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Assessing Outpatient Follow-up Care Compliance, Complications, and Sequelae in Children Hospitalized for Isolated Traumatic Abdominal Injuries

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Abstract

Background: Currently there is limited knowledge on compliance with follow-up care in pediatric patients after abdominal trauma. The Indiana Network for Patient Care (INPC) is a large regional health information exchange with both structured clinical data (e.g., diagnosis codes) and unstructured data (e.g., provider notes). The objective of this study is to determine if regional health information exchanges can be used to evaluate whether patients receive all follow-up care recommended by providers.

Methods: We identified 61 patients treated at a Pediatric Level I Trauma Center who were admitted for isolated abdominal injuries. We analyzed medical records for two years following initial hospital discharge for injury using the INPC. The encounters were classified by the type of encounter: outpatient, emergency department, unplanned readmission, surgery, imaging studies, and inpatient admission; then further categorized into injury and non-injury related care, based on provider notes. We determined compliance with follow-up care instructions given at discharge and subsequent outpatient visits, as well as the prevalence of complications and sequelae.

Results: After reviewing patient records, we found that 78.7% of patients received all recommended follow-up care, 6.6% received partial follow-up care, and 11.5% did not receive follow-up care. We found that 4.9% of patients developed complications after abdominal trauma and 9.8% developed sequelae in the two years following their initial hospitalization.

Conclusions: Our findings suggest that health information exchanges such as the INPC are useful in evaluation of follow-up care compliance and prevalence of complications/sequelae after abdominal trauma in pediatric patients.

Level of Evidence: Level IV

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Keywords

abdominal trauma; follow-up care compliance; outpatient complications; secondary health conditions; pediatric healthcare utilization

1. INTRODUCTION

Trauma is a leading cause of morbidity and mortality in children worldwide. Abdominal trauma in particular can result in severe and missed fatal injuries in children [1, 2]. Most pediatric abdominal injuries are treated non-operatively; and therefore, patients may be less likely to receive all follow-up recommended by physicians [3, 4]. For adult populations, attendance of follow-up appointments is associated with improved patient outcomes, reduced emergency department visits, and often mitigates the likelihood of potential complications and sequelae [5–7]. Currently, little is known regarding compliance with follow-up care after pediatric injuries [8, 9].

Additionally, few studies have reported on the prevalence of outpatient complications after pediatric abdominal injury and the development of secondary health conditions in injured children [10]. A lack of post-injury follow-up data on patients, particularly those who receive care outside of the trauma center where they received initial treatment, is a major contributing factor to this gap in knowledge [11]. Regional health information exchanges that collect data on inpatient, outpatient, and emergency department visits, as well as imaging, prescription, and lab data, may help determine compliance with follow-up care after pediatric injury [12, 13]. These exchanges may be useful in identifying patients who receive follow-up care in different health systems, as well as patients who are at risk for not receiving recommended care.

The objective of this study is to determine if regional health information exchanges can be used to evaluate whether pediatric trauma patients receive all follow-up care recommended by inpatient providers at hospital discharge. We hypothesized that a mature, regional health information exchange would contain outpatient records on a majority of patients treated at the only level 1 pediatric trauma center in the state. Additionally, we examined the incidence of injury-related unplanned care events after discharge (ED visits and unplanned readmissions) as well as the prevalence of outpatient complications and sequelae that develop within two years of a patient's injury. Regional health information exchanges may provide insight into healthcare utilization after pediatric injury and which patients are at risk for ongoing health problems after discharge.

2. METHODS

2.1 Study Design and Sample

This study was approved by Indiana University's Institutional Review Board in August 2016 (approval number 1607503734). This is a retrospective cohort study that analyzes data for pediatric trauma patients admitted in 2013–2014 for isolated abdominal injuries to a Pediatric Level I Trauma Center. Riley Hospital is the only pediatric Level 1 Trauma Center in the State of Indiana, population 6.6 million. Over 1,300 pediatric trauma patients are

treated at the hospital annually. Only patients 18 years of age or younger and admitted for trauma with isolated abdominal trauma were included in the sample. Healthcare utilization data for two years after discharge from their index injury-related hospitalization was examined.

2.2 Data Source

We obtained data on patient encounters from the Regenstrief Institute's Indiana Network for Patient Care (INPC) database [12–14]. The INPC is a large regional health information exchange with more than 17 million unique patients over 30 years with both structured (e.g., ICD-9/10 codes) and unstructured clinical data (e.g., provider notes), as well as procedure data. We extracted all records contained in the INPC for patients for two years from the date of discharge for the index injury-related hospitalization. Record evaluation examined detailed clinical data describing the injury upon initial hospitalization included in the hospital trauma registry and hospital's electronic health record. Longitudinal healthcare utilization data contained within the INPC was examined for two years after a patient's initial discharge for injury and included in the review of provider notes and structured data, such as ICD-9 codes. Post-discharge encounters were assessed based on different care settings and evaluated as to whether they were potentially related to the index injury according to the provider notes linked to each encounter.

2.3 Outcome Variables

Healthcare encounters were classified into inpatient, outpatient, emergency department, and radiologic care. Encounters were categorized as related to the index injury, or unrelated care using a combination of manual note review and diagnosis codes. We distinguished injury-related and non-injury-related healthcare encounters. For example, asthma-related ED visits were coded distinct from injury-related visits, such as those for pain or suspected infection due to injury.

We determined patient compliance based on both the initial discharge instructions given to families regarding follow-up appointments with specific providers and time intervals, as well as instructions given to families during follow-up visits. Patients who received all recommended follow-up care were coded as "All Recommended Follow-up". Cases where patients returned for their first follow-up appointment, but did not return for a recommended second visit prior to medical clearance, or who only saw one specialist when two or more were recommended, were considered to have received "Partial Follow-up". Cases where patients had non-injury-related care included in the health information exchange, but no injury-related follow-up care were coded as "No Follow-up". Patients with no follow-up data were coded as "Unknown Follow-up".

We also tracked complication and sequela outcomes (both identified and suspected) based on diagnosis codes, primary patient complaint, and provider notes. In cases where patients were seeing an outpatient physician primarily for non-injury-related care (e.g., asthma medication refills), however, mentioned complaints due to their injury (e.g., ongoing abdominal pain) were coded as "non-injury-related care" but included as injury-related outcomes, such as possible complication or sequela. The patient complaint was coded as a

“complication” if found to be a short-term adverse event or outcome (e.g. infection, ED visit for injury-related pain prior to first follow-up visit); whereas it was coded as “sequela” if noted by the records to be long-term or an ongoing event (e.g., ongoing pain, onset of behavioral and learning difficulties in school following injury).

2.4 Analysis

Frequencies and percentages were calculated for categorical variables and means, standard deviations, and ranges were reported for continuous variables. We examined associations between demographic and clinical variables with compliance, utilization, and complication/sequelae outcomes using Fisher’s exact tests and Student’s t test. Alpha was set at 0.05 and all tests were two-tailed.

3. RESULTS

We identified 61 pediatric patients admitted for abdominal injuries. All patients had at least one encounter included in the health information exchange, however, two patients had no encounters following hospital discharge. The cohort had a mean age of 10 (± 4.6) years, was nearly 70% male, and 66% white. Over 20% of patients were in the Intensive Care Unit (ICU) for at least one day, 6.6% were on the ventilator for at least one day, and the average length of stay was 3.9 (± 3.8) days. Nearly 10% of patients had penetrating injuries and 75% of patients had an ISS of 14 or less. (Table 1)

We found 69 injury-related care encounters and 42 non-injury related care encounters in the two year period following discharge. All patients had at least one encounter included in the health information exchange, however, two patients had no encounters following hospital discharge. After review of patient records we determined that 48 patients received all recommended follow-up care, 4 patients received partial recommended follow-up care, 7 patients did not receive follow-up care, and 2 patients had no encounters in the exchange after discharge. (Table 2)

We found that 3 patients developed complications after abdominal trauma and 6 developed sequelae after abdominal trauma. Pain and vomiting were the most common complications. Ongoing pain and psychosocial issues, such as PTSD, behavioral issues, and poor school performance were the most common sequelae, either confirmed or suspected. We were unable to determine compliance and development of complications/sequelae in 4 patients due to lack of information available in the INPC. (Table 3)

Age, gender, race, ICU admission, ventilator, ISS, and injury mechanism are reported for patients experiencing the outcomes we examined (injury-related ED visits, compliance, complication, or sequelae). Patients not receiving all recommended follow-up, experiencing complications, and developing sequela tended to have ISS below 10. Patients with ISS below 10 were also most commonly those who visited the ED. (Table 4)

4. DISCUSSION

Overall, our results indicate that regional health information exchanges are useful in examining compliance, healthcare utilization, and health outcomes longitudinally in pediatric trauma patients with abdominal injuries. Although our cohort was small, over 96% of patients had encounters in the health information exchange. Additionally, our study demonstrates that unstructured clinical data is crucial to understanding the nature of a patient encounter, particularly when assessing the development of secondary health conditions, which may only be discussed with outpatient providers during routine visits.

We focused on patients with injury to solid abdominal organs (liver, spleen, kidneys) in this study. Abdominal injuries are commonly seen in pediatric patients [15]. We showed that 65.6% of the injury-related care were outpatient visits, with a low rate of readmission or ED visits. This may be explained by previous studies showing pediatric solid organ injuries have shorter hospital stays, indicating less acuity [16]. This may also reflect the non-operative treatment approach, which is common in pediatric abdominal trauma patients [17, 18]. Studies indicate a high success rate in treating patients non-operatively, which may be due to physiology rather than reliance on radiological studies [17, 19]. Our findings found that 78.7% patients received all recommended follow-up care, which again may be due to a lower burden of returning for multiple follow-up care appointments after non-operative treatment. However, 18.1% received no follow-up or partial follow-up care. This may be due to a variety of reasons such as patients feeling healthy and not wanting to return for a follow-up visits; parents having difficulty accessing follow-up care because of proximity to the trauma center, transportation, or childcare; patients seeking care at facilities that do not contribute data to the INPC; or other unknown reasons. Future studies should prospectively examine reasons for not obtaining follow-up care in children, who primarily rely on parents or guardians to ensure their medical needs are met.

In regards to complications, previous studies have noted that abdominal organ imaging studies do not always correlate with the integrity of the organ and may be of limited use to clinicians in selecting treatment options [20–22]. Thus, evidence suggests that experience caring for children is vital to successful management of abdominal injury, as pediatric surgeons and pediatric trauma centers treat fewer operative complications than adult trauma centers [18, 19, 23]. As a result, treating non-operatively may lead to better outcomes and eliminate complications due to surgery. Only 3 patients needed surgery related to their injury following hospital discharge. One was a delayed hernia repair and two were potentially missed urological injuries. However, outpatient complications in our cohort were rare and consisted of patients needing wound care, hematuria, developing infections, and returning to the ED for pain and vomiting. This is similar to other studies which have found complications most commonly occur with Grade 3 or greater organ injuries that are in conjunction with fever, abnormal function tests, pain, or any feeding intolerance [17]. Our results demonstrated that complications after discharge were seen in only 4.9% of patients, indicating it is a relatively rare outcome in patients hospitalized for pediatric abdominal trauma.

We found that 9.8% of our cohort had either a confirmed or suspected sequela in the two years following their injury. These were most commonly ongoing pain and psychosocial issues such as PTSD or new onset behavioral issues early in recovery may benefit some patients likely to develop psychological conditions later on. This is evident in that more initiatives by the American College of Surgeons are requiring behavioral health screenings such as alcohol use and PTSD in both adult and pediatric trauma centers [24].

4.1 Limitations

The health information exchange is not complete for the entire state, specifically in regards to outpatient provider notes that are scanned in using older systems for patients that live in rural areas of the state. In addition, some notes are difficult to determine with certainty whether there is a true complication or sequela, or if it is just suspected. Prospective studies with patient families which collect more detailed utilization and outcome data in children that can then be compared to data from the health information exchange are necessary. This data is particularly needed for patients who live further from the trauma center, which may both have difficulty obtaining follow-up care and are less likely to see providers that contribute data to the health information exchange. However, the Indiana Health Information Exchange is the largest interorganizational clinical data repository in the nation and includes approximately 50,000 providers within Indiana and neighboring states [25]. Additionally, due to the small cohort size and rare outcomes, our study may have been underpowered to detect any associations between patient characteristics and poor outcomes such as outpatient complications. Because isolated abdominal trauma is not the most common type of injury seen in pediatric trauma centers, we will examine our findings in conjunction with other trauma types such as orthopedic, head, and polytrauma injuries in future studies.

4.2 Conclusions

Regional health information exchanges are useful for determining longitudinal healthcare utilization outcomes after pediatric abdominal trauma. The quality of the exchange's unstructured data and availability of provider notes is critical in determining patient outcomes. Furthermore, the completeness of data varies geographically, and not all patients may have data captured by these systems. Despite these limitations, regional health information exchanges offer access to data that allows researchers and clinicians to assess follow-up care compliance and adverse outcomes in populations that may be less likely to receive care at the trauma center which they are admitted. This makes health information exchanges a potentially rich data source for following long-term outcomes after hospitalization for injury.

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Table 1.

Cohort Characteristics, n = 61

Age, years	
Mean \pm Std. Dev.	10.02 \pm 4.6
Range	0 to 17
Gender, n (%)	
Male	42 (68.9)
Female	19 (31.1)
Race, n (%)	
White	40 (65.6)
Non-White	21 (34.4)
ICU, n (%)	13 (21.3)
Ventilator, n (%)	4 (6.6)
Length of Stay, days	
Mean \pm Std. Dev.	3.87 \pm 3.8
Range	1 to 21
Injury Mechanism, n (%)	
Blunt	55 (90.2)
Penetrating	6 (9.8)
ISS, n (%)	
Less than 10	32 (52.4)
10 to 15	14 (22.9)
Greater than 15	15 (24.5)

Table 2.

Health Service Utilization Two Years after Hospital Discharge for Traumatic Abdominal Injury, number of patients (%)

n = 61	
Injury-Related Care	
Any Injury-Related Care	27 (44.3%)
Outpatient Visit	40 (65.6)
ED Visit	5 (8.2)
Unplanned Readmission	1 (1.6)
Surgery	3 (4.9)
Imaging Studies	20 (32.8)
Non Injury-Related Care	
Any Non Injury-Related Care	27 (44.3%)
Outpatient Visit	16 (26.2)
ED Visit	10 (16.4)
Inpatient Admission	1 (1.6)
Imaging Studies	15 (24.5)
No Encounters after Discharge	2 (3.2)

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Table 3.

Follow-up Care Compliance and Prevalence of Complications and Sequela after Pediatric Abdominal Trauma, n (%)

Recommended Follow-up	
No Recommended Follow-up Care	7 (11.5)
Partial Recommended Follow-up Care	4 (6.6)
All Recommended Follow-Up Care	48 (78.7)
Unknown	2 (3.3)
Complications	3 (4.9)
Sequelae	6 (9.8)

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Table 4.

Cohort Characteristics by Injury Care, Compliance, and Outcomes, n (%)

	Injury-Related Follow-Up Care			Compliance		Outcomes	
	ED Visit	All F/U	No F/U	Complication*	Sequela*		
Age, mean (years)	8.6	9.9	10.7	7.7	9		
Gender							
Male	4 (80.0%)	16 (30.8%)	5 (71.4%)	3 (100%)	4 (66.7%)		
Female	1 (20.0%)	36 (69.2%)	2 (28.6%)	0 (0.0%)	2 (33.3%)		
Race							
White	4 (80.0%)	35 (67.3%)	4 (57.1%)	3 (100%)	4 (66.7%)		
Non-White	1 (20.0%)	17 (36.7%)	3 (42.9%)	0 (0.0%)	2 (33.3%)		
ICU	2 (40.0%)	13 (25.0%)	0 (0.0%)	1 (33.3%)	3 (50.0%)		
Ventilator	1 (20.0%)	4 (7.7%)	0 (0.0%)	1 (33.3%)	2 (33.3%)		
Hospital Length of Stay, mean (days)	4.0	3.9	4.3	3.7	6.0		
Injury Mechanism							
Blunt	4 (80.0%)	47 (90.4%)	6 (85.7%)	2 (66.7%)	5 (83.3%)		
Penetrating	1 (20.0%)	5 (9.6%)	1 (14.3%)	1 (33.3%)	1 (16.7%)		
ISS							
Less than 10	3 (60.0%)	27 (51.9%)	4 (57.1%)	2 (66.7%)	4 (66.7%)		
10 to 15	0 (0.0%)	12 (23.1%)	1 (14.3%)	0 (0.0%)	1 (16.7%)		
Greater than 15	2 (40.0%)	13 (25.0%)	2 (28.6%)	1 (33.3%)	1 (16.7%)		

* Includes yes, possible, and/or suspected. ED = Emergency Department; F/U = Follow-up visit; ISS = Injury Severity Score