Tetanus in the United States: A Review of the Problem

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While it is true that in the United States infectious diseases have largely been brought under control, there are still islands of stubborn resistance. It is necessary to examine these more closely and to pin point their nature so that appropriate action may be taken, if possible, to eradicate them. This approach to tetanus delimits the problem geographically as well as in several other respects and indicates steps to be taken in the future.

Tetanus remains a highly fatal disease with about 60 deaths occurring for every 100 cases reported in the United States. The stability of this picture in the past decade is striking in view of the increasing knowledge on the prevention and treatment of this condition. The effectiveness of preventive immunization practices, particularly that of the tetanus immunization series, has been well established. In World War II there was ample demonstration [1] of the effectiveness of mass tetanus prophylaxis in the military. Present evaluation of the long-term effectiveness of tetanus immunization [2, 3] indicates a persistence of the ability to respond to recall antigenic stimuli for considerable periods of time, varying in maximal estimate from 10 years to a life duration status. The prophylaxis of the young infant with combined immunization against diphtheria, tetanus, and pertussis is now a tested and accepted practice in the care of the well child. It has been estimated [4] that the frequency of tetanus has decreased 25–30 times under the influence of active immunization programs. Therefore it would appear worth while to examine closely the nature of the residual tetanus problem today, since there has been no national review of the tetanus problem since the mortality review of Moore and Singleton [6] in 1939.

The incidence of tetanus in the United States has shown little change since 1947, when morbidity data were first published on a national basis. During the period 1947–1955, the reported annual morbidity rate averaged 0.3 cases per 100,000 population, while the mortality averaged 0.2 deaths per 100,000 population (Table 1). In 1955, the most recent year for which national data are available, 462 cases were reported and 265 deaths were registered in the United States.

The monthly occurrence of reported cases shows a sharp seasonal pattern of increased late summer and fall incidence with an abrupt drop during the late winter months for each year during the 1951–1954 period (Figure 1). Noel and McSwain [5] previously noted a late spring and summer peak in their study of hospital cases in Nashville, Tenn., during the years 1925–1948.

When the geographic distribution of tetanus cases is examined the higher incidence in the South Atlantic, East South Central, and West South Central Regions during the 1951–1954 period

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Table 1—Trends in Reported Tetanus Morbidity and Mortality, United States, 1947–1955

Year	Cases	Case Rates *	Deaths	Death Rates *	Death-Case Ratio (Deaths per 100 Cases)
1947	560	0.39	511	0.36	91.2
1948	601	0.41	506	0.35	84.2
1949	579	0.39	398	0.27	68.7
1950	486	0.32	336	0.22	69.1
1951	506	0.33	394	0.26	77.9
1952	484	0.31	360	0.23	74.4
1953	506	0.32	337	0.21	66.6
1954	524	0.33	332	0.21	63.4
1955	462	0.28	265	0.16	57.4

* Rates per 100,000 population.

(Figure 2) is immediately apparent. Over one-half of the reported morbidity is concentrated in these southern states. Florida had the highest average rate of 1.5 cases per 100,000 population, followed by Alabama with 1.3 cases during this period. Other states with high rates were Georgia, Arkansas, Mississippi, and Louisiana. An additional 13 states ranked above the United States rate of 0.3 cases per 100,000 population (Table 2).

Reported morbidity data do not provide further information on epidemiologic characteristics and consequently the registered mortality and literature must be examined to further define the tetanus problem.

Although more favorable prognosis in tetanus has been shown in recent years, reflected in the slightly declining mortality trend during the 1947–1955 period, the death-case ratio remains about 60 deaths per 100 cases (Table 1). While it is recognized that the reporting practices may vary from state to state, and some underreporting occurs, selected hospital studies [7-9] indicate a fatality of treated cases of 33 deaths per 100 cases during the same approximate period. For various earlier periods during the last half century, hospital studies [3, 5, 10–13] yielded an average ratio of 43 deaths per 100 cases, ranging from 29 to 50 deaths per 100 cases.

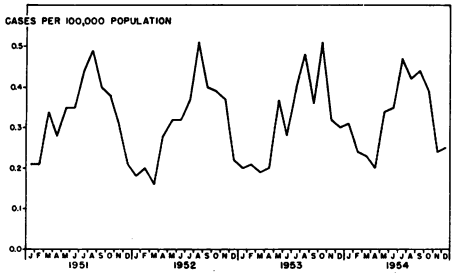

Figure 1—Seasonal Incidence of Tetanus, United States, 1951–1954, Monthly Case Rates Adjusted to an Annual Base

Hospital studies [14–17] also indicate that the case-fatality of children is lower than that of adults. However, the results of treatment of tetanus neonatorum remain disappointing. A review of hospital experience [15, 18, 19] shows a high average case fatality in the neonatal period of 77 deaths per 100 cases, ranging from 55 to 100 deaths per 100 cases.

Another feature of the tetanus mortality in the United States is the frequency of deaths among nonwhites. During the 1947–1950 and the 1951–1954 periods the rates for nonwhites were about five to six times higher than for whites. Both white and nonwhite males were affected more frequently than females, but it should be noted that the rates for nonwhite females were

three times higher than for white males.

The age distribution of tetanus mortality indicates that more deaths are ascribed to tetanus among children under one year of age than in any other age group, accounting for almost one-third of the tetanus deaths registered in the United States during the 1951–1954 period. For both whites and nonwhites age-specific rates under one year are markedly higher than other age groups. After the first year of life the age-specific rates drop abruptly, increasing slightly in the 65-year and over age group. Consistent differences are noted between whites and nonwhites in all age groups. An excess of male over female mortality prevails in all age groups except in the 20–44 year age group. Table 3 shows the age-race-sex specific rates for tetanus in the United States during the 1951–1954 period.

Of the tetanus deaths occurring in the first year of life, the overwhelming majority were neonatal deaths under 28 days of age during the 1951–1954 period. Almost two-thirds of these deaths were among nonwhites, largely in the southern states. These states form a regional concentration from the Gulf to the Atlantic Seaboard, extending upward from Missouri to Virginia. Texas registered a majority of the white neonatal deaths with an annual rate of 13.0 deaths per 100,000 live births during this period. Florida had the highest nonwhite neonatal rate of 34.3 deaths per 100,000 live births. Ranking next were Alabama, Oklahoma, Arkansas, Texas, Tennessee, Missouri, and Georgia. It is interesting to note that Texas has high white and nonwhite neonatal rates. Table 4 shows the tetanus neonatal mortality by race for selected states during the 1951–1954 period.

It is apparent that tetanus neonatorum is an important age category of tetanus. These infections are presumed to occur

Figure 2

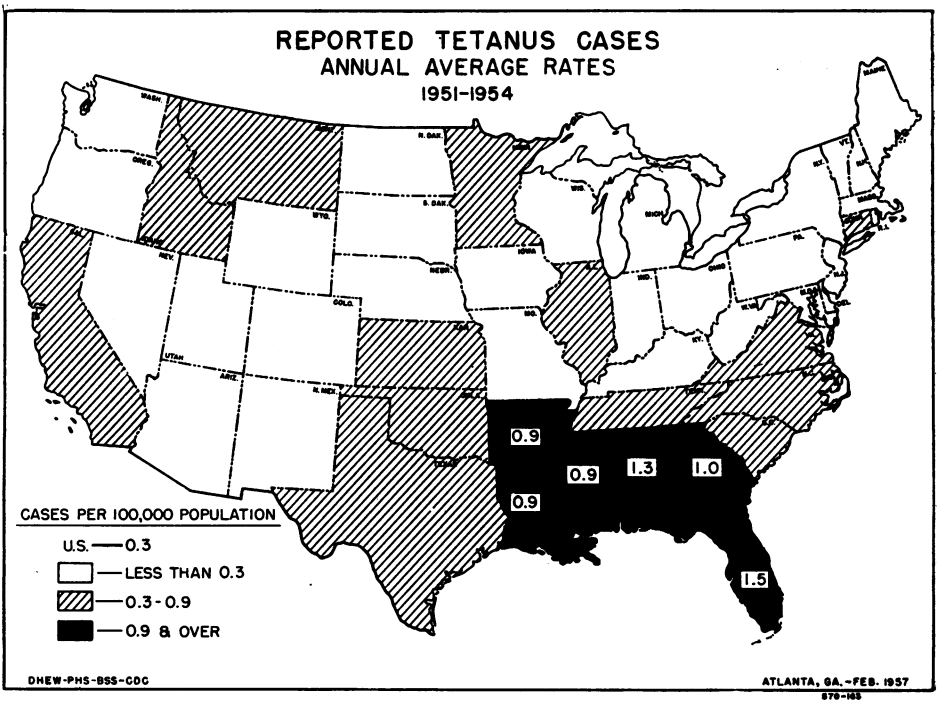

Table 2—Geographical Distribution of Reported Tetanus Morbidity, Annual Average Case Rates, 1951–1954

States	No. of Cases 1951	1952	1953	1954	Total	Average No.	Case Rate * Annual Average (Cases per 100,000 Population)
New England							
Maine	1	1		†	2	0.67 ‡	0.1 ‡
New Hampshire			1		1	0.25	0.0
Vermont					–	–	–
Massachusetts	14	9	5	6	34	8.50	0.2
Rhode Island	1	2	1	1	5	1.25	0.2
Connecticut	6	9	4	4	23	5.75	0.3
Middle Atlantic							
New York	36	33	32	30	131	32.75	0.2
New Jersey	10	11	7	7	35	8.75	0.2
Pennsylvania					–	–	–
East North Central							
Ohio	8	11	18	5	42	10.50	0.1
Indiana	10	10	7	4	31	7.75	0.2
Illinois	22	33	29	40	124	31.00	0.3
Michigan	17	8	11	8	44	11.00	0.2
Wisconsin	3	3	5	9	20	5.00	0.1
West North Central							
Minnesota	11	9	17	10	47	11.75	0.4
Iowa	1	3	1	4	9	2.25	0.1
Missouri	6	7	4	4	21	5.25	0.1
North Dakota		2	2		4	1.00	0.2
South Dakota			1	2	3	0.75	0.1
Nebraska	1				1	0.25	0.0
Kansas	8	7	4	2	21	5.25	0.3
South Atlantic							
Delaware			1		1	0.25	0.1
Maryland	8	7	8	2	25	6.25	0.2
Dist. of Columbia	8		1	2	11	2.75	0.3
Virginia	8	12	22	17	59	14.75	0.4
West Virginia	1	2	2		5	1.25	0.1
North Carolina	†	26	18	23	67	22.33 ‡	0.5 ‡
South Carolina	11	3	6	5	25	6.25	0.3
Georgia	46	30	34	29	139	34.75	1.0
Florida	34	46	44	59	183	45.75	1.5
East South Central							
Kentucky	1	7	6	5	19	4.75	0.2
Tennessee	31	11	20	26	88	22.00	0.7
Alabama	48	44	36	32	160	40.00	1.3
Mississippi	23	21	14	23	81	20.25	0.9
West South Central							
Arkansas	21	15	15	15	66	16.50	0.9
Louisiana	31	15	24	28	98	24.50	0.9
Oklahoma	15	9	14	7	45	11.25	0.5
Texas	†	22	43	55	120	40.00 ‡	0.5 ‡

(continued)

* Case Rate less than 0.05 are shown as 0.0.

† Not notifiable by state.

‡ Three year averages (Maine, 1951–1953; North Carolina and Texas, 1952–1954).

Table 2—Geographical Distribution of Reported Tetanus Morbidity, Annual Average Case Rates, 1951–1954—Continued

States	No. of Cases				Total	Average No.	Case Rate * Annual Average (Cases per 100,000 Population)
	1951	1952	1953	1954			
Mountain							
Montana	1	1	2	3	7	1.75	0.3
Idaho	4	1	1		6	1.50	0.3
Wyoming					–	–	–
Colorado		3		1	4	1.00	0.1
New Mexico	2	3			5	1.25	0.2
Arizona	1	1		2	4	1.00	0.1
Utah					–	–	–
Nevada					–	–	–
Pacific							
Washington	4	1	2	6	13	3.25	0.1
Oregon	1	3	2	1	7	1.75	0.1
California	52	43	42	47	184	46.00	0.4
United States	506	484	506	524	2,020	520.75	0.3

usually after delivery at home or after a hospital-delivered baby reaches home. The unhealed umbilicus is the usual site of contamination with tetanus spores and consequent toxin production. Spivey [18] emphasizes that the chance of recovery increases with the length of the incubation period. He also states that the prognosis is more favorable if the onset is after the seventh day of life, although the mortality remains high in this group.

A review of recent literature reveals that there are a few other sources of tetanus infections which may be defined. Postoperative or surgical tetanus is now a rare occurrence in this country, judging by published reports, whereas about 30 years ago [20] it was said to account for up to 10 per cent of cases. Although there is no doubt that some cases were associated with contaminated catgut, it has been pointed out by Hayes [21] that too much emphasis has been placed on this one source and that imperfect sterilization of dressings also was important. A recent report from Stoke-on-Trent, England, of an outbreak in a surgical ward [22] emphasizes that this can still occur in modern hospitals. The source in this episode had not been established at the time of the report. Chronic skin lesions or ulcers are thought to be important sources of tetanus infection, especially with subsequent operative procedures. For this reason some authors [23] have suggested that all patients who are to undergo operations for old contaminated wounds or chronic ulcers should be protected by active or passive immunizations. A final subgroup of the postoperative category which should be mentioned is tetanus following criminal abortion, although the extent can not be estimated.

Another category of tetanus is that among drug addicts using unsterilized needles, syringes, or contaminated drugs. In a one and one-half year period ending in July, 1954, Levinson [24] reported that 12 of 22 adult tetanus cases treated at Cook County Hospital, Chicago, had been heroin addicts. The fatality in these cases was 100 per cent. This high frequency of drug addict cases seems atypical, even in large cities, for only scattered cases have been reported in other cities.

Table 3—Distribution of Tetanus Mortality by Age, Race, and Sex, Annual Average Specific Rates, United States, 1951–1954

Age (Years)	Sex	White Deaths		Nonwhite Deaths	
		Total Number	Age-Race-Sex Specific Rate * (Annual Average)	Total Number	Age-Race-Sex Specific Rate * (Annual Average)
Under 1	Male	85	1.4	140	15.6
	Female	62	1.1	108	12.0
1–4	Male	35	0.1	25	0.7
	Female	26	0.1	15	0.4
5–19	Male	136	0.2	80	0.9
	Female	58	0.1	41	0.4
20–44	Male	53	0.1	29	0.3
	Female	53	0.1	41	0.3
45–64	Male	117	0.2	59	1.1
	Female	52	0.1	23	0.4
65 and over	Male	97	0.4	24	1.4
	Female	49	0.2	13	0.7
Total All Ages	Male	523	0.2	358	1.1
	Female	301	0.1	241	0.7

* Deaths per 100,000 population.

By far the largest category of tetanus cases are those following injury. Recently,[24, 19, 25, 5] emphasis has been placed on the incidence of tetanus following apparently minor or trivial injury. The most frequent injuries of this type were puncture wounds, which are ideal for the anaerobic propagation of the tetanus bacillus. The current emphasis on minor wounds and lacerations reflects the efficacy of medical practices today in the prevention of tetanus in the more severe wounds.

While the number of children immunized against tetanus steadily increases, two immediately problems seem apparent in the residual tetanus picture in the United States. These are neonatal tetanus, predominantly in the southern infant, and the incidence in all age groups of tetanus infections following apparently minor wounds.

The long-term goal for the elimination of tetanus neonatorum depends on increased public health education, particularly in the care of the newborn infant in the southern states. Universal hospital delivery does not provide the answer completely, for reports of the experience in Dade County, Fla.,[26] or Charity Hospital, New Orleans,[18] demonstrate that infection may occur after a hospital-delivered baby reaches home. In the 1955 report on the "Control of Communicable Diseases in Man" the American Public Health Association[32] recommends that mothers should be actively immunized with toxoid during pregnancy in areas where tetanus neonatorum is prevalent. The resultant titer of passively transmitted maternal antibody in the newborn will protect the infant in the first month, when the risk is maximal. Fernan-Nunez urged such

a course in 1938 and cited an instance in a tropical medical practice[27] where this technic had reduced the incidence of tetanus neonatorum to zero. Cohen in 1946[28] and Scheibel and Mathes in 1955[4, 26] also indicated such a course. On the other hand, it should be noted that others have advised against such a plan[29, 30] on the grounds that the passive immunity produced in the infant will prevent an effective response to the established active immunization programs in early infancy. Peterson and Christie[31] emphasize that the administration of vaccine to pregnant mothers to enhance passive immunity would complicate current immunization programs. Careful studies should be initiated in areas where this type of immunization program is in practice to determine the effect on the infant's response to subsequent active immunization.

The second problem is that of tetanus following apparently minor wounds. As the majority of these are not brought to the notice of a physician, the solution must be directed toward universal active tetanus immunization starting in childhood, as well as education of the importance of minor wounds.

In previously immunized individuals a booster dose may be given for a minor wound without fear of reactions, such as are seen with the administration of antitoxin. It has been estimated[4] that passive immunization with antitoxin involves a risk of about one per 100,000 of fatal immediate serum reactions and about a 20–30 per cent risk of delayed serum reactions. This necessary administration of antitoxin may also result in sensitivity to all horse serum preparations and deny the individual subsequent protection in incidents of other infections.

Finally, some reference should be

Table 4—Tetanus Mortality by Race, Total Deaths Under 28 Days of Age, Annual Average Rates, 1951–1954, Selected States *

State	Total Deaths Under 28 Days of Age			
	White		Nonwhite	
	No.	Annual Rate †	No.	Annual Rate †
Florida	–	–	31	34.3
Mississippi	2	1.8	10	6.7
Texas	106	13.0	27	20.0
Alabama	3	1.4	41	30.3
Louisiana	2	1.0	21	15.2
Arkansas	4	3.0	15	23.5
Georgia	3	1.2	29	18.6
Tennessee	1	0.4	14	19.6
South Carolina	–	–	6	4.7
North Carolina	1	0.3	12	7.5
Oklahoma	1	0.5	8	29.6
Virginia	1	0.4	3	3.1
Missouri	4	1.2	8	19.4
Total, Selected States	128	3.7	225	16.2
Other States	10	0.1	7	0.8
United States	138	1.0	232	10.2

* Selection criterion was states registering four or more deaths during the 1951–1954 period.
† Deaths under 28 days per 100,000 live births.

made of the so-called high-risk groups, defined by occupational exposure, such as agricultural workers, industrial and construction workers, or the military forces. With the exception of the last group—although there is much discussion in the literature of immunization programs for these individuals—there is little evidence that these groups incur tetanus more frequently. Studies should be made to determine whether high-risk groups exist, and the emphasis in public health immunization programs should be directed to assure active immunization with tetanus toxoid to those risk groups and perhaps to all individuals if high-risk groups do not exist. Tetanus may evenutally be an entirely preventable disease.

Summary

1. The morbidity and mortality due to tetanus in the United States is reviewed for the period 1947–1955.

2. Despite the advent of improved preventive and therapeutic methods, the incidence of tetanus has shown little change.

3. Important features of the mortality data are the frequency of tetanus deaths in nonwhites and among children under 28 days of age.

4. Thirteen southern states accounted for nearly all of the neonatal deaths.

5. A proposal is made for increased efforts of public health workers for universal active immunization in infancy. In addition, it is suggested that in areas where tetanus neonatorum is reported, that the incidence may be reduced by active immunization of the expectant mother.

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Peaceful Uses of Atomic Energy

The First International Conference on Peaceful Uses of Atomic Energy was held in 1955. It was so successful that the United Nations General Assembly has called a second conference in Geneva, September 1–13, 1958. The United States government has accepted an invitation to participate.

The Atomic Energy Commission, which has established an office for the International Conference, will develop the technical participation of this country. The American Public Health Association has been invited to submit the names of authors, titles, and abstracts of papers that might be considered for presentation.

A paper for presentation before the conference should be submitted by January 1, 1958, with an abstract of not more than 500 words, to the Technical Director, Office for the International Conference, Atomic Energy Commission, 1901 Constitution Ave., N.W., Washington 25, D. C. The AEC suggests that "Subjects of papers should be broad in scope rather than the presentation of results of individual research and development projects."