Original Article

Exposure Risks and Tetanus Immunization Status in Farmers Ages 50 and Over

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Background: Despite an effective tetanus vaccine, tetanus continues to claim lives worldwide. The very young and the elderly are at highest risk for the disease. Farmers are at high risk for injury, the leading factor associated with tetanus.

Methods: As part of a larger study of older members of farm households in the southern United States, 595 participants provided data on health, injuries, work, socioeconomic status, and healthcare.

Results: 69% reported receiving a tetanus booster in the past ten years, 24% had not, and 7% did not know. Females were less likely to be currently immunized. There was no association between immunization status and age, income, or race. There were associations between farm tasks, farm work-related injury, and immunization.

Conclusions: Older farmers are at risk for tetanus by virtue of their age and work environment. Health care providers should explore strategies to improve immunization status among this work group.

Key Words: farmers, immunization, injury, tetanus

Tetanus is an easily preventable disease that afflicts between 500,000 and one million persons per year.[1,2] The United States reported 345 cases of tetanus between 1996 and 2005; this number probably reflects between 26–46% of the true case incidence.[3] Even though tetanus is considered a rare disease, the severity of the illness results in a 50% mortality rate.[4] The Advisory Committee on Immunization Practices (ACIP) recommended studies to determine the immunization status of the U.S. population, as well as immunization practices across the nation and in special populations at risk.[5] This paper reports on the tetanus immunization status for aging farmers, a population at high risk for injury and poor outcomes for both illnesses and injuries.

Disease Agent

The Gram-negative anaerobic bacillus *Clostridium tetani* thrives in the soil of temperate zones and appears in the intestines and excrement of cattle, sheep, dogs and other animals.[6] The spores are highly resistant and can be found in the soil, on the skin, and in the feces of animals and humans.[7] Symptoms of the disease include muscle stiffening, "lockjaw," and severe spasms. The disease may present with only symptoms of dysphagia or nuchal rigidity and may progress to death by acute respiratory failure.[4] Among a smaller percentage of cases, the disease may manifest in symptoms confined to the localized area at the site of injury.

Risk Factors

The most obvious risk for tetanus is lack of immunization. In the United States, only half of the population age 60+ have protective levels of antibodies; this decreases to less than 30% by age 70.[8,9] African Americans and Hispanics are less likely to be protected than whites, and lower income is associated with decreased immunization.[8] In studies that reported immunity status, military service was a protective factor, a direct indicator of the importance of timely vaccination.[8,10]

Adults age 60 and over have twice the incidence of tetanus compared to their younger adult counterparts.[1] Advancing age is a worldwide risk factor for tetanus. In a recent report, the mean age for tetanus cases in Korea was 63 years

Key Points

- Farmers are at high risk for injury.
- Protection against tetanus wanes with advancing age.
- Farmers, particularly older farmers, should be screened for current immunization status.

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old.[11] Since 1993, the percentage of persons aged 65 and over who died from tetanus ranged between 44–83% of the total tetanus cases in Australia.[12]

The vaccine for tetanus is nearly 100% effective.[13] After receiving the full complement of initial vaccinations, boosters are required every 10 years to maintain adequate levels of protection. Boosters may also be indicated for prophylaxis on a case-by-case basis for wound management.[14] Serologic testing for tetanus immunity in the National Health and Nutrition Examination Survey III (NHANES III) demonstrated that males were more than twice as likely as females to have immunity, and that the gap widened as age increased.[8] In a study of women in farm households in Louisiana, only 54% of the sample had received a tetanus booster in the past ten years.[15] Half of those who were current for tetanus immunization had received the vaccine following an injury. Women aged 50 and over were less likely to be adequately immunized than women under age 50.

Environmental Risks and Farming

Since *Clostridium tetani* is so widespread, any break in skin integrity or protective body barrier provides a potential portal of entry. The classic example is a puncture wound, where the offending agent is projected into the tissue and immediately sealed by the body. The leading predisposing factor for tetanus infection is acute injury, primarily puncture wounds and lacerations.[4] These types of injuries are common on farms where physical labor is performed outside, often in unsanitary conditions. Animal bites, superficial and deep wounds, even abrasions from thorns and bushes, can carry with them the deadly bacteria.

A study of Colorado farmers showed that women were at higher risk for injury compared to men in "other" (i.e., non-machinery, crop, or animal) tasks but had similar injury rates while performing animal handling, farm materials handling, and crop production, even though women worked less hours than men in these tasks.[16] A study of California farm operators reported 8.2 farm work-related injuries per 100 farmers and an above-expected number of multiple injuries,[17] while a similar study of Kentucky farmers age 55 and older reported a crude injury rate of 9.03.[18] The coalescence of these studies reveals that farmers experience a multitude of injuries that could lead to tetanus if they are not adequately protected.

Given the high injury rates among farmers, it is essential that adequate protection against tetanus be maintained. Unlike the NHANES III results,[8] income was not linked to tetanus immunization status among farm women in Louisiana. Immunization status did not vary by income, but it was linked to the farm work performed.[15] Those who reported driving a tractor and working with farm animals were more likely to be current, indicative of the cognizance of the women to identify potential risks for tetanus. Even so, less than half the sample reported a tetanus booster in the last ten years. A similar finding was reported in a study of rural dwelling persons in Wisconsin.[10] The authors noted that although men had higher rates of tetanus protection, women farmers had the highest levels of seropositivity of any of the participants. Although some natural immunity may be generated by the body after prolonged exposure to the agent for tetanus, this protection is not sufficient to prevent development of the disease, especially at older ages.[19,20]

Methods

This report is based on a subsample of 595 Kentucky and South Carolina farmers who completed telephone and mailed surveys on farm work and health as part of a larger panel study about sustained work factors in farmers over age 50. Institutional Review Board approval was obtained prior to survey distribution. Data were collected between 2002 and 2006 across five waves of surveys.

The survey instruments were adapted from the Kentucky Farm Family Health Interview Survey (FHIS)[18] and gathered data on farm type, farm work tasks, off-farm employment, and injury. Data on farm demographics and standard socioeconomic factors were also collected. The question about tetanus immunization (included in wave 5 only) asked if the respondent had received a tetanus immunization in the last ten years. Injury data for this analysis included only the prevalence of burns, amputations, and lacerations requiring stitches during the study period. A list of farm tasks adapted from the FHIS was used. Respondents checked each task they had performed in the past year. To understand the relationship between up-to-date tetanus immunization and farmer and farm characteristics, bivariate analyses were conducted and chi-square tests run. *P* values less than 0.05 were considered statistically significant.

Results

The majority of respondents (407, 68.4%) reported having a tetanus booster within the last 10 years ('takers'); 144 (24.2%) reported no current vaccination ('nontakers'), and 44 (7.4%) did not know their tetanus vaccination status. The latter group was reclassified as nontakers, resulting in 188 (31.6%) in that category. Table 1 outlines the sample characteristics. They were slightly older than the average farmer, with 83% being over age 60 and 45% over age 70. Nearly all of the respondents had seen a health care provider within the past year. Males were more likely to be up to date on their tetanus booster than females. There was no difference in tetanus booster by health care provider visit status, income, education, age, or race.

There were no differences in farm characteristics between takers and nontakers. Most nontakers (71%) lived on farms where livestock was present. Nearly all (97%) produced crops, and the majority (70%) produced both crops and livestock. There were no differences in tetanus booster status by farm acreage or type.

Table 1. Demographic characteristics by tetanus booster status

	Takers (n = 407)	Nontakers (n = 188)
	N (%)	N (%)
Age (yr)		
60 and under	67 (16.6)	33 (17.5)
61–70	152 (37.6)	71 (37.8)
Over 70	185 (45.8)	84 (44.7)
Gender[a]		
Male	331 (81.3)	134 (71.3)
Female	76 (18.7)	54 (28.7)
Education (yr)		
Less than high school	93 (23.0)	40 (21.3)
Completed high school or greater	312 (77.0)	148 (78.7)
Total household income		
$40,000 and less	197 (51.2)	97 (56.4)
>$40,000	188 (48.8)	75 (43.6)
Race		
White	335 (83.8)	150 (80.6)
African American	65 (16.2)	36 (19.4)
Seen health care provider within past year		
No	29 (7.4)	16 (8.9)
Yes	362 (92.6)	163 (91.1)

[a] *χ^2 test shows significant differences at $P < 0.05$.*

The questionnaire included an extensive list of farm-related chores done in the past year. The sample performed an extensive variety of farm tasks as shown in Table 2. Performing repair work, driving a tractor in the past year, castrating animals or doing other veterinarian-type work, applying pesticides, herbicides or insecticides, and doing tasks that required climbing higher than 8 feet were associated with having a tetanus booster within the last 10 years.

The number of farmers who reported having at least one cut requiring stitches, burn, or amputation over the 5-year data collection period was tallied. There was no difference in the percentage reporting these types of injuries by tetanus booster status. However, the takers were more likely to have received these injuries while performing farm-related duties. Of the takers who were injured, 58.3% received their injuries while doing farm work, compared to 34.3% of the nontakers. Table 3 displays the cuts, burns and amputations of the entire sample, as well as by tetanus booster status. Injuries are reported overall and also by farm-work status. There were no differences in percentage of cuts, burns, or amputations reported by tetanus booster status; however, takers were more likely to have farm-related cuts than nontakers.

Table 2. Farm tasks performed by tetanus booster status

	Takers (n = 407)	Nontakers (n = 188)
	N (%)	N (%)
Administrative		
Pay farm bills, do books, order supplies		
No	32 (7.9)	14 (7.5)
Yes	375 (92.1)	174 (92.5)
Run farm errands		
No	64 (15.7)	32 (17.0)
Yes	343 (84.3)	156 (83.0)
Repair work (equipment/structures)[a]		
No	77 (18.9)	57 (30.3)
Yes	330 (81.1)	131 (69.7)
Drive a tractor in past year[a]		
No	57 (14.4)	45 (26.2)
Yes	338 (85.6)	127 (73.8)
Mow fields		
No	109 (26.8)	71 (37.8)
Yes	298 (73.2)	117 (62.2)
Bale		
No	223 (54.8)	109 (58.0)
Yes	184 (45.2)	79 (42.0)
Plant crops		
No	250 (61.4)	117 (62.2)
Yes	157 (38.6)	71 (37.8)
Hand harvest crop (tobacco, row crops)		
No	330 (81.1)	150 (79.8)
Yes	77 (18.9)	38 (20.2)
Transport crops or animals		
No	195 (47.9)	106 (56.4)
Yes	212 (52.1)	82 (43.6)
Feed animals		
No	139 (34.2)	74 (39.4)
Yes	268 (65.8)	114 (60.6)
Castrate animals, other vet work[a]		
No	226 (55.5)	123 (65.4)
Yes	181 (44.5)	65 (34.6)
Herd animals		
No	225 (55.3)	112 (59.6)
Yes	182 (44.7)	76 (40.4)
Apply pesticides, herbicides, insecticides[a]		
No	193 (47.4)	108 (57.5)
Yes	214 (52.6)	80 (42.5)
Climb >8 feet[a]		
No	165 (40.5)	102 (54.3)
Yes	242 (59.5)	86 (45.7)
Received cut, burn or amputation within last 5 yr		
No	304 (74.7)	153 (81.4)
Yes	103 (25.3)	35 (18.6)
Injuries that were farm-related[a]	60 (58.3)	12 (34.3)

[a] *χ^2 test shows significant differences at $P < 0.05$.*

Discussion

Aging farmers continue to work in an environment laden with *Clostridium tetani*. In developed nations, the elderly are at highest risk for mortality from the disease, and though an effective tetanus immunization exists, is inexpensive, and can be obtained easily, this report reveals that aging farmers do

Table 3. Farmers reporting at least one cut, burn, amputation from 2002–2006

	Overall (n = 595)	Takers (n = 407)	Nontakers (n = 188)
	N (%)	N (%)	N (%)
Cut	99 (16.6)	78 (19.2)	21 (11.2)
Farm-related cut[a]	54 (54.6)	46 (59.0)	8 (38.1)
Burn	44 (7.4)	30 (7.4)	14 (7.4)
Farm-related burn	21 (47.7)	17 (56.7)	4 (28.6)
Amputation	4 (0.7)	3 (0.7)	1 (0.5)
Farm-related amputation	2 (50.0)	1 (33.3)	1 (100.0)

[a] *χ^2 test shows significant differences at $P < 0.05$.*

not take advantage of the opportunity to prevent this deadly disease. One third of the sample either had not had the immunization within the recommended time frame or did not know if they had received it. The majority of the unimmunized farmers actively produced crops and livestock, often performing high-risk tasks such as mowing fields, performing veterinarian work, and feeding animals. These tasks increase the farmers' risk of acquiring the disease if an injury occurs.

Females in this study had slightly higher reported current immunization status (58.5%) compared to the younger sample of farm women who participated in the Louisiana study (53.6%).[15] However, the females in this study were less likely to be current in immunization status compared to males. This is congruent with the literature[4,8,21] and illustrates the need for increased attention to immunization adherence for older women.

The ACIP advises an immunization evaluation at age 50.[1] Even though persons may report current immunization status, recall may be unreliable. In a study of seropositivity of tetanus antibodies among adults over age 65, the authors were unable to obtain an accurate immunization history for 64% of the sample.[21] Tetanus immunization recall was not reliable in a study of emergency patients.[22] Health care providers should be especially vigilant in evaluating the tetanus immunization status of their farm clients, particularly the older members of farm households. In this sample of older farmers, over 90% of those who were not current on their immunization status had seen a health care provider in the last year. Nearly one out of every four farmers in the study reported at least one cut, burn or amputation during the study, yet only cuts were associated with increased immunization status. These injury events may have been missed opportunities for evaluating tetanus immunization. Opportunities for increasing the immunization status of the farm community can include health fairs, county agriculture field days, and co-sponsorship of a dedicated "Take your Tetanus" day at local agribusinesses. In a demonstration project in a rural practice in Kentucky, a chart sticker for farm clients improved assessment of farm injury risk and tetanus immunization status.[23]

Our findings coincide with those of Holland and Carruth,[15] who did not find a relationship between income and immunization status among Louisiana farm women, unlike reports from other studies[4,8,21] that linked lower income status to poorer protection against tetanus. Similarly, while Gergen et al[8] reported that minorities were less likely to have tetanus protection, there was no difference by racial group in this study.

Limitations

This study used self-reported data and there may be instances in which the respondent misestimated the time since the last tetanus immunization. The sample was not randomized and the majority of respondents were white, despite an oversampling of African-American households, thus, generalization should be made with caution. Farmers who live in other regions of the nation may have different characteristics. The injury data was limited only to sentinel events that resulted in breaks in skin integrity; thus, the results underestimate total injuries that might also have triggered immunization.

Conclusion

Despite the low incidence of tetanus, the mortality rate remains high once the disease is contracted. The continued evidence of the waning protection against this deadly disease as age increases is sufficient to warrant a focused campaign for immunization among the elderly. Perhaps of even greater importance is the need for vigilance in evaluating the immunization status of persons in high risk occupations such as farming. The average age of the U.S. farmer is 55 and increasing; concomitantly, a drastic drop in protection against tetanus begins at this age. With support and vigilance of health care providers, all farmers can attain adequate protection against tetanus. The inclusion of one question about tetanus immunization status is very simple and quick, yet yields a rich description for the need to focus on strategies to prevent this very serious disease.

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Please see Mary S. Hayney's editorial on page 231 of this issue.

"I hear and I forget. I see and I remember. I do and I understand."

—Confucius