Diagnosis of Depression in Adolescents Following Traumatic Fracture: A Retrospective Analysis

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ABSTRACT

Objective: To assess how frequently adolescents are clinically diagnosed with depression following hospitalization for traumatic fracture, with the assumption that a retrospective approach would yield lower rates of depression compared to those reported previously in prospective studies. We hypothesized that depression would be less common among adolescents whose injuries were primarily limited to fractures of the appendicular skeleton, vertebral column, and/or thoracic cage compared to those sustaining concomitant spinal cord and/or brain injuries and those suffering from facial/skull fractures.

Method: A patient population of 1,121 adolescents, aged 12 to 19 years, who were hospitalized overnight at the University of Virginia (UVA) Health System, Charlottesville, for fractures between 2000 and 2009, was generated using the health system's Clinical Data Repository. The number of these adolescents who received a new diagnosis of depression (per *ICD-9* codes) at the UVA Health System within the first year following their injury was determined.

Results: By the end of the first year, 37 of 913 adolescents (4.1%) who had at least 1 follow-up visit after their fracture were diagnosed with depression. When patients with a concomitant spinal cord injury and those with a facial/skull fracture with or without an associated brain injury were excluded, this percentage dropped to 3.2% and 1.1%, respectively.

Conclusions: The results support our initial hypothesis that the percentage of adolescents diagnosed with depression following a traumatic fracture determined retrospectively would be lower than the percentages previously reported in related prospective studies. This finding adds to the growing concern that depression in youth is underdiagnosed, even among youth who have contact with health care providers. When compared to our own retrospectively determined data, the much higher rates of depression reported in several prospective studies indicate that more proactive, routine implementation of depression screening tools in the postinjury period is likely to improve identification of at-risk youth.

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According to the World Health Organization, major depressive disorder is the leading cause of disability among Americans aged 15 to 44 years.[1] Lower educational attainment, substance abuse, and an increased risk of suicide are just a few of the numerous and well-documented adverse consequences of depression.[2–6] An estimated 11% of adolescents have a depressive disorder by age 18 years,[7] and depression in youth often recurs, persists into adulthood, and is associated with more severe illness in adult life.[8] It is therefore critical to identify populations of youth who are at an increased risk for depression in order to facilitate prevention, early diagnosis, and treatment.

Several studies suggest that children and adolescents who experience a traumatic, physical injury may be at an increased risk for depression and other psychiatric disorders.[9–17] Reported rates of postinjury depression are highly variable, ranging from 7% to 41% in children and adolescents following different types of traumatic physical injury.[9,12,14–16] These rates appear alarmingly high when compared to the yearly prevalence of depression in the general population of children and adolescents—estimated to be 4.3% in 9 to 17 year olds and 9% in 12 to 17 year olds[18,19]— and are of particular concern in light of the fact that physical injury has been identified as the leading cause of death and disability in children and youth aged 1 to 19 years.[20] Although fractures are the most common type of serious physical injury in youth,[21] only a handful of published studies have focused on the psychiatric consequences of traumatic fracture in this population,[22–25] and no studies to date have looked specifically at postfracture depression in youth.

To our knowledge, this study is the first to retrospectively assess the frequency with which adolescents are clinically diagnosed with depression following hospitalization for traumatic fractures. We anticipated that our retrospective approach would yield lower rates of depression diagnoses compared to those previously reported in prospective studies and hypothesized that depression would probably be less common among adolescents whose injuries were primarily limited to fractures of the appendicular skeleton, vertebral column, and/or thoracic cage compared to those sustaining concomitant spinal cord and/or brain injuries and those suffering from facial/skull fractures.

METHOD

We performed a retrospective analysis using the Clinical Data Repository (CDR) of the University of Virginia (UVA) Health System, Charlottesville, to determine the percentage of adolescents aged 12 to 19 years diagnosed with clinical depression after a traumatic fracture. The CDR is an enterprise-wide data warehouse located and managed by the Division of Clinical Informatics in the Department of Health Evaluation Sciences of the UVA School of Medicine, Charlottesville.[26,27] The CDR contains over 10 years of data from patients seen at the UVA Health System, providing researchers and clinicians with direct access to detailed, flexible, and rapid retrospective views of clinical, administrative, and financial patient data. These data include patient demographics, inpatient and outpatient visit details, diagnoses, procedures, laboratory results, inpatient medications,

Clinical Points

- Depression is underdiagnosed in the adolescent population.
- Hospitalizations and follow-up visits are important opportunities to evaluate young adults for depression.
- A more proactive approach to depression screening is needed to identify members of this population who are at risk.

financial transactions, attending physicians, payers, costs, charges, and reimbursement.

The CDR supports Health Insurance Portability and Accountability Act–compliant data deidentification for research and educational purposes. The CDR can be accessed directly through a custom-developed Web-based interface that allows flexible query creation and a wide selection of canned and custom reports. The CDR extracts and links data from several UVA clinical and administrative computer systems and is enriched with clinical details from additional internal and external sources, including the Virginia Department of Health death certificate data. All data were deidentified and aggregated. No information accessed or reported could be used to identify any patient individually. In consultation with members of the UVA Institutional Review Board, our study was determined to meet criteria for nonhuman subjects research and was therefore exempt from formal review.

We began our database search by generating a population of adolescents aged 12 to 19 years who experienced traumatic fractures from the beginning of 2000 to the end of 2009. Fractures of the skull and face, hip, ribs, sternum, vertebral column, and upper and lower limbs were among those included (*ICD-9* codes 800–829). In order to exclude very minor fractures that would be unlikely to cause significant trauma, only adolescents whose fracture resulted in inpatient hospitalization with a length of stay > 1 day were included. To avoid duplicating patients in the parent population who may have been admitted for the same fracture and/or additional fractures resulting from separate incidents of trauma occurring within the 10-year study period, only the first fracture admission for each patient was considered. We were unable to consistently differentiate between patients who experienced multiple fractures versus a single fracture, which was a limitation of our study. Subpopulations of patients were derived by excluding those who experienced a spinal cord injury (*ICD-9* code 806) and/or facial or skull fracture with or without resultant brain injury (*ICD-9* codes 800–804).

Further, we identified and excluded patients in our fracture populations who had a depressive diagnosis appearing in their chart at the time of their hospital admission. It was not possible to determine which of these diagnoses were past, recent, or current using the deidentified CDR data. A patient with a diagnosis of depression, whether past or current, appearing in his or her chart on admission would be counted in the number of patients with a "postinjury" depressive diagnosis (whether or not the diagnosis was made after their injury). Therefore, we decided to exclude these patients in order to increase the chances that any depressive diagnosis identified by the CDR search of patient records from visits that occurred after each patient's fracture hospitalization would represent a depressive diagnosis made at the UVA Health System in the postinjury period.

A retrospective review of patient chart information available electronically in the CDR was used to generate the number of adolescents diagnosed with depression at the UVA Health System during specific time intervals following each patient's traumatic fracture. Diagnoses of major, atypical, and neurotic depression as well as depression not elsewhere classified were among those included in our search (ICD-9 codes 296.2, 296.20–296.25, 296.3, 296.30–296.35, 296.82, 300.4, and 311). The numbers of adolescents diagnosed with depression during specific time intervals following traumatic fracture are reported as percentages of the total number of adolescents seen in follow-up during those time intervals at the UVA Health System after hospitalization for traumatic fracture.

RESULTS

From 2000 through 2009, 1,121 adolescents aged 12 to 19 years old were admitted with nonfatal traumatic fractures of the upper extremity, lower extremity, skull, face, hip, or other bone requiring hospitalization for more than 1 day according to the CDR. Of these patients, 53 had a diagnosis of depression (either past or current) included in their records at the time of admission. To focus on patients who received a "new" depressive diagnosis in the postinjury period, these patients were excluded, leaving a total of 1,068. Of these patients, 913 (85.5%) were seen in follow-up at least once in the year after their fractures. A total of 4.1% (37 of 913) of these adolescents were diagnosed with depression by the end of this first year.

Most patients who were diagnosed with depression after their fracture (31/37, > 80%) received this diagnosis within the first 2 months' postinjury. By 6 months, the number of adolescents diagnosed with depression following any type of fracture reached a plateau (Table 1). After excluding patients who sustained a concomitant spinal cord injury (a total of 86), 982 patients remained, and 842 of these were seen in follow-up. About 3.2% (27 of 842) of these patients were diagnosed with postinjury depression by the end of the first year following their hospitalizations (Table 2). When patients who suffered a traumatic facial or skull fracture with or without an associated brain injury were also excluded, 491 remained. Among these 491 adolescents who were hospitalized for traumatic fractures that did not include facial or skull fractures or concomitant spinal cord or brain injuries, 5 of the 443 (1.1%) patients seen for follow-up during the first year following their injury were diagnosed with depression (Table 3). The findings from Tables 1, 2, and

Table 1. Patients Diagnosed With Depression Following Any Traumatic Fracture

No. of weeks or months postfracture	1 wk	2 wk	1 mo	2 mo	3 mo	4 mo	5 mo	6 mo	7 mo	8 mo	9 mo	10 mo	11 mo	12 mo
Patients diagnosed with depression postinjury, n	24	25	26	31	32	33	33	35	35	36	37	37	37	37
Patients seen in follow-up, n	407	662	834	886	900	902	904	905	907	909	910	911	912	913
Percentage of 37 patients diagnosed with depression by 1 year	65	68	70	84	87	89	89	95	95	97	100	100	100	100

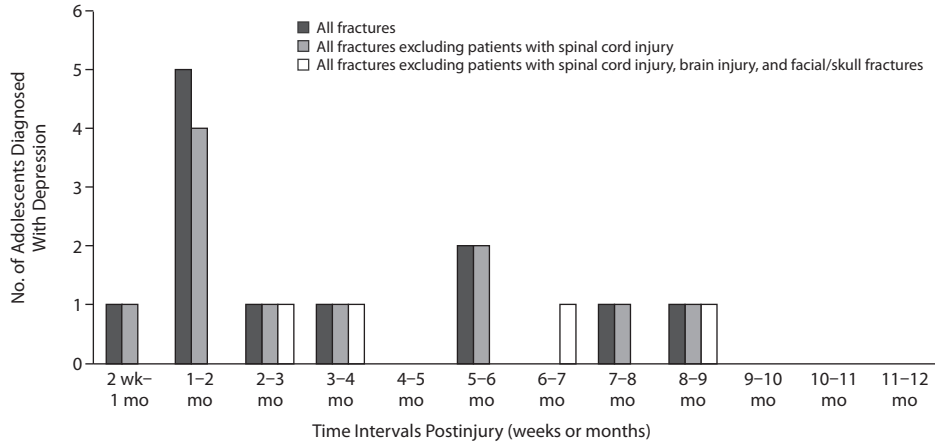
Table 2. Patients Diagnosed With Depression Following Traumatic Fractures Not Complicated by Spinal Cord Injury

No. of weeks or months postfracture	1 wk	2 wk	1 mo	2 mo	3 mo	4 mo	5 mo	6 mo	7 mo	8 mo	9 mo	10 mo	11 mo	12 mo
Patients diagnosed with depression postinjury, n	15	16	17	21	22	23	23	25	25	26	27	27	27	27
Patients seen in follow-up, n	362	609	768	818	830	831	833	834	836	838	839	840	841	842
Percentage of 27 patients diagnosed with depression by 1 year	56	59	63	78	82	85	85	93	93	96	100	100	100	100

Table 3. Patients Diagnosed With Depression Following Traumatic Fracture Not Including Facial/Skull Fracture or Complicated by Spinal Cord or Brain Injury

No. of weeks or months postfracture	1 wk	2 wk	1 mo	2 mo	3 mo	4 mo	5 mo	6 mo	7 mo	8 mo	9 mo	10 mo	11 mo	12 mo
Patients diagnosed with depression postinjury, n	1	1	1	2	3	3	3	4	4	5	5	5	5	5
Patients seen in follow-up, n	150	321	419	436	437	437	439	440	440	440	440	441	442	443
Percentage of 5 patients diagnosed with depression by 1 year	20	20	20	40	60	60	60	80	80	100	100	100	100	100

Figure 1. Number of Patients Diagnosed With Depression During Various Time Intervals Postinjury



3 are combined and presented in a graph in Figure 1, which illustrates that more depressive diagnoses were made in the first 2 months' postinjury.

DISCUSSION

Earlier, prospective studies report alarmingly high rates of depression in youth who completed self-report questionnaires within the first few weeks or months following various types of physical injury. Han et al[14] reported that 41% of injured adolescents met criteria for depression at discharge using the Children's Depression Inventory. Injury severity score, involvement of more than 3 body regions, low socioeconomic status, the presence of family members injured at the scene, and a history of suicidal ideation or attempts were all associated with this increased risk of postinjury depression.[14] Ellis et al[16] reported that 23% of youth met criteria for depression in the months following a car accident–related physical injury (a score of 8 or higher on the short form of the Mood and Feelings Questionnaire). In another study, 19% of adolescents met criteria for depression (Center for Epidemiological Studies Depression Scale score > 27) at baseline when they were interviewed roughly 11 days after an injury.[12] Stallard et al[15] reported that 17.7% of youth met criteria for clinical depression when screened with the Birleson Depression Inventory 1 month after sustaining car accident–related injuries

In contrast to the high rates of depression reported in these prospective studies, we report that 37 of 913 adolescents (4.1%) in our population were clinically diagnosed with depression during a follow-up visit within 1 year of hospitalization for traumatic fracture. This relatively modest percentage is in keeping with our initial hypotheses but must be interpreted carefully, as it most likely reflects a number of factors including differences in study design, study limitations, and characteristics of our study population.

Unlike most earlier studies[12,14–16] that do not distinguish between different types of traumatic physical injury, this

study was designed to focus on fractures. We hypothesized initially that fractures, as opposed to other types of physical injury that may not heal as quickly or completely, are associated with lower rates of depression. For instance, one might expect brain injury to be more closely associated with comorbid psychiatric problems compared to a femur fracture. In 1 retrospective study, Zatzick and Grossman[13] reviewed the charts of young people who had sustained a variety of traumatic injuries, including traumatic brain injury, and reported that 7.4% of injured adolescents received a diagnosis of depression within 1 year of their injury. When we excluded patients in our own study who sustained concomitant brain and/or spinal cord injuries in addition to their fractures, the rate of depression was reduced.

Only 2 studies specifically report on the psychosocial impact of fracture. Stancin et al[24] reported that "functional limitations" in children aged 6 to 12 years and "family stress" can be observed up to 6 months after a traumatic fracture and tend to be more significant among children with lower extremity fractures and those whose treatment involved lengthy immobilization. Interestingly, these researchers reported that the psychological and behavioral impact of traumatic fracture in this population assessed prospectively at 6 months and 1 year is minimal after the first 6 months. Unfortunately, they did not distinguish between depression and other types of psychological consequences, which limits comparison of their results to our own.[24] In another study of Croatian children aged 10 to 18 years,[23] researchers found that self-reported symptoms of depression and anxiety, collectively, were increased immediately after injury but were greatly reduced beyond the first 6 months. Although these studies did not focus specifically on depressive diagnoses made postinjury, they suggest that the psychological impact of orthopedic injury in children and adolescents may be limited to the acute postinjury period, a finding that is consistent with our own.

In the present study, a greater number of adolescents were diagnosed with depression at the UVA Health System within the first 2 months after their injury. Although this finding suggests, as others have, that the psychological consequences of traumatic fracture are more pronounced in the acute postinjury period, it may also reflect greater exposure to health care providers—and therefore increased opportunities for diagnosis—in the early postinjury period when follow-up visits were scheduled more frequently. Beyond 6 months' postinjury, it is likely that more patients were seen by community providers outside of our health system. If diagnoses of depression were made by these providers, they would have been missed in our retrospective review of the CDR.

Unlike earlier studies already discussed, our study did attempt to focus on new, presumably injury-related depression in our population by excluding patients with a known premorbid diagnosis of depression. This aspect of our study design is yet another factor that might have contributed to the lower rate of depression that we report. The deidentified data provided by the CDR did not permit us to differentiate between patients who had a past, recent, or current diagnosis of depression at the time of their admission for fracture. Excluding patients with a depressive diagnosis in their record at the time of admission means that we excluded an unknown number of patients with a prior history of depression who might therefore have been particularly likely to develop postinjury depression.

Finally, while the higher rates of depression reported by earlier studies may in part reflect the considerable symptom overlap between posttraumatic stress disorder, acute stress disorder, and depression and/or the potentially confounding effects of pain, medication side effects, and the stress of hospitalization on self-reported depression symptoms assessed in the acute postinjury period, the lower rates reported here may reflect clinical underdiagnosis of depression. Our retrospective approach might have missed cases of subclinical depression. There are no data to indicate if and how patients were evaluated for depression during their follow-up visits at the UVA Health System.

Theoretically, traumatic injury that requires hospitalization and follow-up care presents an opportunity to screen for depression in adolescents who ordinarily do not frequent doctors' offices. Unfortunately, evidence suggests that adolescents often lack an identifiable primary care provider and therefore do not benefit from such screening after injury.[10,19] As 1 study reported, 40% of adolescents who were hospitalized following a traumatic physical injury reported no source of primary care.[10] Among the 60% of adolescents who did identify a primary care provider, fewer than 1 in 4 followed up with the physician after their injury.[10] Although depression affects a significant proportion of the general population of adolescents, somewhere between 4.3% and 9% according to some studies, only a fraction of depressed adolescents consult a primary care physician for their treatment.[19,28] In the 2004 National Survey on Drug Use and Health, only 25% of surveyed adolescents aged 12 to 19 years had consulted their family doctor and just 5% had seen another medical doctor for their depression over the previous year.[19] There is an apparent need for the establishment of better long-term relationships between adolescents and primary care physicians. As others have suggested, there is also a need for improved coordination of care between trauma centers and primary care physicians, who may be in a position to improve prevention, detection, and treatment of psychiatric disorders in this population.[10,28,29]

The lack of other studies focusing specifically on orthopedic fracture and postinjury depression limits direct comparison of our results to others. Most of the studies reporting very high rates of depression following different types of traumatic injury prospectively screened for postinjury depression, and results of these studies vary considerably. More studies are needed to clarify the relationship between traumatic injury and depression in adolescents. In our retrospective review, we were not able to control for a wide variety of potentially confounding factors that might determine an individual's risk for postinjury depression. It would be interesting, for example, to consider whether adolescents with a known

history of depression, those experiencing multiple fractures rather than a single fracture, and/or those with a history of other psychiatric disorders that might contribute to increased risk-taking behavior are more predisposed to depression following a traumatic fracture.

However, regardless of whether or not (or how much) the risk of depression is increased in youth postinjury, our findings may be viewed as supporting concerns regarding the general underdiagnosis and undertreatment of depression in adolescents. When more routine and active screening for depression was undertaken postinjury in various prospective studies, a greater number of adolescents were identified as having symptoms of depression. Our finding that a relatively small percentage of adolescents seen in follow-up were clinically diagnosed with depression in the first year following a traumatic fracture may indicate that different types of physical injury, such as fracture, are associated with less postinjury depression than others. However, our findings may also be viewed as further evidence that supports the need for improved depression screening efforts, especially in the postinjury period.

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