Journal of the Pediatric Infectious Diseases Society

BRIEF REPORT

Pediatric Tetanus in Central Pennsylvania

Bilaal S. Ahmed,[1] Michael J. Beck,[2] Gregory Williamson,[1] Jessica E. Ericson,[1,3] and Parvathi Kumar[2,3]

[1]Penn State College of Medicine, Hershey, Pennsylvania; and [2]Division of General Inpatient Pediatrics, Department of Pediatrics, and [3]Division of Pediatric Infectious Disease, Department of Pediatrics, Penn State Children's Hospital, Hershey, Pennsylvania

Approximately 20% of the nationally reported tetanus infections in children aged 0 to 14 years that occurred in the United States between 2005 and 2015 were treated at Penn State Children's Hospital. With an electronic medical record search, we identified 5 cases of pediatric tetanus; 100% of these cases occurred in unimmunized children. Their median length of stay was 10 days, and the costs were significant.

Keywords: Amish; central Pennsylvania; tetanus; vaccine-preventable illness.

If infected with a tetanus toxin-producing strain of *Clostridium tetani* [1], a minor wound can cause significant morbidity and death. Widespread vaccination programs have reduced the number of tetanus cases in the United States by 96% from an estimated 580 cases per year in 1947 to 26 cases per year in 2010 [2].

Between 2005 and 2015, 22 pediatric cases of tetanus were reported to the Centers for Disease Control and Prevention [3]. Previous studies have suggested that Amish communities are not universally opposed to vaccination, but these groups often have a lower immunization rate than that in the general population [4]. We sought to describe the cases of pediatric tetanus at Penn State Children's Hospital (PSCH) in central Pennsylvania and to quantify the financial impact of hospital admission to treat tetanus on the affected families and the hospital.

METHODS

We used International Classification of Diseases, Ninth Revision (ICD-9) codes 037 and 781.7 to identify all patients aged <18 years who were discharged from PSCH with a diagnosis of tetanus or tetany between January 2005 and December 2015. We reviewed our electronic medical records to confirm the diagnosis of tetanus and to determine how that diagnosis was made. Demographic characteristics were abstracted into REDCap and are presented with descriptive statistics [5]. In addition, we recorded Amish affiliation, likely source of exposure, vaccination status, hospital length of stay, complications during admission, and outcome at discharge.

To determine charges, expected payments received, and hospital costs associated with each case between January 2006 and December 2015, we used Horizon Business Insight software (McKesson, San Francisco, California). Cost data were not available for 2005. "Charges" are individual list prices that a hospital sets for services it provides, "costs" are expenses incurred by the hospital in providing patient care, and "expected payment" is the amount the hospital expects to receive for providing patient care. For Amish health care consumers, PSCH offers a discounted rate. We made no adjustments for inflation, and costs are reported in dollars for the year in which the case occurred.

This study was approved by the Human Subjects Protection Office of the Penn State University College of Medicine.

RESULTS

We identified 5 patients who received a diagnosis of tetanus. All of them were unimmunized, and 4 (80%) of the 5 were Amish. Their median age was 8 years (range, 3–11 years) (Table 1), and their median length of stay was 10 days (range, 7–22 days).

Patient 1

A 3-year-old unvaccinated Amish girl presented to an outside hospital after 7 days of fever, fatigue, vomiting, and back and abdominal pain. Because of her dehydration and concern about sepsis, she was admitted to the hospital and started on clindamycin and ceftriaxone. Her abdominal pain and fever continued, and she developed abdominal distension, lethargy, and opisthotonos. She underwent an exploratory laparotomy, which revealed enlarged mesenteric lymph nodes. She was then transferred to our center for subspecialty management. Given her development of generalized spasms and stiffness, a presumptive diagnosis of tetanus was established by a pediatric infectious disease consultant on the sixth day of hospitalization. The patient was given tetanus immunoglobulin (peripherally) and tetanus toxoid vaccine and was started on metronidazole. She was subsequently discharged tolerating oral nutrition after 10 days of hospitalization.

Patient 2

A 7-year-old unvaccinated Amish boy presented after 2 days of generalized stiffness. His symptoms progressed to "lockjaw" and significant spasms of his back, neck, and proximal leg muscles.

Received 17 June 2018; editorial decision 7 August 2018; accepted 9 August 2018; published online September 4, 2018.

Correspondence: P. Kumar, Penn State Children's Hospital, Department of Pediatrics, 500 University Dr., Hershey, PA 17033 (pkumar@pennstatehealth.psu.edu).

Journal of the Pediatric Infectious Diseases Society 2019;8(4):358–360

DOI: 10.1093/jpids/piy086

Table 1. Description of Pediatric Patients With Tetanus Admitted to Penn State Children's Hospital (2005–2015)

Characteristic	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Median (range)
Age (years)	3	7	11	9	7	8 (3–11)
Sex	Female	Male	Male	Female	Female	NA
County of residence	Lancaster	Lancaster	Lancaster	Lancaster	Lebanon	NA
Year of admission	2005	2007	2008	2013	2014	NA
Inoculation site	Foot laceration	Hand laceration	Knee laceration	Foot splinter	Foot laceration	NA
Presenting symptoms	Fever, abdominal distention, and back pain	Trismus, jaw pain, and neck, back, and leg stiffness	Trismus, pain, and discharge from wound	Trismus and dysphagia	Trismus, sore throat, and body stiffness	NA
Incubation period (days)[a]	Unknown	5	7	6	11	6.5
Hospital length of stay (days)	10	10	22	7	17	10 (7–22)

Abbreviation: NA, not applicable.
[a]Number of days between soft-tissue injury and onset of presenting symptoms.

Tetanus was diagnosed at the referring hospital, and he received tetanus immunoglobulin (peripherally), tetanus toxoid vaccine, and penicillin before transfer. He was discharged with nasogastric tube (NGT) feeds after 10 days of hospitalization.

Patient 3

An 11-year-old unvaccinated Amish boy presented to the emergency department of a community hospital with trismus 7 days after a fall complicated by a skin and soft-tissue infection overlying his knee injury. He was transferred with a clinical diagnosis of tetanus for additional surgical management of his knee wound. He was given tetanus immunoglobulin (peripherally), tetanus toxoid vaccine, and metronidazole. He also received cefazolin and underwent vacuum-assisted closure of the knee wound. The patient was discharged home on day 22 of hospitalization with NGT feeds as a result of his continued oropharyngeal dysphagia.

Patient 4

A 9-year-old unvaccinated Amish girl presented to the emergency department of a community hospital with an acute onset of lockjaw. The inciting injury was a foot splinter that was removed approximately 6 days before presentation to the hospital. She was transferred for further management after she received tetanus immunoglobulin (peripherally) and tetanus toxoid vaccine. She completed a 7-day course of metronidazole. Persistent trismus and abdominal spasms limited her oral intake, and on day 7 of hospitalization, she was discharged home with NGT feeds.

Patient 5

A 7-year-old unvaccinated girl presented 11 days after a foot laceration that had healed with no apparent complications. She developed a sore throat that progressed to trismus and body stiffness. She was admitted to the pediatric intensive care unit, where intravenous magnesium was initiated for autonomic stability. She was given tetanus immunoglobulin (peripherally), tetanus toxoid vaccine, and metronidazole. During her hospitalization, she suffered a fall that caused a subdural hematoma and temporal bone fracture that did not require neurosurgical intervention. After 17 days of hospitalization, she was discharged home on nasojejunal feeds.

Costs

Cost data were available for 4 (80%) of the 5 cases. The median hospital charge for the 4 hospitalizations was $50 122 (range, $21 671–$92 872) (Table 2). The median cost was $29 790 (range, $13 833–$47 757), and the median expected payment was $12 582 (range, $10 146–$45 353). The parents of 3 of the Amish patients were uninsured and ultimately responsible for 96% of the billed hospital costs for their care, totaling $70 518.

DISCUSSION

Nearly one-fourth of the reported pediatric tetanus cases in children aged 0 to 14 years that occurred in the United States between 2005 and 2015 were treated at PSCH.

Tetanus should be considered as a cause of muscle spasm and dysphagia in patients who live in an underimmunized

Table 2. Costs Associated With Hospital Admission for Tetanus at Penn State Children's Hospital (2006–2015)

Financial Information	Patient 2	Patient 3	Patient 4	Patient 5	Median
Insurance status	Uninsured	Uninsured	Uninsured	Private	NA
Hospital charges ($)	21 671	70 468	29 777	92 872	50 122
Total cost ($)	13 833	40 163	19 417	47 757	29 790
Expected payment ($)	13 948	45 353	11 217	10 146	12 582
Margin ($)[a]	115	5190	(8200)	(37 611)	NA

Abbreviation: NA, not applicable.
[a]Numbers in parentheses are negative.

community. Delays in diagnosis can increase morbidity and associated costs [6]. In some cases, a missing patient history and the absence of typical examination findings can contribute to a delay in diagnosis. In our cohort, Patient 1 underwent an extensive workup for fever and abdominal pain, including an exploratory laparotomy, before arriving at our hospital. She was not diagnosed with tetanus until after she developed generalized spasms.

The cost of vaccination is low; the diphtheria, tetanus, and pertussis vaccine (DTaP) costs $1.71 per dose (total cost for the 5-dose primary series, $8.55), and tetanus, diphtheria, and pertussis vaccine (Tdap) boosters cost $3.13 per dose [7]. Results of a 2009 economic evaluation of the routine childhood immunization program in the United States suggested that 100% of tetanus infections necessitate hospital admission, and the average cost is $90 635 per hospitalization [8]. Our costs were less than this average, probably because the median duration of hospitalization for these children was nearly 1 week less than that previously reported, our population included only pediatric patients, and only 1 of our patients required intensive care unit–level care. Considering the cost of vaccine administration, adverse events from vaccination, and parental time off work, it has been estimated that savings of $12 million from direct costs and $45 million of societal costs could be realized with routine tetanus vaccination [8].

Vaccine-preventable diseases (VPDs) occur disproportionately more often in Amish children than in non-Amish children [4]. The increased risk and incidence are mostly a result of lower vaccination rates. For Amish children, it is widely assumed that the objections to immunization are based on their religion. However, in most cases, immunization refusal is not required by religious doctrine but, rather, reflects a social tradition [9]. During outbreaks of VPDs, Amish community leaders have participated in vaccination programs [2, 9]. Results of previous research also suggested that low immunization rates among Amish populations are attributable to reasons similar to those in the general population, namely, limited access to care, limited understanding of the diseases to be prevented, and concerns about vaccine safety [10–12]. All 5 of our patients received tetanus vaccine with no resistance from their family, which suggests that openness to immunization exists if paired with proper community education and outreach.

Our study had several limitations. Cost data were not available for the hospitalization that occurred in 2005. We limited our study to pediatric patients between 0 and 17 years of age. These cutoffs enabled us to compare our data to state- and national-level statistics and reveal that a disproportionate number of pediatric tetanus infections occur in our catchment area. Our data reflect only the costs of treatment at our institution. Charges incurred at the referring hospital are not included; hence, the costs reported are underestimates of actual family expenses. Although tetanus is a reportable disease, data housed by the Centers for Disease Control and Prevention and state agencies rely on passive surveillance; therefore, some cases may not be reported [13]. It is possible that we have overestimated the proportion of total pediatric tetanus cases treated at our institution.

CONCLUSION

This characterization of pediatric tetanus infections in unvaccinated children in central Pennsylvania highlights the importance of maintaining clinical suspicion for tetanus infection in areas with a suboptimal vaccination rate. Because most of the infections occurred in Amish children, efforts to increase tetanus vaccination among Amish communities should be studied further.

Notes

Author contributions. B. S. A. conceived the study, analyzed the data, and drafted the manuscript; M. J. B. acquired data and critically reviewed the manuscript; G. W. conceived the study, acquired the data, and critically reviewed the manuscript; J. E. E. conceived the study, acquired and analyzed the data, and critically reviewed the manuscript; and P. K. conceived the study, acquired data, and critically reviewed the manuscript. All authors reviewed and approved the final manuscript as submitted.

Acknowledgment. We acknowledge Thomas Abendroth, MD, for his valuable time and effort spent acquiring the master data set used in this study.

Potential conflicts of interest. All authors: No reported conflicts of interest. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

References

1. Bleck TP. Tetanus: pathophysiology, management, and prophylaxis. Dis Mon **1991**; 37:545–603.
2. Lynfield R, Daum RS. The complexity of the resurgence of childhood vaccine-preventable diseases in the United States. Curr Pediatr Rep **2014**; 2:195–203.
3. National Notifiable Diseases Surveillance System, 1990–2015.
4. Williamson G, Ahmed B, Kumar PS, et al. Vaccine-preventable diseases requiring hospitalization. Pediatrics **2017**; 140:e20170298.
5. Harris PA, Taylor R, Thielke R, et al. Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. J Biomed Inform **2009**; 42:377–81.
6. Skuby SO, Rhee E, Thilo EH, Simoes EA. Tetanus and Occam's razor: almost forgotten but not gone: a case report. Pediatrics **2016**; 138:pii:e20160298.
7. Centers for Disease Control and Prevention. CDC vaccine price list. Available at: https://www.cdc.gov/vaccines/programs/vfc/awardees/vaccine-management/price-list/. Accessed May 15, 2017.
8. Zhou F, Shefer A, Wenger J, et al. Economic evaluation of the routine childhood immunization program in the United States, 2009. Pediatrics **2014**; 133:577–85.
9. Grabenstein JD. What the world's religions teach, applied to vaccines and immune globulins. Vaccine **2013**; 31:2011–23.
10. Dickinson N, Slesinger DP, Raftery PR. A comparison of the perceived health needs of Amish and non-Amish families in Cashton, Wisc. Wis Med J **1996**; 95:151–6.
11. Yoder JS, Dworkin MS. Vaccination usage among an old-order Amish community in Illinois. Pediatr Infect Dis J **2006**; 25:1182–3.
12. Wenger OK, McManus MD, Bower JR, Langkamp DL. Underimmunization in Ohio's Amish: parental fears are a greater obstacle than access to care. Pediatrics **2011**; 128:79–85.
13. Hamborsky J, Kroger A, Wolfe S. Epidemiology and Prevention of Vaccine-Preventable Diseases. 13th ed. Washington, DC: Public Health Foundation; **2015**.