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Post-operative follow-up care after acute spinal trauma: What is the reality?

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1. Introduction

Postoperative follow-up care in patient with acute spine trauma allows clinicians to monitor the progression of recovery over time. In orthopedics, follow-up for patients treated surgically with implants have historically followed "standard" patterns. An early (2–3 week) postoperative check for suture removal and wound evaluation, is often followed by three-month follow-up for assessment of bony healing; with brace removal and weight bearing progression as necessary. A six-month follow-up to ensure the integrity of the hardware, and a one-year visit to assess the fracture healing and implant integrity are commonly recommended, as these complications typically do not present prior to six months or one year. Specific to patients who have undergone instrumentation for acute traumatic spine fractures are the concerns for pseudarthrosis or adjacent level disease within one-year. In conjunction with these visits, radiographs are usually obtained at 3, 6, and 12 months to monitor the progression of healing. These follow-up time points are not evidence-based and may have been more clinically relevant when post-operative care included immobilization with a resultant potential for atrophy and loss of motion. As clinical care options shift to video and teleconferencing, a critical review of the need and timing for post-operative follow-up care is important.

The current rate and length of patient post-operative follow-up care recommendations is unknown for patients who have sustained acute spinal trauma. The rate of incomplete follow-up care in general orthopaedic trauma patients without spine trauma is reported to be between 30 and 70%, with 10–25% never showing up to any postoperative follow-up care (Aaland et al., 2012; Zelle et al., 2013; Stone et al., 2014). For elective spine procedures, the follow-up rate is reported to be as low as 40% at one year(Staartjes et al., 2019). The purpose of this study is to determine the rate and length of post-operative follow-up care for adult patients with acute spine trauma who underwent instrumented fixation. Our primary hypothesis was that the length of follow-up care for acute spinal trauma patients who underwent instrumented fixation would be significantly lower than one year with the rate of completed follow up care similarly low to the reported rates of orthopaedic trauma patients overall in the literature. Our secondary hypothesis was that certain demographic and medical characteristics are associated with the rate of follow-up.

2. Materials and methods

After Institutional Review Board approval, all adult patients with acute spine trauma treated surgically at a level I trauma center between January 2013 and December 2017 were retrospectively identified using CPT codes. All patients were a minimum of one year out from their initial surgical care at the time of the review. Each patient's electronic medical record was reviewed to confirm eligibility. Patients under the age of 18 and those who sustained non-acute or pathologic fractures were excluded.

The length of follow-up was calculated from the date of admission for the initial injury to the date of their last clinic visit at the spine clinic. Each patient's last spine clinic visit note was reviewed by one of the authors to determine if the patient was requested to return to clinic for continued care or was advised to follow-up on as-needed basis. The patient's clinical care was defined as complete if in the last clinical visit note the patient was instructed to follow-up on as-needed basis, otherwise was categorized as incomplete care. If a patient never returned for any post-operative clinical care after discharge, their length of follow-up was considered to be the duration of their hospital stay and they were categorized as incomplete care. All follow-up visits were completed at our outpatient spine clinic located on the same campus as the trauma center where the surgeries were performed.

From the electronic medical record, patient demographic and past medical data, including age, sex, primary language, home zip code, insurance type, Workers' Compensation, tobacco use, illicit drug use, marital status, and the presence of household members were collected. Using the patient's home zip code, Google maps (https://maps.google.com) was used to calculate the distance from the patient's primary residence to the spine clinic. Distances were then categorized into a local metropolitan area of less than 15 miles, a regional metropolitan area of 15–29 miles, a regional catchment of 30–100 miles, over 100 miles but within the same state as the study center, and a final region of ZIP codes located outside the state. Clinical variables were also collected,

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comprising the spinal region of injury, whether the injury occurred in isolation or in association with other non-spine injuries that required surgical intervention, whether the patient sustained a spinal cord injury, and discharge placement. The patient's spinal cord injury status at time of discharge was assessed using the American Spinal Injury Association (ASIA) Impairment Scale, and categorized based on the ability to walk as high degree of impairment (ASIA A, B or C) or low degree of impairment (ASIA D or E). Only complication requiring a return to the operating room at any time after hospital discharge for unplanned procedures related to their index injury were collected. These were subcategorized into wound-related (including surgical site infections), hardware failure or pseudarthrosis, errant screw placement, or hardware removal.

As part of the discharge protocol in the spine service, all patients were given verbal and written instructions for follow-up care at the outpatient spine clinic. All patients received a discharge folder with information including the name of their surgeon, time and dates of appointments, address and directions to the clinic, and the clinic phone number. Instructions were personally explained to the patient by the nurse prior to discharge. Patients were given a specific first follow-up care appointment prior to being discharged. No follow-up reminders about clinic appointments were made by the clinic, but all patients received one post-discharge wellness call from a discharge nurse.

2.1. Statistical analysis

Continuous variables were expressed as mean and median (SD). Categorical, ordinal, and binary variables were compared by chi^2 test. Student's *t*-test was used to compare normally distributed continuous variables. A *P* value of <0.05 was required for statistical significance. All data analysis was completed using SSPS version 26 (@IBM).

3. Results

A total of 754 patients were identified for review during the study period. There were 64 patients who did not meet inclusion criteria, 27 under the age of 18 and 37 who had sustained pathologic or non-acute traumatic fractures. Of these 690 eligible patients included in our study, 34 patients died during their initial hospital stay and 78 patients were discharged with follow-up care planned at an outside facility. There were 578 remaining patients discharged with a plan for return to follow-up care at the spine clinic who were included in our analysis. Of these, 389 were male and 189 female with an average age at admission of 51.6± 20.3 years. 547 (81%) lived within the state of the trauma center. Fracture distribution by spine region was: 266 cervical, 298 thoracolumbar and 14 sacral. Table 1.

Overall mean follow-up length was 227 days. The median follow-up length was 120± 163 days. There were 27 (4.7%) patients who had a length of follow up greater than 2 years. A total of 441 patients (76.2%) had follow up durations of under one year (defined as less than 335 days to allow for a 30-day grace period), of those 64 (14.5%) had completed their clinical care. Table 2.

At the time of the last clinic visit, 159 (27.5%) patients were categorized as having complete clinical care by their healthcare provider. Of the 419 (72.5%) patients who did not return for a clinical follow-up as requested by their healthcare provider and were classified as incomplete clinical care, 70 (12%) patients did not present for any clinical follow-up after discharge from initial admission. Fig. 1.

By bivariate analysis was identified insurance status, intravenous drug use, increased injury severity score, and presence of high degree impairment spine cord injury (ASIA A, B or C) as statistically significantly associated with lower rates of complete clinical care. A Workers' Compensation case related to the injury was associated with a statistically increased likelihood of completing follow-up. Table 3.

A total of 61 (11%) patients required a return to the operating room for treatment of post-operative complications, 34 (57%) of these complications were identified within 3 months of their initial surgery, 2 (3%) between the 3 and 6 months, 8 (14%) between 6 months and 1 year, 15 (26%). Among all patients with complications, 38 had incomplete follow-up after their subsequent surgery. Table 4.

Table 1
Patient's demographic characteristics.

Characteristic	Value
No. of patients	578
Age	51.6 ± 20.3
Sex	
Male	475 (68.8%)
Female	215 (31.2%)
Tobacco Use	
Yes	117 (20.2%)
No	461 (79.8%)
Illicit Drug Use	
Yes	38 (6.6%)
No	540 (93.4%)
English primary language	
Yes	545 (94.3%)
No	33 (5.7%)
Household members	
Yes	441 (63.9%)
No	137 (19.9%)
Insurance	
None	18 (3.1%)
Medicaid	131 (22.7%)
Medicare	184 (31.8%)
Commercial	245 (42.4%)
Multiple Injuries	
Yes	142 (24.6%)
No	436 (75.4%)
Injury severity Score (points)	19 ± 11.9
Spine Injury Distribution	
Cervical	266 (46.1%)
Thoraco-Lumbar	298 (51.5%)
Sacral	14 (2.4%)

Table 2
Patient's distance to hospital and follow-up characteristics.

Characteristic	Value
Length of Hospital Stay (days, median ± SD)	9 ± 15.3
Discharge Disposition	
Home	282 (48.8%)
Other facility	296 (51.2%)
Distance to clinic	
≤ 15 miles	188 (32.5%)
16 to 29 miles	106 (18.3%)
30 to 99 miles	196 (33.9%)
≥ 100 miles	57 (9.9%)
Outside Washington State	31 (5.4%)
Length of Follow up (days, median ± SD)	120 ± 163
Complete Follow-up Care	
Yes	159 (27.5%)
No	419 (72.5%)

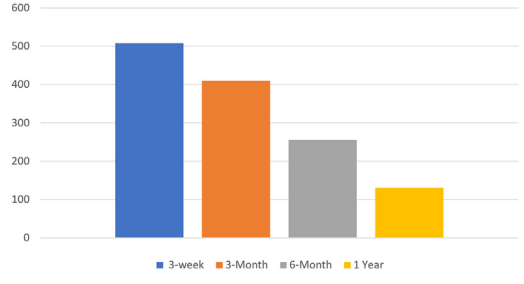

Fig. 1. Patient's compliance to standard clinic follow-up appointments.

Table 3
Bivariate analysis of predictors of post-operative follow-up care.

Predictor of Care	No.	Complete Follow Up Care	Incomplete Follow-up Care	P Value
Age (Years, Mean ± SD)	578	52.3 ± 19.2	50.5 ± 20.5	0.09
Sex				
Male	389	112	227	
Female	189	47	142	0.49
English Primary Language				
Yes	545	148	397	
No	33	11	22	0.44
Tobacco Use				
Yes	117	28	89	
No	461	131	330	0.94
Drug abuse				
Yes	38	3	35	
No	540	156	384	**0.005***
Discharge Disposition				
Home	282	86	196	
Rehab/SNF	296	73	223	0.15
Household members				
Yes	137	31	106	
No	441	128	313	0.14
Insurance Type				
None	18	5	13	
Medicaid	131	24	107	
Medicare	184	48	136	
Commercial	245	82	163	**0.018***
Workers Compensation				
Yes	35	18	17	
No	543	141	402	**0.001***
Injury Severity Score	568	16.7 ± 10.5	19.8 ± 12.2	**0.002***
Multiple Injuries				
Yes	142	37	105	
No	436	122	314	0.65
Spinal Cord Injury				
Non-Ambulatory (ASIA A-B-C)	126	24	102	
Ambulatory (ASIA D-E)	452	135	317	**0.016***

Table 4
Patient's Post-Operative re-operations distribution among clinical follow up care.

Complication Type 61/578 (11%)[a]	3-months of Follow-Up 36/410 (9%)	6-months of Follow-Up 2/255 (1%)	1-Year of Follow-Up 8/130(6%)	> 1-Year of Follow-Up 15/92(16%)
Surgical Site Infection[b]	28 (4)	1(1)	1	1
Hardware Related[b]				
Hardware Failure/ Pseudarthrosis	5 (3)	1(1)	4 (2)	9 (6)
Painful Hardware Removal	1	–	3 (2)	7 (4)

*3 month 7 completed, 6 month 2 completed, 1 year 4 completed and >1 year 10 completed.

[a] total of complication/total of patients who attend to the clinical visit.

[b] total of complications (complete clinical care).

4. Discussion

Patient compliance with recommended clinical follow-up after surgery for acute spinal trauma is a continuing challenge for providers and researchers alike. This is not unique to spine surgery, as incomplete follow-up care is a common phenomenon in orthopaedic trauma patients overall (Zelle et al., 2013). Proposed reasons for incomplete follow-up care include lack of an established patient-surgeon relationship prior to surgery, the typical demographic characteristics of the trauma population that tend to correlate with lower engagement in healthcare overall, and individual patient medical and socioeconomic factors (Malhotra et al., 2009; Agel et al., 2021). The inherent unpredictability of trauma could possibly increase the effect of patient mobility on lack of complete follow up, as it is impossible to anticipate a need for long-term medical care following trauma when planning to move, a factor that prior studies of orthopaedic follow-up compliance have proposed in light of the nearly 20% of Americans who move every year (Tejwani et al., 2010). In a study examining follow-up for all orthopedic trauma patients, Coleman et al. observed that spine-related orthopedic trauma patients had the highest no-show rate for clinic visits following emergency department orthopaedic consultations (Coleman et al., 2014). Even in patients undergoing elective spine surgeries, consistent longitudinal clinical follow-up after surgery has proved challenging (Staartjes et al., 2019). To our knowledge, this is the first dedicated investigation of follow-up care patterns in patients who have undergone surgery for acute spinal trauma.

Our study findings validated our primary hypothesis that clinical follow-up care duration of acute spinal trauma patients who underwent instrumentation is significantly below one year (median of 121 days, mean of 227 days). Indeed, only 137 (23.7%) met or surpassed one-year follow-up duration. Just 27.5% of our patients completed their recommended follow-up care. The reality of clinical care at our institution was far from that which an ideal clinical research world would demand. Therefore, this data may be used as a starting point for setting new expectations of timing of clinical care, which might then carry over into more realistic benchmarks for clinical research (Leukhardt et al., 2010; Somerson et al., 2016).

We identified several factors statistically significantly associated with completing clinical follow-up. Factors associated with lower rates of completed follow-up were Injury Severity Score, presence of high degree impairment spinal cord injury (ASIA A, B or C), history of intravenous drug use, and insurance type. Higher ISS has previously been found to be associated with decreased follow-up completion for trauma patients, and our results confirm the same for those with acute spine trauma(Malhotra et al., 2009; Somerson et al., 2016). Intravenous drug use has been previously found to correlate negatively with trauma patient follow up rates (Zelle et al., 2013), and our data supports the same for acute spine trauma patients. Increased rates of completed follow-up were seen in patients with a Workers' Compensation case, a finding not previously demonstrated in the literature. Potential reasons for increased follow-up care completion in these patients include the increased need for regular documentation of progress to obtain benefits and regular assessments of function, which may encourage patients to complete their recommended follow up care. Interestingly, in contrast to a previous study on follow up rates of patients with extremity or pelvic orthopaedic trauma from our same trauma center, we found no significant effect of distance from the center on follow up rates.

These findings show that the "standard" clinical follow-up care at 2–3 weeks, 3, 6, and 12 months demanded of our spine trauma population is very different from the reality. Our initial post-discharge follow-up rate, defined as patients who attended at least one clinic visit after initial admission, was 87.9%, similar to that found in previous studies of general trauma patients (Aaland et al., 2012). The contrast between this and the low rate of follow-up completion may indicate that the greater challenge is ensuring a patient will return from one clinic visit to the next. Consideration must be given to whether a year of clinical follow-up care is necessary. "Standard" recommendations are based on the need to assess for union at 6 months and adjacent segment disease at one-year, but this must be balanced against the realities of the time and financial costs patients incur by making trips to clinic. Careful education delivery and thoughtful discussions between providers and patients on the role of follow-up care, and specific targeted instructions on return precautions could preclude the need for these longer-term visits in the future. Our

investigation found that while most acute complications were identified within three months, there was a higher rate of patients returning at over a year with chronic complications, such as hardware failure or pseudarthrosis, implying that patients who experience longer-term complications tended to follow-up at higher rates. This suggests that patients may be relied upon to identify symptomatic longer-term complications, and will seek out follow-up care without the need for a scheduled or "routine" follow-up. Based on our findings, a distinction between the recommended one year of follow-up and the reality of follow-up completion suggested by our study must be recognized by clinicians, and patients may best be served by a discussion between patient and clinician on the need for extended follow-up care, even as we work to drive the difference between recommendations and reality to zero.

5. Limitations

There are several limitations to this investigation, both in design and broader applicability. This is a retrospective study, and we did not attempt to determine why individual patients did not keep their recommended follow-up appointments. There were no additional attempts made to contact the patients for purposes of this investigation. We were thus unable to assess whether failure to complete recommended follow-up resulted in any measurable detrimental outcome, such as a missed complication or a delayed diagnosis of sequela. The external validity of this investigation is inherently limited as it only considers data from a single public hospital, and thus the applicability of our findings to other systems is variable. Additionally, our trauma center has a large catchment area, with 15% of included patients living over 100 miles away. This is a theoretical burden to follow-up that may not be relevant to centers with smaller catchment areas, although no significant correlation between follow-up and distance was found.

6. Conclusion

Patients who sustain acute spine trauma requiring surgical instrumentation have length of follow-up care well below one year, and a high rate of clinically incomplete follow-up that is similar to those reported for general orthopaedic trauma patients. The factors associated with lower follow-up care rates were primarily injury- and patient-specific, rather than demographic. While the surgical community continues to develop systems that make follow-up easier for patients, in the meantime failure to adopt a more realistic expectation of clinical follow-up care for this population will result in the exclusion of a large majority of patients from necessary clinical study.

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Contributors

Conception and design: Agel and Zhou, Acquisition of data: Tavolaro, Jung and Dhillon. Analysis and interpretation of data: Agel, Zhou and Tavolaro. Drafting the article: Tavolaro and Vincent. Critically revising the article: Agel and Zhou. Reviewed submitted version of manuscript: Agel and Tavolaro. Approved the final version of the manuscript on behalf of all authors: Agel and Tavolaro.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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