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Original Research

# Clinic Study Completion Rate in Orthopedic Surgery

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*Purpose:* The primary aim of this study is to determine the rate of completion of clinic-based study orders. Secondarily, we attempt to determine factors associated with study incompletion.
*Methods:* This retrospective study included 591 clinic-based studies that were ordered for 510 patients at the time of clinical evaluation at a single medical center between April 8, 2018 and August 22, 2019. Inclusion criteria were studies ordered in a hand clinic for consecutive adult patients to be completed after the visit. Exclusion criteria included pediatric patients and routine radiographs obtained prior to the visit. Invasive studies were defined as studies with a significant procedural component, such as aspirations, injections and electromyography/nerve conduction (electrodiagnostic) studies (EDS). Blood tests and imaging were considered noninvasive. Patient demographics and study completion rates were collected through chart reviews. Univariate and bivariate analyses were performed, and $P < .05$ was considered significant.
*Results:* The overall clinic-based study completion rate was 94.2%, with the highest incompletion rates seen in invasive studies (8.3%, n = 34) compared to noninvasive studies (3.3%, n = 10). Within the invasive study category, EDS had the highest rate of incompletion (11.4%) and contributed to the majority of incompletions in the invasive cohort (20/24). The median time to study completion was 7 days (interquartile range [IQR] 2–21). Race, gender, English as primary language, marriage status, insurance type, and distance from facility were similar between completed and noncompleted studies.
*Conclusion:* Study completion rates were similar between all patients regardless of race, gender, and other social economic variables. Invasive studies, particularly EDS, had higher rates of incompletion and can be barriers to patients receiving additional care.
*Type of study/level of evidence:* Therapeutic III.



In orthopedic surgery, patients must navigate multiple hurdles from initial consultation to post-surgical follow-up. Prior to surgery, patients often must complete diagnostic tests; meet with their surgeons, anesthesiologists, and primary care doctors; and schedule their surgeries, all which can be barriers to receiving the surgery necessary to improve their function. After surgery, they must continue to be followed in the clinic to monitor their progress and outcome. Thus, it is important to determine if these diagnostic tests are the rate limiting step to patients getting the care they need.

Socioeconomic factors are only a few of the many determinants of health that influence how easily patients navigate through the process from initial consultation to surgery to final follow-up. Structural and institutional bias as well as individual physician implicit bias all contribute to racial inequality within the US health care system.[1,2] A 2007 randomized survey-based study analyzing implicit bias among physicians demonstrated a significant disparity in perceptions of African American/Black and White patients.[1] Specifically, Black Americans were viewed as less cooperative and were less likely to be treated with thrombolysis for coronary artery disease symptoms compared to White American.[1] This study

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encouraged physicians of all specialties to critically examine their individual implicit bias and evaluate how social determinants of health impact patient outcomes.[3]

Racial and socioeconomic disparities are widespread within medicine and orthopedic surgery is no exception.[1–5] Race was found to be an independent factor associated with longer hospitalization post-operatively and increased medical and surgical complications after spine surgery.[5] Similarly, the total joint replacement literature has shown differences in total joint replacement use between Black and White Americans despite similar disease severity.[6] Black Americans who present with hip fractures wait much longer for radiographic diagnosis and surgical fixation compared to White Americans.[7]

To better understand how socioeconomic factors influence patient outcomes in hand surgery, we conducted a retrospective study to evaluate completion of preoperative work-up. The primary aim of this study is to define the rates of and better understand barriers to completion of studies ordered in a hand and upper extremity clinic, including imaging, laboratory studies, and nerve conduction/electrodiagnostic studies (EDS).

## Materials and Methods

### *Study design*

A retrospective study was conducted of all consecutive patients seen in hand surgery clinic at a single academic medical center between April 8, 2018 and August 22, 2019 who were ordered for a post-visit diagnostic study, including laboratory studies, imaging studies, and nerve conduction studies.

Approval was obtained from the institutional review board (Protocol 2010P002462). No funding was obtained for this study.

### *Patient selection*

Patients were identified retrospectively by reviewing all orders placed in a hand and upper extremity surgery clinic during the study period. Inclusion criteria were adult patients with studies ordered in a hand clinic to be completed after the visit. Exclusion criteria were patients seen in the clinic without studies ordered or patients with routine studies obtained prior to the visit. A total of 591 clinic-based studies were ordered for 510 patients at the time of clinical evaluation.

### *Clinic workflow*

Patients who present to an orthopedic hand clinic with osseous pathology often obtain x-rays prior to seeing a physician, usually on the same day. Some patients will then go on to need additional studies, which will be ordered at the time of the visit. During checkout, patients have the option to schedule their studies.

### *Variables*

Patient demographics and study completion rates were collected through chart reviews. Explanatory variables including patient age, sex, race, marital status, primary language, insurance status, area deprivation index (ADI), distance from hospital, and study order date were collected. Invasive studies were defined as studies with a significant procedural component, such as aspirations, injections, and EDS. Blood tests and imaging were considered noninvasive. The primary outcome variable was study completion rate, and the secondary outcome variable was time to completion.

### *Statistical methods*

Bivariate analyses were used to identify explanatory variables associated with the chosen outcome measures. Student's t test was used for comparison of parametric continuous variables, Mann-Whitney U test was used for nonparametric continuous variables, and Fisher's exact test was used for categorical variables. Continuous variables were compared across variables with multiple levels with one-way analysis of variance (ANOVA) or Kruskal–Wallis tests based on normality distributions. The standard significance criterion of $P < .05$ was used. A standard power criterion of $(1\text{-}\beta) = 0.80$ was employed for all statistical tests. A convenience sample of 16 months was used.

## Results

A total of 510 patients with 591 ordered studied were included. Patient baseline characteristics and studies ordered are presented in Tables 1 and 2. Patients had similar demographics and socioeconomic factors when analyzed by completion rate and study type.

A total of 557 studies were completed (94.2% completion rate). Studies were scheduled quickly, on average 1.8 days from the date of clinic visit (SD = 10.3) (to be completed at a later time) with 82.7% of the studies scheduled the same day as the clinic visit (to be completed at a later time). The median time to study completion was 7 days (interquartile range [IQR] 2–21).

When analyzing risk factors for incomplete studies, no patient-specific explanatory variable demonstrated statistical significance (Table 1). ADI was inversely correlated with the rate of study completion, though this was not statistically significant. There was no relationship between race, age, sex, distance from hospital, primary language, or marital status with study completion. Including all studies, men completed tests quicker (11 vs 18.4 days, $P = .001$); however, excluding EDS and dual x-ray absorptiometry, time to completion was similar between genders (7.1 vs 8.8 days, $P = .22$).

Studies that were scheduled at the time of the clinic visit were more likely to be completed compared to studies that were scheduled at a later time (93.8% vs 84.3%, $P = .002$). When comparing studies that were completed vs incomplete at the time of data collection, 84.3% of studies in the completed cohort were scheduled on the day of clinic visit compared to only 55.9% in the incomplete cohort ($P = .00005$, Table 3). In the incomplete cohort, the studies that were scheduled later tended to be invasive studies (10 of 15). Seven of those were EDS.

In addition to timing of study scheduling, invasiveness of a test was predictive of clinic orders being incomplete (8% vs 3%, $P = .01$, Table 3). Specifically, EDS studies (11.3% incomplete rate) accounted for the majority of incomplete studies (58.8%), including 83.3% of incomplete invasive studies. Furthermore, invasive tests took longer to complete (18 vs 13.5 days, $P = .03$). Of note, insurance type was correlated with invasiveness of tests ordered. Specially, patients with commercial insurance accounted for a higher percentage of the noninvasive tests ordered, and there was a higher percentage of patients with public insurance in the invasive study cohort.

## Discussion

The primary aim of this study was to determine the rate of completion of clinic-based studies in an urban academic hand and upper extremity surgery practice. The secondary aim was to determine risk factors for associated with study incompletion. We examined 510 patients and a total of 591 clinic-based studies over a

**Table 1**
Patient Demographic Characteristics by Completion

| | Completed (N = 557) | Incomplete (N = 34) | *P* Value* |
|---|---|---|---|
| Age (years), median (IQR†) | 57.9 (45.5–67.7) | 57.9 (45.1–70.5) | .9 |
| Female, n (%) | 372 (66.8%) | 25 (73.5%) | .5 |
| White, n (%) | 361 (64.8%) | 25 (73.5%) | .4 |
| Married/Partner, n (%) | 296 (53.1%) | 15 (44.1%) | .4 |
| English speaking, n (%) | 506 (90.8%) | 30 (88.2%) | .8 |
| Distance from hospital (miles), (median, IQR) | 8.6 (5–22.8) | 9.4 (4.5–32.3) | .9 |
| Area Deprivation Index, median (IQR) | 13.5 (6–24) | 12.0 (7–23) | .4 |
| Insurance type, n (%) | | | .09 |
| Medicare | 153 (27.5%) | 10 (29.4%) | |
| Medicaid | 61 (11.0%) | 5 (14.7%) | |
| Commercial | 315 (56.6%) | 18 (52.9%) | |
| Motor vehicle | 1 (0.2%) | 1 (2.9%) | |
| Workers compensation | 22 (3.9%) | 0 | |
| Self-pay | 5 (0.9%) | 0 | |

* *P* <.05 is considered significant.
† IQR, interquartile range Q1–Q3.

**Table 2**
Patient Demographic Characteristics by Study Type

| | Invasive Test (N = 289) | Noninvasive Test (N=302) | *P* Value* |
|---|---|---|---|
| Age (years), median (IQR†) | 58.0 (46.5–68.8) | 57.8 (44.7–66.8) | .3 |
| Female, n (%) | 191 (66.1%) | 206 (68.2%) | .6 |
| White, n (%) | 189 (65.3%) | 197 (65.2%) | 1.0 |
| Married/partner, n (%) | 153 (52.9%) | 156 (51.7%) | .8 |
| English speaking, n (%) | 262 (90.7%) | 274 (90.7%) | 1.0 |
| Distance from hospital (miles), median (IQR) | 8.6 (5–22.7) | 8.4 (5–26.1) | .1 |
| Area Deprivation Index, median (IQR) | 14.0 (7–26) | 13.0 (6–22) | .3 |
| Insurance type, n (%) | | | **.005*** |
| Public | 131 (45.3%) | 98 (32.4%) | |
| Commercial | 144 (49.8%) | 189 (62.6%) | |
| Other | 14 (4.8%) | 15 (5.0%) | |
| Completed, n (%) | 266 (92.0%) | 279 (92.4%) | .9 |
| Time to completion (days), mean (range) | 13 (7–28) | 4.0 (0–11.5) | **.0001*** |
| Study scheduled, n (%) | 283 (97.9%) | 298 (98.7%) | .7 |
| Study scheduled at time of visit, n (%) | 228 (78.9%) | 261 (86.4%) | **.02*** |

* *P* <.05 is considered significant.
† IQR, interquartile range Q1-Q3.

**Table 3**
Invasiveness of Study and Correlation to Study Completion

| | Completed (N = 557) | Incomplete (N = 34) | *P* Value* |
|---|---|---|---|
| Invasive vs Noninvasive Studies | | | **.03*** |
| Invasive studies, n (%) | 266 (47.8%) | 24 (70.6%) | .2 |
| EDS | 156 (28.0%) | 20 (58.8%) | |
| MRI arthrogram | 24 (4.3%) | 1 (2.9%) | |
| CT arthrogram | 6 (1.1%) | 0 | |
| Fluoroscopic arthrogram | 1 (0.2%) | 0 | |
| Image guided aspiration | 10 (1.8%) | 1 (2.9%) | |
| Image guided injection | 69 (12.4%) | 1 (2.9%) | |
| Noninvasive studies, n (%) | 284 (51.0%) | 11 (32.4%) | **.00003*** |
| Blood work | 45 (8.1%) | 0 | |
| DXA | 35 (6.3%) | 2 (5.9%) | |
| CT | 32 (5.7%) | 2 (5.9%) | |
| MRI | 165 (3.0%) | 6 (17.6%) | |
| MRI angiography | 0 | 1 (2.9%) | |
| US | 7 (1.3%) | 0 | |
| Study scheduled, n (%) | 557 (100%) | 24 (70.6%) | **<.00001*** |
| Study scheduled at time of visit, n (%) | 470 (84.3%) | 19 (55.9%) | **.00005*** |

EDS, electrodiagnostic study; MRI, magnetic resonance imaging; CT, computed tomography; DXA, dual x-ray absorptiometry; US, ultrasound.
* *P* <.05 is considered significant.

16-month period and found a study completion rate of 94.2% with the highest incompletion rates seen in invasive studies, specifically EDS. There were no patient-specific characteristics associated with study completion, suggesting the current workflow sufficiently clears inequitable barriers to study completion.

Social determinants of health are difficult to measure and study. A combination of racial, cultural, religious, and financial factors contributes to an individual's health outcome. As such, we attempted to indirectly measure social determinants of health using race, age, sex, address, primary language, marital status, ADI, and insurance type, all of which demonstrated no correlation to clinic study completion rate or time to study completion. There was a correlation between insurance type and invasive vs noninvasive study, but this correlation was not present when looking at study completion. It is difficult to interpret this data point alone without more details regarding each patient. It is possible that patients with commercial insurance were getting more noninvasive studies ordered and still getting invasive studies performed as well. It is also possible that patients with public insurance, such as Medicare, were more likely to get joint injections to defer surgery due to patient preference.

The current literature demonstrates mixed evidence on whether socioeconomic factors, such as race and insurance, contribute to study completion adherence. Milano et al[8] looked at compliance with outpatient stress testing after presentation to the emergency department and found a low completion rate of 42% and only 6% within 72 hours of ED discharge. Race and insurance were both correlated with compliance. However, Ayotte et al[9] demonstrated that race was not a contributing factor when social context was considered. Knowing someone who had completed the study or procedure, receiving social support, and being encouraged by family were critical to patients completing recommended life-saving procedures, such as cardiac catheterization. These findings are likely generalizable to invasive studies, such as EDS and arthrograms.

Interestingly, the completion rate for elective, clinic-based studies evaluated in our hand clinic was much higher than the necessary cardiac stress tests analyzed by Milano et al.[8] One contributing factor is that patients in our clinic often schedule their studies at checkout and do not need to call a provider to schedule bloodwork, imaging, injection, or EDS. This is supported by the fact that 84% of completed studies were scheduled at the time of the clinic appointment compared to only 56% of incomplete studies. Furthermore, 94% of studies scheduled at the time of clinic visit were completed compared to 84% of studies that were scheduled later. Both of these were statistically significant. Oftentimes, the necessary cardiac stress tests ordered in the emergency department are not scheduled at the time of discharge and require patients to call the clinic at a later date or rely on clinics to call patients to schedule studies, which adds additional barriers for patients. It is worth noting that noninvasive tests are more likely to be scheduled at the time of clinic visit, whereas invasive tests tend to be scheduled later. Invasive tests, such as EDS, arthrogram, and joint injections, often require the presence of a physician to perform the procedures and may require patients to coordinate with a caregiver to drive them to and from their appointment. Thus, patients may not be ready to schedule their procedural appointment at the time of the clinic visit, requiring patients to call clinic or clinic staff to call patients to schedule their study. Noninvasive studies may be more

easily scheduled if patients do not need to coordinate with family or friends and can be scheduled immediately at the end of the clinic visit. Similarly, laboratory tests do not require scheduling and patients can complete these on their way out of clinic.

Other factors that were correlated with study incompletion were the invasiveness of a test and more specifically EDS tests. Currently there is a debate on the utility of obtaining an EDS preoperatively for diagnoses, such as carpal tunnel syndrome.[10–12] While EDS tests have been shown to help with severity classification and prognosis following carpal tunnel release, there are controversial data on its utility as a diagnostic test for carpal tunnel syndrome, which largely remains a clinical diagnosis.[12] Owolabi[13] demonstrated that only half of all patients in their study cohort with clinically diagnosed carpal tunnel syndrome had an abnormal EDS. As such, less than 60% of surgeons obtain a preoperative EDS.[12] Arguments against obtaining EDS preoperatively include delays to surgery (on average 2 months), additional clinic visits, and higher costs both to the healthcare system and patient.[12] However, Zhang et al[11] demonstrated that 9% of patients receive a postoperative EDS for persistent or recurrent symptoms, and having a preoperative baseline EDS in these cases is beneficial for comparison. A noninvasive alternative to EDS is ultrasound, which has been shown to have similar sensitivity and specificity as EDS.[14] As such, for patients who are unlikely to obtain a preoperative EDS and have this be a delay to care, it may be worth considering other diagnostic modalities, such as ultrasound, if the diagnosis is unclear.

## Limitations

There are several limitations to this study including the lack of outcomes data. We were unable to include outcomes data and time to surgery as these were outside the study dates. We were also unable to determine what studies were offered and the role each provider played in facilitating study completion. Furthermore, there was a relatively low rate of incompletion despite a large cohort of 591 studies. As such, we may need a larger study and include more clinical sites to see more nuanced risk factors that contribute to study incompletion. Future studies should evaluate additional points in the workflow that are affected by social determinants of health and propose measures to address these modifiable barriers to care.

In conclusion, booking studies at the time of the clinic visit can help decrease disparities as other studies have demonstrated high rates of missed follow-ups when patients are discharged or leave clinic without a scheduled appointment.

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