mL in the CG and TG, respectively ( $P = 0.831$ ). 15 randomized patients were lost to follow-up (17%; 8 in the TG, 7 in the CG) and two had failure of fixation prior to union (one per group). No patients exhibited toxicity related to high-dose vitamin D supplementation. The overall nonunion rate for the study cohort was 4.5% (N = 4) with 2.3% in the TG (N = 1) and 6.7% in the CG (N = 3). However, this difference was not statistically significant ( $P = 0.855$ ).

**Conclusion:** At a Level I trauma center in the Southeastern United States, hypovitaminosis D affected 87% of patients enrolled in this prospective randomized study. Acute high-dose vitamin D supplementation was administered to 44 patients without any adverse effects or toxicity. The nonunion rate observed in the TG was 2.3% versus 6.7% in the CG. To

discriminate the effect of vitamin D supplementation, using the observed nonunion rates, power analysis requires 830 patients (415 per group), assuming a power of 80%, significance of 5%, and a 20% attrition rate. Further study of the effect of vitamin D on acute fracture healing is warranted.

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**Statistical Significance in Trauma Research: Too Unstable to Trust?**

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**Background/Purpose:** Comparison trials are the most compelling evidence available for surgeons to make decisions. The outcomes of trials are based on hypothesis testing with an a priori statistical cutoff, which is generally accepted to be  $P < 0.05$ . This is to say that with 95% certainty one treatment is better than another and should therefore influence decision-making. However, when categorical outcomes are considered (such as nonunion, infection, etc), the statistical outcome of trials is dependent on the number of "outcome events", which are often a small percentage of the overall study population. We sought to examine how easily the statistical significance of comparison trials in fracture care would change if the number of events in one group were incrementally changed. By example, in one study, if 15 infections had occurred in one arm instead of 12, the  $P$  value would change from  $P = 0.02$  to  $P = 0.08$ , changing its statistical significance (from  $<0.05$  to  $>0.05$ ) and likely how it would influence practice.

**Methods:** We screened all fracture care studies in the *Journal of Bone and Joint Surgery* and the *Journal of Orthopaedic Trauma* over a 20-year period. Inclusion criteria were comparison trials whose outcomes were categorical and had data included to be evaluated. Data on the number of patients in each arm of the trial, the number of events in each arm, and the number lost to follow-up were tabulated. Reported outcomes were considered "significant" if the  $P$  value was  $<0.05$ . For each study outcome we confirmed the  $P$  value that was reported and then we changed the number of events in one arm enough to "flip" the significance of the study. If the outcome was significant, then the required number of event changes to raise  $P$  to above 0.05 was determined, and if the outcome was not significant, the number of event changes that would drop  $P$  to  $<0.05$  was determined. Analyses were performed using Fisher's exact test. The number of events as a percentage of the arm and the study population was calculated.

**Results:** Of 4040 studies, 198 met inclusion criteria and had 253 primary and 516 secondary outcomes. There were 118 randomized controlled trials (RCTs) and 80 retrospective studies. 230 outcomes were significant as reported and 539 were not. The median  $P$  value for significant studies was 0.003 (1.3E-09–0.049) and for nonsignificant studies was 0.6 (0.51-1). There were no differences in the findings for randomized versus nonrandomized trials so the data are presented together. The median number of patients in the studies was 95 (12-6000). The number of event changes in one arm for each outcome that would flip the significance is seen in Table 1 separated by the initial reporting of significant and nonsignificant results. The median number of events that were needed to flip the significance of the trials was only 5, which was on average 8.9% of one arm and 3.8% of the total study population. By comparison, the average lost to follow-up for the studies was 3%. Initially significant and nonsignificant studies were affected equally by event changes.

**Table 1. Events Needed to Flip the Significance of RCTs**

	Median No. of Events	Range	% of One Arm of Study	% of Study Population
Studies $P < 0.05$	4	1-340	7.8%	3.4%
Studies $P \geq 0.05$	5	1-40	9.1%	3.8%
All studies	5	1-340	8.9%	3.8%

**Conclusion:** The statistical outcomes of comparison trials that rely on noncontinuous variables such as infection, nonunion, secondary procedures, etc may not be as stable as previously thought. When evaluating trials that rely on events, small numbers of events may change the statistical significance of the trial. In evaluating 769 outcomes of 198 trials, we found that a median of only 4 events would flip studies with reported  $P$  values of  $< 0.05$  to over 0.05 and 5 events would make significant trials initially reporting  $P \geq 0.05$ . The overall percentage of the study population that would change significance was only 3.8% for all studies. Importantly, randomized trials fared no better than nonrandomized trials in this analysis. This highlights the need for readers to understand how  $P$  values relate to study findings and that using a discreet cutoff for  $P$  value in determining importance is likely not appropriate.

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**Are We Evidence-Based? The Effect of Level I Evidence on Surgical Decision-Making**

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**Background/Purpose:** With limited resources available for patient care, surgeons are being called on to make cost-conscious decisions. Comparative analysis is being utilized to determine which procedures are most effective in improving patients' outcomes and should be supported by payers. However, surgeons also rely on their past experience in making decisions, particularly as it relates to surgical indications. We sought to examine the effect of two types of randomized trials on surgeons' indications for surgery. One trial favored surgery, and the other did not. Our hypothesis was that a high-quality study favoring surgery would shift practice toward more surgery and that a trial that did not favor surgery would shift practice towards nonoperative care.

**Methods:** Two Level I studies served as the basis of this study. One was a randomized trial comparing operative and nonoperative treatment of displaced clavicle fractures and the other, operative versus accelerated rehabilitation for complete Achilles tendon ruptures. These trials were chosen as they were both multicenter studies published in the same journal over a year prior to our survey. Both studies were of high methodological quality (5 on the Jadad scale and 6 on the Guyatt scale) and both scored highly on the Detsky and CONSORT (Consolidated Standards of Reporting Trials) reporting criteria (clavicle 16 and 28, Achilles 19 and 28). Thus, both studies are objectively high quality and should have an equal effect on practice patterns. We used e-mail to survey US orthopaedic surgeons regarding their operative indications for displaced clavicle fractures and complete Achilles tendon ruptures. Each surgeon received either the clavicle or the Achilles survey, but not both, and if they did not respond, they were sent two reminders. Each survey asked how the surgeon would treat 5 sample patients (all of whom met the inclusion criteria of their respective study), whether the surgeon was aware of the Level I trial, whether they had changed their indications based on the trial, and also how their operative indications had changed over the prior 5 years. The sample patients were similar for both surveys with respect to age and activity level.

**Results:** Our data are based on 1430 clavicle and 1009 Achilles surveys that were returned. Surgeons strongly favored surgery for 4 of the 5 scenarios presented in the Achilles survey, choosing operative management in 68% to 96%. The only scenario in which nonoperative management was favored was a 65-year-old community ambulator. Additionally, only 27% of respondents operate on fewer ruptures than they did 5 years ago. Surgery was favored for 3 of the 5 clavicle scenarios (54%-79%) and 64% of surgeons operate on more clavicle fractures than 5 years ago. 71% of survey respondents were aware of the clavicle trial and 77% the Achilles trial. Table 1 demonstrates a statistically greater effect of the trial favoring surgery on practice than the trial that did not,  $P = 0.0001$  (Fisher's exact).



**Table 1. Effect of Level I Evidence on Practice ( $P = 0.0001$ )**

	Change in Practice	No Change in Practice
Clavicle trial	61%	39%
Achilles trial	43%	57%

**Conclusion:** We surveyed surgeons regarding their practices related to two equally high-quality multicenter Level I trials of surgical versus nonsurgical care, one favoring surgery and one that did not. Surgeons' practices were more influenced when the trial favors surgery than when it demonstrated no advantage to surgery. Surgeons strongly favored surgery for 4 of the 5 scenarios of Achilles rupture patients presented to them, despite the trial demonstrating no advantage of operative management (including one case of a 50-year-old orthopaedic surgeon whose activities included only golf). In conclusion, surgeons seem more willing to alter their practice to evidence-based indications based on a trial that favors surgery than one that does not.

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**Determining Preinjury Physical Function Scores in Orthopaedic Trauma Patients**

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**Background/Purpose:** Use of patient-reported outcome (PRO) measurement instruments has become a common way to determine health status, with a plentitude of validated and reliable tools available. Computer adaptive tests (CATs) have reduced patient burden and increased availability of these functional tests. Establishing pre- and postintervention functional scores is quite simple in elective surgical practice. However, in orthopaedic trauma, functional status scores are not collected before injury. Further, the patient is often unable to complete the instrument upon entry into the hospital. Due to a lack of baseline data, surgeons are unable to determine if patients have returned to previous physical function. Attempts to rectify this gap in the data focus on patient recall or proxy assessment. This has not been addressed, and is of critical importance to, the orthopaedic trauma literature on functional assessment.

**Methods:** Orthopaedic trauma patients had their first postoperative appointment approximately 2 weeks after surgery. Any patient who met the selection criteria (over 18 years of age, English-speaking, attending the appointment with a proxy) as determined through chart review and interview were asked to participate in the IRB-approved study, as were their proxies (over 18 years of age, English-speaking, had witnessed the patient at their highest level of functioning in the previous 6 months). Participants were asked to complete the PROMIS Physical Function Computer Adaptive Test (PF CAT) and a preinjury activity questionnaire (FITT). Patients were asked to respond to the physical function questions as they believed they were able to function prior to injury. Patient proxies were asked to respond to the physical function questions as they believed the patient was able to function prior to injury. Intraclass correlation as well as paired-sample *t*-tests and 95% confidence intervals (CIs) were used to analyze agreement between patient and proxy responses on both questionnaires. A correlation of 0.7 represents a large effect and shows agreement between patient and proxy responses.

**Results:** 50 patient-proxy pairs completed both questionnaires at an average of 14.33 days postoperative. Patient mean PF CAT T-score was found to be 57.92 (SD = 10.38). Proxy mean PF CAT T-score was found to be 56.59 (SD = 11.50). Paired-samples *t*-test showed that on average, patient's PF CAT score is not different from proxy's PF CAT score (mean score difference = 1.33; 95% CI = -1.28, 3.94; *P* = 0.311). Intraclass correlation between patient's score and proxy's score is 0.79. Patient mean FITT score was found to be 11.32 (SD = 5.46). Proxy mean FITT score was found to be 10.86 (SD = 5.49). Paired-samples *t*-test showed that on average, patient's FITT score is not different from proxy's FITT score (mean score difference = 0.46; 95% CI = -0.70, 1.62; *P* = 0.429). Intraclass correlation between patient's score and proxy's score is 0.84.

**Conclusion:** High agreement in PF CAT and FITT responses between patients and proxies who have been present for the patient's highest level of functioning in the 6 months prior to injury suggest we can be confident in patients' ability to report accurate preinjury

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physical functioning at their first postoperative follow-up appointment. This is critical to furthering research on orthopaedic trauma functional outcomes, as it establishes the ability to assess preinjury function from the patient. Only with this information will it be possible to determine return to functional baseline after traumatic injury.

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## Reduction of Radiation Exposure From C-Arm Fluoroscopy During Orthopaedic Trauma Operations With Introduction of Real-Time Dosimetry

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**Purpose:** The use of fluoroscopy for indirect visualization and closed reductions in orthopaedic trauma surgery has dramatically increased. Approaches to decrease radiation exposure in orthopaedic trauma surgery have been limited. The purpose of this investigation is to assess how real-time visualization of radiation exposure impacts radiation dose levels during orthopaedic trauma operations.

**Methods:** This was a 2-phase observational comparative study of radiation dosing to operating room staff before and after blinding to real-time, intraoperative information reported by a dosimetry device. In each phase, operations on 54 patients with fractures of the distal radius, ankle, tibia, femur, and acetabulum were included. Real-time dosimetry badges were worn by the primary surgeon, assistant surgeon, scrub nurse, x-ray technologist, and patient. Prior to each phase, a mandatory 1-hour course on radiation safety techniques for use of intraoperative fluoroscopy was required for each participating surgeon. Phase 1 was the blinded arm of the study, during which participants were unable to see their radiation exposure. During phase 2, the badges were enabled to project real-time radiation exposure data to a screen connected to the C-arm image viewer. The radiation exposure of each badge for the duration of each operation was collected. Dosing levels were assessed and compared between the 2 phases of the study using the Student *t*-test and analysis of variance.

**Results:** Mean surgeon (MS; average of primary and assistant surgeon) radiation exposure including all fracture types was not different between the 2 phases of the study ( $P = 0.06$ ). In phase 1, MS exposure was highest in femoral shaft fractures (mean 146.2  $\mu$ Sv, SD 163.4  $\mu$ Sv) and acetabular fractures (mean 158.1  $\mu$ Sv, SD 106.9  $\mu$ Sv). Mean non-surgeon personnel (MNSP; average of scrub nurse, x-ray technologist, and patient) exposure was highest in tibial shaft fractures (mean 19.8  $\mu$ Sv; SD 34.0  $\mu$ Sv). In these highest radiation cases, MS and MNSP exposure was significantly decreased in phase 2. MS radiation for femoral shaft fractures demonstrated a mean decrease of 107.2  $\mu$ Sv (95% confidence interval [CI] 38.2-176.2) and of 128.9  $\mu$ Sv (95% CI 69.1-188.6) for acetabular fractures. MNSP radiation exposure for tibial shaft fractures had a mean difference of 19.7  $\mu$ Sv (95% CI 11.4-27.9). Radiation dose (mGy) and duration of C-arm use (minutes) as recorded by the C-arm, and number of fluoroscopy shots were significantly decreased during acetabular fracture surgeries in the unblinded as compared to the blinded phase of the study ( $P < 0.0001$ ;  $P = 0.002$ ;  $P = 0.004$  respectively).

**Conclusion:** Surgeon radiation exposure is highest during femoral shaft fracture and acetabular fracture repair. Our data demonstrate that real-time visualization of radiation exposure during orthopaedic trauma operations can significantly decrease radiation exposure, presumably through immediate feedback and motivation of use of dose-minimizing

techniques. Further research is necessary to establish the health effects of the exposure levels and to further understand how interventions, such as real-time radiation exposure data, can mitigate exposure.

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**ΔAssessing the Oncogenic Risk to Patients From Fluoroscopy During Trauma Surgery***Michael J. Beebe, MD; Peter A. Jenkins, PhD, CHP; Erik N. Kubiak, MD;**David L. Rothberg MD, Thomas F. Higgins, MD;**University of Utah Department of Orthopaedics, Salt Lake City, Utah, USA*

**Purpose:** Recent increased concern about radiation exposure during surgery has focused primarily on exposure to the surgeon. However, the patient is more directly exposed to radiation and, in surgery about the pelvis and hip, cannot be shielded. The purpose of this study was to prospectively evaluate patients' exposure to radiation during fracture surgery of the acetabulum, pelvic ring, and femur for calculation of future cancer incidence (CI) based on previously validated models.

**Methods:** After IRB approval, 63 patients with acetabulum, pelvic ring, and femur fractures were prospectively identified for inclusion through routine trauma workup at a Level I trauma center. Patients were treated by a fellowship-trained orthopaedic trauma surgeon through standard of care treatment as dictated by their injuries. After obtaining informed consent, dosimeters were placed on the patient in locations determined for each surgery by a certified radiation health physicist. The age, sex, injury pattern, weight, height, surgeon, operation performed, operative time, total fluoroscopy time, fixation construct, and average emission energy of the x-ray tube were recorded for each patient. Study dosimeters were processed with a control dosimeter to account for radiation exposure during travel and storage. Total effective dose equivalent (TEDE), or whole body dose, and specific organ doses were determined using custom mapping through commercially available software. Lifetime CI calculations were based on validated BEIR VII models for a 30-year-old patient (National Research Council, 2006).

**Results:** 41% of patients were female and the average body mass index was  $27.2 \pm 6.6$  kg/m<sup>2</sup>. 18 patients were treated for acetabular fractures, 30 for femoral shaft or intertrochanteric femur fractures, and 15 for pelvic ring injuries. Patients with acetabular injuries received the highest TEDE at  $1.970 \pm 0.147$  mGy and  $1.650 \pm 0.062$  mGy for women and men, respectively. The lifetime CI, for any cancer type, associated with these doses is 0.021% for females and 0.011% for males. The greatest mean single-organ dose to the ovaries ( $8.100 \pm 0.617$  mGy) occurred during acetabular fracture surgery and correlated to an increased ovarian cancer risk of 0.003%. The greatest mean single-organ dose to the prostate ( $8.48 \pm 5.180$  mGy) occurred during pelvis fracture surgery and was correlated to an increased prostate cancer risk of 0.003%.

**Conclusion:** While fracture surgeries around the pelvis and femur are some of the most fluoroscopic-dependent orthopaedic procedures performed, the radiation exposure incurred presents a relatively small increased risk to the average patient of future cancer development.

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	Female		Male	
	TEDE*	Ovarian Dose*	TEDE*	Prostate Dose*
Acetabulum	1.970 ± 0.147	8.100 ± 0.617	1.650 ± 0.062	7.750 ± 0.261
Femur	0.193 ± 0.117	0.088 ± 0.070	0.282 ± 0.185	0.582 ± 0.518
Pelvic ring	0.563 ± 0.324	2.730 ± 1.570	1.120 ± 0.717	8.480 ± 5.180
	Overall CI	Ovarian CI	Overall CI	Prostate CI
Acetabulum	0.021%	0.003%	0.011%	0.003%
Femur	0.002%	<0.001%	0.002%	<0.001%
Pelvic ring	0.006%	0.001%	0.008%	0.003%

\*All values in milligray (mGy)

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## Adverse Events in Orthopaedic Surgery: Is Trauma More Risky? An Analysis of the NSQIP Data

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**Background/Purpose:** As we move toward a value-based system of health care, surgeons will increasingly be measured on perioperative complication rates and outcomes. Recently, through an analysis of the American College of Surgeons-National Surgical Quality Improvement Program (ACS-NSQIP) database, studies have demonstrated relatively low perioperative complication rates across the field of orthopaedics. In this study utilizing the NSQIP data, we wanted to better understand the perioperative complication rates and risk factors in orthopaedic trauma and compare them to general orthopaedics. While many insurers group trauma as a subspecialty within orthopaedics (ortho) in terms of adverse events, it is important to evaluate if differences exist, especially in the current payer environment.

**Methods:** Utilizing the NSQIP database, a total of 1066 ortho procedures with 146,773 patients were identified. Of these procedures, 91 were ortho trauma (upper/lower extremity and hip/pelvis fractures) involving 22,361 patients. The remaining 975 codes represented all other ortho surgeries (hand surgery, arthroplasty, etc) involving 124,412 patients. Perioperative complications were recorded and categorized as minor (MiC) (wound dehiscence, superficial surgical site infection, pneumonia, and urinary tract infection) or major (MaC) (death, deep wound infection, myocardial infarction, pulmonary embolism, sepsis, etc). Using a multivariate analysis controlling for age, medical comorbidities, American Society of Anesthesiologists (ASA) status, operative time, and baseline functional status, perioperative complications were compared between the two groups.

**Results:** The overall complication rate in the ortho trauma group was 11.4% (2554/22,361) versus 4.1% (5137/124,412) in the general ortho group,  $P = 0.001$ . Table 1 displays the minor and major complication rates and the differences between ortho trauma and general orthopaedic patients. Similar variables were identified as risk factors for complications in both the ortho trauma group and the general ortho group (age >65, history of CHF [congestive heart failure], ASA >2, and longer operative time) (see Tables 2 and Table 3). When controlling for all variables, trauma was identified as a risk factor for developing any type of complication (odds ratio [OR]: 1.69, 95% confidence interval [CI]: 1.57-1.81).

**Conclusion:** Utilizing the NSQIP data we demonstrate that orthopaedic trauma patients are almost 2 times more likely than those in the general orthopaedic population to sustain complications, despite showing similar risk factors and controlling for individual patient factors. Furthermore we demonstrate a significant difference between complication rates between the two groups (11.4% vs. 4.1%). Our data suggest that orthopaedic trauma should not be grouped with general orthopaedic surgery when benchmarking for complication rates and adverse events.



**Table 1**                      **Complications** \**P* < 0.05

	<b>Major*</b>	<b>Minor*</b>	<b>All*</b>
General	2973 (2.4%)	2733 (2.2%)	5137 (4.13%)
Trauma	1592 (7.1%)	1384 (6.2%)	2554 (11.4%)

**Table 2.** Risk Factors for Complications in Ortho Trauma \**P* < 0.05

<b>Variable</b>	<b>OR</b>	<b>95% CI</b>
Age (>65)	1.96*	1.70-2.26
History of CHF	1.63*	1.26-2.11
ASA >2	2.49*	2.13-2.89
Op time >90 min	1.15*	1.03-1.32

**Table 3.** Risk Factors for Complications in General Orthopaedics \**P* < 0.05

<b>Variable</b>	<b>OR</b>	<b>95% CI</b>
Age (>65)	1.42*	1.32-1.53
History of CHF	2.16*	1.54-3.01
ASA >2	1.71*	1.59-1.85
Op time >90 min	1.69*	1.55-1.92

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**Diagnosis of Fracture Is Associated with Lower Satisfaction with Physician Performance Among Orthopaedic Surgery Patients**

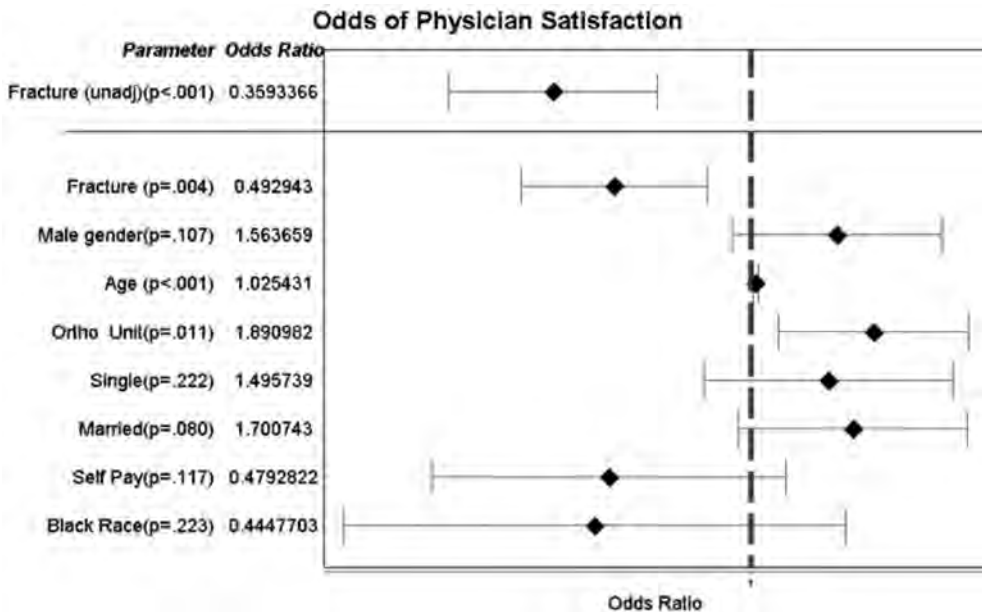
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**Purpose:** Survey-based patient experience data are becoming increasingly important as a tool to guide performance improvement as well as physician and hospital reimbursement. This study is designed to identify risk factors associated with decreased patient satisfaction with physician performance. We hypothesized orthopaedic patients with fractures would be less satisfied with their physicians.

**Methods:** From November 2010 to November 2012, Press-Ganey satisfaction surveys were sent to all patients after an inpatient stay at a suburban Level I trauma center, which is a quaternary care teaching hospital. Our primary outcome was the proportion of patients that were satisfied or very satisfied with physician performance. We compared this outcome for all orthopaedic patients with and without fractures, controlling for demographic differences in patient population as well as other factors with a logistic regression model.

**Results:** 8554 surveys were analyzed with a 30% response rate. 1084 of these patients were admitted to an orthopaedic service. Of all patients admitted to orthopaedic services, those with fractures (n = 114) were significantly less likely to be satisfied with the performance of their physicians (79% vs. 91%,  $P < 0.001$ ). A diagnosis of fracture remained a significant risk factor for decreased satisfaction even after controlling for other demographics in multivariate logistic regression (Figure 1).

PAPER ABSTRACTS



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**Conclusion:** Orthopaedic trauma patients and elective orthopaedic patients may view their care differently because of the unplanned admissions and unpleasant prognoses commonly associated with trauma. We have demonstrated that having a fracture is a strong risk factor for decreased satisfaction with physician performance even when controlling for other relevant variables. As patient satisfaction data are increasingly being used to evaluate hospital and physician performance and to determine reimbursement, it will be important to adjust for factors such as traumatic injury to avoid penalizing those that provide orthopaedic trauma services.

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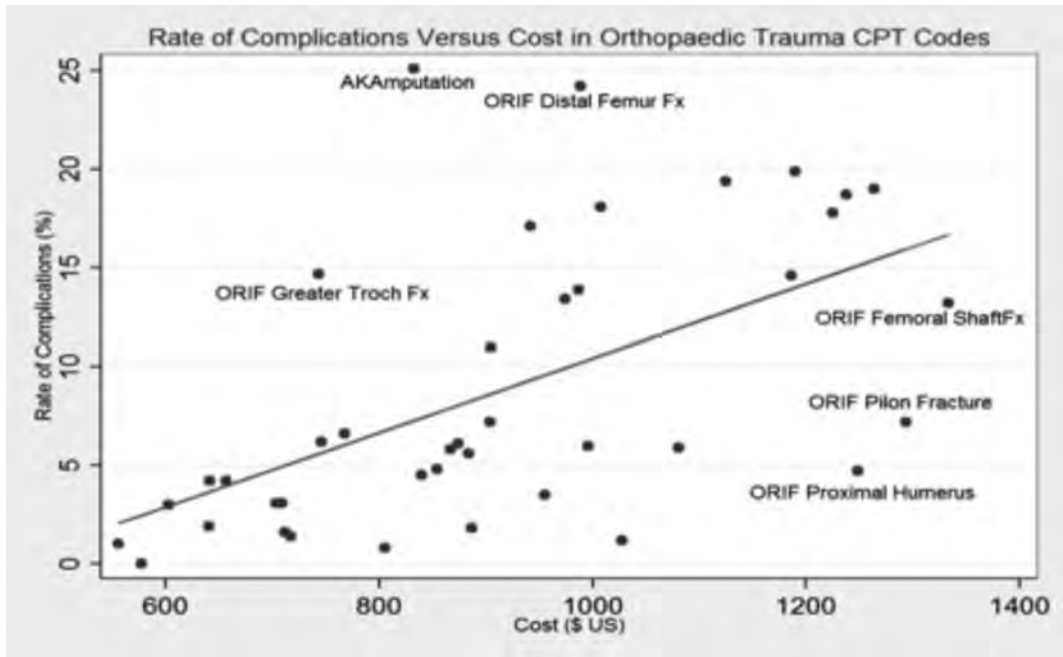
**Does Physician Reimbursement Correlate to Risk in Orthopaedic Trauma?***Rachel V. Thakore, BS; Cesar S. Molina, MD; William T. Obremskey, MD, MPH, MMHC;**Manish K. Sethi, MD**Vanderbilt University, Nashville, Tennessee, USA*

**Purpose:** With the recent dramatic changes in the American health-care landscape, orthopaedic trauma reimbursement models are likely to also shift. But in developing new reimbursement policy, how will the risk of complications for a given injury be considered? Utilizing the ACS-NSQIP (American College of Surgeons National Surgical Quality Improvement Program) database to explore the rate of adverse events for orthopaedic trauma procedures and comparing them with Medicare reimbursement data, we sought to evaluate the relationship between reimbursement and risk in order to determine if procedures with higher risk of complications received increased physician compensation.

**Methods:** 91 CPT codes representing all orthopaedic trauma surgeries, which included hip/pelvis (HP), upper extremity (UE), and lower extremity (LE) fractures (fx), were identified in the 2005-2011 ACS-NSQIP database. 50 CPT codes that had less than 100 patients were excluded. Perioperative complications including wound dehiscence, superficial surgical site infection, pneumonia, urinary tract infection, deep wound infection, myocardial infarction, deep venous thrombosis, pulmonary embolism, peripheral nerve injury, sepsis and septic shock, and death were recorded. Physician payment (Medicare Part B) amounts for each CPT code were found using the 2011 Medicare fee schedule. A linear regression was performed to determine the correlation between complication rates and payment amounts.

**Results:** 41 orthopaedic trauma CPT codes representing 18,854 patients (HP = 5029, UE = 4091, LE = 8582) were included in the analysis. Only a moderate correlation between payment amount and complication rates was found ( $r = 0.55$ ,  $P = 0.001$ ). Overall, a 1.8% increase in complication rate was associated with a payment increase of only \$100 dollars. As show in the figure, there was a minimal relationship between Medicare reimbursement and complication rate; for example, above-knee (AK) amputations demonstrate a complication rate of 25.1% and reimbursement of \$832.00 and open reduction and internal fixation (ORIF) of the distal femur demonstrates a similar payment (\$989) and high complication rate (24.2%). However, other injuries had much higher reimbursement but lower complication rates: pilon (\$1294, 7.2%) and proximal humerus fractures (\$1249, 5.7%).

**Conclusion:** Our data are the first to demonstrate that the current Medicare payment structure does not heavily weigh the risk of adverse events in providing compensation to physicians. However, in a future bundled payment plan that does not consider the risk of complications based on the injury, fractures with lower compensation but higher risks of complications will challenge the financial viability of caring for orthopaedic trauma patients.



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## Cerebral Fat Emboli and Cognitive Impairment Following Reamed Intramedullary Nailing

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**Purpose:** The purpose of this study was to determine the incidence of cerebral fat emboli in patients with traumatic femoral shaft fracture undergoing a reamed intramedullary nail (IMN) procedure. A secondary objective was to examine the association between cerebral fat emboli and cognitive deficits at 6 weeks following hospital discharge. The hypotheses were that 25% of patients would experience cerebral fat emboli and that the presence of intraoperative cerebral fat emboli would be associated with cognitive impairment in patients with femoral shaft fractures.

**Methods:** This study prospectively enrolled 24 patients, 19 to 65 years of age, admitted to a Level I trauma center for surgical treatment of a femoral shaft fracture with a reamed IMN. Participants were enrolled prior to surgery. Transcranial Doppler (TCD) sonography was used to identify intraoperative cerebral embolic particles. An intake assessment during the hospital stay collected information on demographics, health habits, and preinjury function and general health as measured by the Katz Activities of Daily Living Scale, Functional Activities Questionnaire, and Short Form-12 (SF-12). Preexisting cognitive impairment was assessed with the Informant Questionnaire of Cognitive Decline in the Elderly, short form. Clinical characteristics were abstracted from the medical record. A follow-up assessment 6 weeks after hospitalization measured cognitive impairment using a battery of standardized executive functioning tests (Trails B, Verbal Fluency Test, and Delis-Kaplan Tower Test). Depressive and posttraumatic stress disorder (PTSD) symptoms were also measured at 6-week follow-up with the Patient Health Questionnaire-9 (PHQ-9) and PTSD Checklist–Civilian Version (PCL-C), respectively. Cognitive test scores were converted to T-scores and adjusted for age, education, and gender. Cognitive impairment was defined as having 2 cognitive test scores 1.5 SD below the normative population mean or 1 test score 2 SD below the mean. Differences in demographic, psychosocial, and clinical characteristics between those with and without cognitive impairment were examined with Wilcoxon rank-sum and Fisher exact tests. Association between emboli and presence of cognitive impairment was analyzed using logistic regression analysis. The level of significance was set at  $\alpha = 0.05$ .

**Results:** 20 patients completed a 6-week follow-up assessment (83%). Of these, 9 (45%) were admitted to the ICU. One patient in the ICU displayed symptoms of delirium over 5 days. None of the patients received mechanical ventilation. Three participants (15%) had at least two blood transfusions. The average ISS was 15.1 (SD 5.7) and patients stayed an average of 4.6 days in the hospital (SD 2.5). Cerebral fat emboli occurred in 30% of participants both prereaming and postreaming. Ten participants (50%) demonstrated cerebral fat emboli at either prereaming or postreaming. The average number of prereaming and postreaming emboli was 19.3 (SD 46.7) and 7.5 (SD 15.7), respectively. A total of 7 patients (35%) demonstrated cognitive impairment, with 6 having scores below the seventh per-

centile (T-score <35) on 2 of the 3 tests. None of the patients had preexisting cognitive impairment. The mean scores on the PHQ-9 and PCL-C at 6-week follow-up were 5.2 (SD 4) and 40 (SD 17.8), respectively. 15% reported clinically significant depressive symptoms (PHQ-9  $\geq 10$ ) and 40% reported clinically significant PTSD symptoms (PCL-C  $\geq 45$ ). No statistically significant association was found between total number of cerebral fat emboli and cognitive impairment ( $P = 0.41$ ).

**Conclusion:** Cerebral emboli are found in a significant percentage of patients with a femur fracture stabilized with an IMN. A large percentage (35%) exhibit cognitive deficits at 6 weeks postoperatively. 15% reported depressive symptoms and 40% reported PTSD symptoms. Cerebral emboli were not associated with these negative outcomes.

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## Sexual Function Is Impaired Following Common Orthopaedic Trauma

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**Background/Purpose:** Difficulty with sexual activity is an infrequently identified complaint in both men and women following fracture. While some research has been directed toward sexual activity following pelvic trauma, to our knowledge no study has investigated sexual dysfunction following non-pelvic orthopaedic trauma. The purpose of this study was to investigate the incidence and longitudinal improvement of patient-reported sexual dysfunction following 5 common orthopaedic traumatic conditions.

**Methods:** 1359 orthopaedic trauma patients were identified following 5 different orthopaedic fracture conditions. The functional status of patients with 4 acute traumatic conditions—proximal humerus fractures (n = 127), distal radius fractures (n = 391), tibial plateau fractures (n = 135), and ankle fractures (n = 434)—were followed with standard functional outcome measures. In addition, patients surgically treated for long bone fracture nonunion (n = 272) were analyzed. Data were collected at 3 distinct time points after treatment: 3, 6, and 12 months posttreatment. Patient-reported sexual dysfunction scores, acquired from validated functional outcome surveys, were compared to overall functional outcome scores and demographic information for both men and women. Subgroup analysis was analyzed for age, body mass index (BMI), marital status, and mechanism of injury.

### Results:

Percentage of Postoperative Sexual Dysfunction at Standard Follow-up Intervals				
	Initial/Baseline	3 months	6 months	12 months
Proximal humerus fracture	Not recorded	30%	15%	15%
Distal radius fracture	6%	29%	17%	13%
Tibial plateau fracture	2%	43%	13%	9%
Ankle fracture	6%	11%	5%	4%
Long bone nonunion	42%	26%	17%	14%

All acute and chronic fracture conditions demonstrated significant correlation between patient-reported sexual dysfunction and their related overall DASH (Disabilities of the Arm, Shoulder and Hand) or SMFA (Short Musculoskeletal Function Assessment) functional indexes. Women reported a significantly higher degree of sexual dysfunction than men at 3-month ( $P = 0.02$ ) and 6-month follow-up ( $P = 0.01$ ). Women reported a borderline significant higher degree of dysfunction at 12 months ( $P = 0.05$ ). However, women reported equivalent or better overall functional status than men at all intervals. Subgroup analysis did not show a significant effect.

**Conclusion:** In the first 3 months following treatment of 4 acute and 1 chronic orthopaedic trauma condition, a considerable number of patients experience sexual dysfunction. By 6

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months, greater than 80% of both sexes return to baseline sexual activity levels. Women have a higher incidence of postoperative sexual dysfunction than men. While sexual dysfunction is highly correlated to functionality, functional status alone does not account for the gender disparity in postoperative sexual dysfunction. The results of this study should allow orthopaedic trauma surgeons to counsel patients regarding expectations of sexual function following traumatic orthopaedic conditions.

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**Familiar Faces: The Prevalence of Recidivism in Trauma Patients**

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**Purpose:** Treatment expenses related to trauma approach \$500 billion per year in the US. High recidivism rates of trauma patients have been reported at some trauma centers, contributing to the financial burden as well as other social costs. The purpose of this study was to determine the prevalence of trauma recidivism among patients with operative musculoskeletal trauma and to identify associated patient and injury characteristics. We hypothesized that substance abuse and mental illness would be associated with recidivism.

**Methods:** We identified 880 patients, treated surgically for high-energy fractures of the pelvis, spine, and/or femur between 2007 and 2011 at an urban Level I trauma center. Records were assessed through the end of 2012 to identify recidivist patients. Recidivism was defined as presentation to the trauma center for new, unrelated injury, and a recurrent recidivist was a repeat patient who returned for treatment another time for an additional injury.

**Results:** 164 patients returned during the period of study for new injury, a recidivism rate of 18.6%. 28.8% of recidivists were admitted on a secondary trauma visit, and 34.8% of recidivists returned due to the same mechanism of injury as their initial trauma admission. Recidivists were more likely to be between the ages of 18 and 40, with mean age 37.2 years, versus 40.1 ( $P = 0.02$ ). Recidivists were 80% male, and were more likely to be unmarried (76.2% vs. 67.2%,  $P = 0.03$ ) and unemployed (40.4% vs. 19.6%,  $P < 0.0001$ ). Recidivists were also more likely to be uninsured (33.5% vs. 17.9%,  $P < 0.0001$ ) or to have Medicaid coverage (33.5% vs. 12.2%,  $P < 0.0001$ ). Substance use among repeat patients was significantly higher than non-repeat patients, as recidivists were more likely to have ingested alcohol (47.2% vs. 32.0%,  $P = 0.0001$ ) or be intoxicated (32.4% vs. 21.2%,  $P < 0.0001$ ) when presenting to the hospital, and be tobacco (66.2% vs. 50.3,  $P < 0.001$ ) or recreational drug users (59.1% vs. 43.1%,  $P < 0.0001$ ) at baseline. Documented mental illness was also significantly higher in recidivists (28.1% vs. 20.0%,  $P = 0.03$ ).

**Conclusion:** Trauma recidivism is common among an urban trauma population, with a prevalence of 19% among patients treated surgically for fractures of the femur, pelvis, or spine. We identified several factors associated with recidivism including: age, marital status, employment status, insurance coverage, and also substance use. Recidivists were twice as likely to be uninsured. The influence of alcohol at the time of injury for repeat patients, as well as the prevalence of tobacco, alcohol, and recreational drug use for both repeat and non-repeat patients, present opportunities for intervention in the hope of diminishing the incidence of trauma, especially for patients with multiple recurrences and persistent risky behaviors. Substantial opportunity exists for injury prevention, which should not only reduce morbidity but also should decrease health-care expenses.