Building an Automated Orthopedic Trauma Registry with NLP:
A Pediatric and Young Adult Emergency Department Study

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INTRODUCTION: Musculoskeletal injuries are among the most common reasons for pediatric and young adult emergency department (ED) visits and frequently require orthopedic follow-up. However, due to fragmented care pathways and reliance on incomplete manual tracking, many patients are lost to follow-up, limiting both care continuity and the ability to build institutional trauma registries. To address these challenges, we aimed to leverage natural language processing (NLP) to automate this process to lower the burden and increase the accuracy of data collection to facilitate continuous care, quality improvement and large-scale clinical research into mechanisms and risk factors for these injuries.

METHODS: Following IRB approval, we developed an NLP pipeline based on locally hosted large language model (LLM; Llama-3.1-405b-Instruct) connected to our institutional data warehouse. Beginning of each month, the pipeline surveys clinical notes to identify orthopedic consults and then extracts patient demographic, diagnosis (classified into predefined injury categories), and follow up decisions (e.g., treatment plan). That information will then be automatically exported into a REDCap database for storage and review. We have validated this pipeline against manual chart reviews conducted by orthopedic surgeons (accuracy = 98%). We then used this pipeline to evaluate the temporal trends as well as age- and sex-differences in orthopedic trauma cases at a large tertiary pediatric hospital between June 2024 and July 2025. Patients were stratified into pediatric (≤13 years), adolescent (14–19 years), and young adult (≥20 years) cohorts. Chi-squared test was used to compare the distribution of data between age and sex groups.

RESULTS: The NLP pipeline identified 3,120 consult notes representing 2,976 unique patients (61% male; mean age 10.0 ± 5.2 years). The most common diagnoses were upper extremity fractures (55%), lower extremity fractures (22%), soft tissue injuries (15%), and open wounds/lacerations (13%). Rare but critical conditions, including compartment syndrome (n=6) and amputations (n=21), were also captured (Figure 1A). Seasonal variation was evident, with consult volume peaking in summer (highest in August 2024, n=333) and lowest in winter, paralleling upper extremity fracture trends (Figure 1B). Age-stratified analysis showed fractures dominated in pediatric patients (e.g., upper extremity fractures in 1,389/1,623, 86%, p<0.001), while adolescents had proportionally more dislocations (36%, p<0.001) and postoperative complications (48%, p<0.001). Young adults represented <2% of the cohort but had disproportionately higher postoperative and implant-related complications (Figure 1C, p<0.001). Sex-based differences included a higher burden of upper extremity fractures in males (63% vs 51% in females, p=0.001), while postoperative complications were more common in females (95 vs 63 cases, p<0.001).

DISCUSSION: This study provides a systematic characterization of ED orthopedic consults across pediatric and young adult patients using an NLP-driven pipeline. The data confirm well-known seasonal spikes in fracture incidence but also highlight age- and sex-specific injury distributions that may guide prevention strategies and clinical resource allocation. The capture of rare but time-critical diagnoses (e.g., compartment syndrome, SCFE, amputations) underscores the importance of automated registries for surveillance and rapid response planning. Importantly, the high rate of postoperative and implant-related complications in adolescents and young adults emphasizes the need for structured follow-up pathways beyond the initial ED encounter.

SIGNIFICANCE: By eliminating reliance on incomplete manual lists, this NLP-driven approach establishes a scalable, real-time trauma registry with both clinical and research utility. These findings demonstrate the feasibility of automated injury surveillance, enable institution-level benchmarking, and provide a framework for improving continuity of care for pediatric and young adult musculoskeletal trauma. Beyond local implementation, this methodology can serve as a model for other health systems seeking to integrate AI-driven registries into orthopedic trauma care.
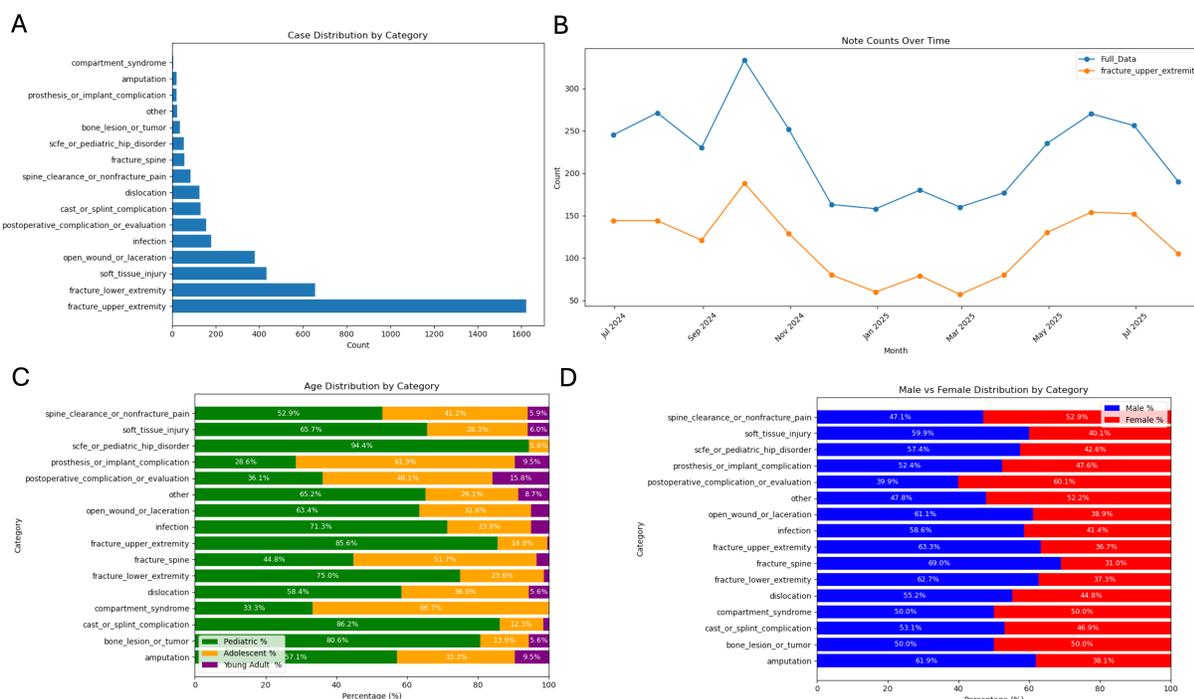

Figure 1: (A) Distribution of identified injuries. **(B)** seasonal changes in injury volumes, **(C)** age-related distribution of injuries, **(D)** sex-differences in injury distributions.