

And now, in conclusion, I may remind you that I commenced by referring to the plaint of Elizabethan science, that cold was not a natural available product. In the course of a long struggle with nature, man, by the application of intelligent and steady industry, has acquired a control over this agency which enables him to produce it at will and with almost any degree of intensity short of a limit defined by the very nature of things. But the success in working what appears at first sight to be a quarry of research that would soon suffer exhaustion has only brought him to the threshold of new labyrinths. The battle-fields of science are the centres of a perpetual warfare in which there is no hope of final victory, although partial conquest is ever triumphantly encouraging the continuance of the disciplined and strenuous attack on the seemingly impregnable fortress of nature.

TETANUS AND VACCINATION:

AN ANALYTICAL STUDY OF 95 CASES OF THE COMPLICATION.

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DURING the year 1901 an unusual number of cases of small-pox in different parts of the United States stimulated the health authorities to a vigorous endeavour to protect the public by vaccination and in that year great activity in this direction took place throughout the United States.

The occurrence of a number of cases of tetanus succeeding vaccination, at first in Cleveland, Ohio, and then in Camden, New Jersey, early attracted my attention as this, to me, unknown complication seemed a matter of the greatest importance, increasing the danger of vaccination and correspondingly increasing the animosity of those misguided persons who have banded themselves together for the organised opposition of this well-recognised and only safeguard against small-pox.

The cases of tetanus in Camden have been so exploited in the newspapers and have been made the subject of so many editorial articles and comments in the medical press that they will, no doubt, form the starting-point of numerous future attacks against vaccination, so that I deemed it important that as many cases of the complication as could possibly be collected should be brought together and carefully analysed in order to determine whether tetanus is a necessary or an avoidable complication of vaccination. If necessary, we should be prepared for it and should know how often to expect it; if avoidable, we should seek to eliminate it by every precaution regarding the selection of a superior virus and the performance of a careful operation. At all events, we should know what relationship exists between the two affections.

TETANUS IS NOT A RECOGNISED COMPLICATION OF  
VACCINATION.

The only text-book in which I have been able to find any mention made of the complication is the recent edition of Osler's "Text-book of Medicine," in which it is simply stated that "tetanus occasionally follows vaccination." In the Minority report of the British Commission, published in 1896, in which the disadvantages of vaccination are carefully and forcibly summarised, a single case, apparently the only one they were able to collect, is mentioned. Ordinary writers upon vaccination entirely ignore tetanus. The literature on the subject is extremely meagre. In the Index Catalogue of the Surgeon-General's Library at Washington only seven cases are mentioned under titles by which they can be recognised and I have found a total of but 14 cases in the literature. These cases have occurred at remote periods in different parts of the world and were all attributed to secondary infection of the wound. It seems reasonable, therefore, to conclude that tetanus has not been a frequent or important complication of vaccination in the past, either in this or any other country. It may, however, be surmised that what is true at the present time has also been true in the past and that when a case of tetanus did occur an attempt was made to suppress rather than to publish it, lest

its influence should be injurious; but if in the past any such epidemics of tetanus had taken place as have been recently experienced the medical literature would certainly contain some reference to it, for, suppressed as the cases are at the present time, very few of the recent cases having been published in detail, rumours of cases and editorial articles referring to the cases and speculating upon their occurrence are to be found in many of the journals both in this country and abroad. The lack of information concerning the complication cannot depend upon the failure to recognise it, as tetanus has been a well-known disease for centuries and, indeed, very little has been added to its symptomatology since the days of Hippocrates.

I have been able to collect a total of 95 cases of tetanus following vaccination. Throughout the paper I shall refer to "cases," meaning by the term occurrences of tetanus that I have succeeded in authenticating and of which I have considerable detail, while the term "rumour" will be used for cases of tetanus the occurrence of which is certain but concerning which for various reasons I have been unable to secure the details. The greater part of my information has been collected by personal correspondence and has been obtained with the request that it should be regarded as confidential. I do not, therefore, append the synoptical lists from which my conclusions are drawn, though I can at once place the matter at the disposal of anyone interested in the subject.

Cases of tetanus following vaccination are reported as follows:—

1854.—Isabella XX. Dr. J. D. Cottman, *New Orleans Medical and Surgical Journal*, 1854-55, vol. xi., p. 783.  
1878.—Edward K. Dr. G. Ross, *South Clinic*, Richmond, Va., 1878-79, vol. i., p. 468.  
1882.—Ben Jones. Dr. W. C. T. Bates, *Transactions of the South Carolina Medical Association*, Charleston, 1882, vol. xxxii., p. 105.—John McLane. Dr. T. Dimon, *St. Louis Courier of Medicine*, 1882, vol. vii., p. 310-312.—D. M. Dr. H. J. Berkeley, *Maryland Medical Journal*, Baltimore, 1882-1883, vol. ix., pp. 241-245.  
1886.—Male. Dr. Rudesindo Garcia Rijo, *Cron. Med.-Quir. de la Habana*, 1886, vol. xii., p. 388.  
1889.—Infant. Bromley Case. *THE LANCET*, Nov. 2nd (p. 922) and 9th (p. 970), 1889.  
1891.—Negro boy. Dr. Ruiz, *Cron. Med.-Quir. de la Habana*, 1891, vol. xvii., p. 649.  
1893.—M. D. W. Bellport, L.I. Dr. S. W. S. Toms, *Medical News*, Feb. 24th, 1894.  
1897.—British Commission case. Appendix IX. to the Final Report of the Royal Commission on Vaccination, 1897, Case 10, p. 6.  
1899.—A. K., XXX, and C. R. Surgeon-General's Report, June 30th, 1900, pp. 205 and 206.  
1901.—XXX. Dr. W. Findlay and Dr. J. W. Findlay, *THE LANCET*, Feb. 22nd, 1902, p. 506.

TABLE I.—Synoptical Table of the Cases.

Cases from the literature	...	...	...	...	...	...	...	14
Cases collected but not published—								
<i>a.</i> With complete details	...	...	...	...	...	...	40	
<i>b.</i> With incomplete details	...	...	...	...	...	...	13	
							—	53
Rumours	...	...	...	...	...	...	...	28
								95

Fatalities	...	...	61	Adults	...	...	...	25	Males	...	...	...	38
Recoveries	...	...	24	Children	...	...	...	45	Females	...	...	...	29
Unknown	...	...	10	Unknown	...	...	...	25	Unknown	...	...	...	28
			95					95					95

The following table shows the chronological order of the cases which I have succeeded in collecting.

TABLE II.—Cases of Tetanus showing the Chronological Occurrence.

Chronology.	Cases.	Rumours.	Chronology.	Cases.	Rumours.
1854	...	1	1898	...	3
1878	...	1	1899	...	3
1882	...	3	1900	...	1
1886	...	1	1901	...	45
1889	...	1	1902	...	5
1891	...	1	Unknown		1
1892	...	0	date	...	
1893	...	1			67
1897	...	1			28
					95

TABLE IIA.—Showing the Month of Appearance of Symptoms of Tetanus in the Cases occurring in 1901.

Cases.			Cases.		
January...	...	0	July...	...	1
February...	...	0	August...	...	1
March...	...	1	September...	...	1
April...	...	0	October...	...	1
May...	...	0	November...	...	24
June...	...	1	December...	...	7

TABLE IIB.—Showing the Locality and Source of Virus in Cases occurring in November, 1901.

Case.	Locality.	Virus.	Case.	Locality.	Virus.
33	Atlantic City, N.J.	E	54	Philadelphia, Pa.	E
27	St. John's, N.B.	E	55	"	E
26	Three Rivers, Ont.	I	58	"	E
34	Atlantic City, N.J.	E	66	Camden, N.J.	E
36	"	E	67	"	E
37	"	E	68	"	E
39	Milville, N.J.	E	69	"	E
40	Bridgeton, N.J.	E	70	"	E or A
47	Bristol, Pa.	S	72	"	E or A
48	"	E	73	"	E or A
52	Philadelphia, Pa.	E or A	74	"	E
53	"	E	76	"	E

Virus E = 18 cases; E or A = 4 cases; S = 1 case; I = 1 case; total, 24 cases.

The large number of cases in the year 1901 indicates that some exceptional condition existed that changed an unimportant and infrequent complication into a very important and frequent one.

The occurrence of tetanus as a complication of vaccination has been variously explained as follows.

1. That it is an accidental, secondary infection of the vaccination sore.—Those holding this view think that the complication depends upon conditions ever present and only to be expected and that its deplorable occurrence can be prevented by the exercise of greater skill and caution in the performance of the operation of vaccination and in the subsequent treatment of the wound. That such a micro-organism as the tetanus bacillus, the natural habitat of which is the soil and which occurs widely disseminated in nature, may occasionally be able accidentally to find its way into vaccination lesions cannot be gainsaid. It is certainly possible, and may occasionally happen, as, indeed, the scattered cases in the literature seem to prove, but there are very cogent reasons opposed to the view that the many cases of 1901 can be so explained, and to content one's self with this simple explanation may be to fall into egregious error, for if tetanus does thus occur it should do so in all parts of the world and with more or less regularity.

The various indices to the medical literature are without any references to cases of tetanus following vaccination in most European countries. A communication from the Imperial Health Office of Berlin informs me that the complication is unknown in the German Empire. Letters from the Pasteur Institute at Paris, the Pasteur Institute at Lille, and the French Institute inform me that the complication is unknown in France. No cases appear to have occurred in Italy, Russia, Austria, or other European countries, so that we are engaged in the consideration of a complication that is chiefly American, has become important within a year, and was epidemic in the month of November, 1901.

2. That the occurrence of the complication depends upon a local prevalence of the tetanus germs.—The epidemic in Camden has been attributed to germs in the dust of that city, in which there had been a prolonged period of dry weather. Were this the true explanation we should find ordinary traumatic tetanus occurring more frequently than usual. See tables of statistics of Camden and Philadelphia Health Departments. This is, however, not the case, as aside from the vaccination cases there were fewer than the

usual number of cases both in Camden and Philadelphia. Further, while it is true that a greater number of cases of tetanus following vaccination occurred in Camden than in other places of equal size, the occurrence of tetanus following vaccination has too wide a geographical distribution to be explained in this way.

Cases are reported from 17 different States in the United States, from the Dominion of Canada, Porto Rico, the Philippine Islands, Cuba, &c.

TABLE III.—Report of the Board of Health, Room 610, City Hall, Philadelphia, March 4th, 1902.—Deaths from Tetanus.

Months.	1897.	1898.	1899.	1900.	1901.
January...	6	5	0	4	3
February...	1	4	3	1	1
March...	4	2	2	3	0
April...	1	1	0	4	2
May...	1	4	3	3	1
June...	3	3	3	1	1
July...	1	1	10	6	6
August...	3	1	7	5	1
September...	3	1	3	1	2
October...	1	3	5	5	5
November...	1	2	2	1	4
December...	3	2	3	3	3
Totals...	28	29	41	37	29

Note.—This table is of but small value, as it shows no apparent increase of tetanus during the year 1901 and shows only 29 reported cases in all, whereas I have been able to collect nine fatal cases resulting from vaccination. Should we subtract these we would find much less traumatic tetanus than usual in Philadelphia during that year. The table certainly shows very little, but fails to show that because of atmospheric or telluric conditions tetanus was exceptionally prevalent in Philadelphia during 1901.

TABLE IV.—Report of the Health Department of the City of Camden.—Deaths from Tetanus.

—	1901	1900	1899	1898	1897	1896	1895	1894	1893	1892	1891	1890
January...	—	—	—	—	—	—	—	—	—	—	—	—
February...	—	—	—	—	—	—	—	—	—	—	1	—
March...	—	—	—	—	—	—	—	—	—	—	—	—
April...	—	—	—	—	—	—	—	—	—	—	—	—
May...	—	—	1	—	1	—	—	—	—	—	—	—
June...	—	—	—	—	—	—	1	—	—	—	—	—
July...	1	—	—	—	—	—	—	—	—	—	—	—
August...	—	—	—	2	—	—	—	—	—	—	—	—
September...	—	—	—	1	—	—	—	1	—	—	—	1
October...	—	—	—	—	—	—	—	—	—	—	—	—
November...	9	—	—	—	—	—	—	—	—	—	—	—
December...	1	1	—	—	—	—	—	—	—	—	—	—
Totals...	11	1	1	3	1	—	1	1	—	—	1	1

Note.—I was able to collect 11 cases of tetanus following vaccination in Camden and one case of traumatic tetanus occurred about the same time, making a total of 12 cases. The table shows 11 deaths. Three of the vaccination cases recovered, so that there is here a slight difference between my collected cases and the report of the Health Department. The eight fatal vaccination cases, plus the fatal traumatic case, subtracted from the 11 reported fatalities, leave us two cases unaccounted for—a difference not sufficient to show any greater general prevalence of the disease than occurred in 1898.

That geographical conditions may exert a pronounced influence upon the occurrence of the tetanus which is known to be particularly prevalent in certain districts. Thus it is said that Cuba and Porto Rico have soils particularly rich in tetanus bacilli and that Long Island has a similar dangerous soil. That such an influence is important is, however, very doubtful, as from the so-called dangerous localities very few cases have been reported (three Cuba, three Porto Rico, and two Long Island). (See table.)

TABLE V.—*Tetanus Cases showing the Geographical Distribution.*

	Cases.	Rumours.
Canada.—Three Rivers, Quebec ... ..	1	—
St. John, N.B. ... ..	1	—
Connecticut.—South Glastonbury... ..	1	—
Cuba.—Havana ... ..	3	—
England.—Recorded in THE LANCET ... ..	1	—
Commissioners' Report ... ..	1	—
Illinois.—Chicago... ..	0	1
Louisiana.—New Orleans ... ..	1	—
Maine.—Biddeford ... ..	1	—
Maryland.—Baltimore ... ..	1	—
Massachusetts.—Belmont... ..	1	—
Cambridgeport ... ..	1	—
East Dennis ... ..	1	—
Boston ... ..	1	—
Michigan.—Kalamazoo ... ..	1	—
Minnesota.—Minneapolis ... ..	1	—
Taylors Falls... ..	1	—
Missouri.—St. Louis ... ..	0	1
New Jersey.—Atlantic City ... ..	4	2
Bridgeton ... ..	1	—
Camden... ..	11	—
Jordantown ... ..	0	1
Millville ... ..	1	—
New York.—Albany ... ..	1	—
Long Island ... ..	2	—
Owego ... ..	1	—
Ocean.—City of Para ... ..	1	—
Ohio.—Cincinnati ... ..	0	1
Cleveland... ..	4	—
Pennsylvania.—Bristol ... ..	2	—
Easton ... ..	1	—
Girardville ... ..	1	—
Lyndell ... ..	1	—
Millbach ... ..	0	1
Philadelphia ... ..	11	12
Rosemont ... ..	0	2
Philippine Islands ... ..	1	—
Porto Rico ... ..	1	2
Scotland ... ..	1	—
South Carolina.—Charleston ... ..	1	—
Tennessee.—Paris ... ..	1	—
Unknown ... ..	0	6
Virginia.—Richmond ... ..	1	—
Wisconsin.—Milwaukee ... ..	1	—
	67	28
	95	

3. *That carelessness in the treatment of the vaccination wound facilitates accidentally secondary infection with tetanus.*—While this has a ring of genuineness about it, and is doubtless true in some of the scattered cases, the argument is extremely unconvincing when applied to the cases of 1901. For 100 years vaccinations have been performed with a total disregard to cleanliness and asepsis in all parts of the world, on all classes of people, in towns and cities, by careless and careful physicians, upon clean and dirty persons, without the use of any dressing, yet during these many years tetanus has remained almost an unknown complication. We cannot conceive of any difference between the social conditions of the present and those of the past that are not immensely in favour of the present, yet it is at present that we find tetanus epidemic.

In our own country greater care is undoubtedly exercised at the present time than heretofore, and in those countries in which, because of ignorance and poverty, the same social conditions prevail at the present time that existed a hundred years ago—as, for example, among the peasantry of Europe—we find tetanus practically unknown.

Vaccination wounds are treated with much greater care at the present time than ever before, and it is now becoming recognised that vaccination is an operation, and that to free it from the common dangers of all operative manipulations cleanliness and care are essential. We therefore find that at present the skin is cleansed and disinfected and the lesion itself protected and subsequently dressed with a care never dreamed of a few years ago, yet when we come to examine

the details of those cases which have come within our knowledge we find that this care of the wound appears to be without influence upon the occurrence of tetanus, for while many cases have occurred among ignorant and filthy children, in an equally great number of cases more than ordinary care seems to have been exercised. Thus one case occurred in the person of an adult sister of a physician in Cleveland, Ohio. Both the patient and the operator were refined and cultured people, were apprehensive of the results, and exerted unusual precautions, yet despite all death from tetanus followed this vaccination. Here let it be said that the virus associated with so many cases (virus E) was used.

The ignorant and filthy people of the island of Porto Rico, with no knowledge of hygiene or personal cleanliness, living in a place reputed to be extremely dangerous because of tetanus bacilli in the soil, were vaccinated by the United States authorities after the occupation of that territory, and out of some 800,000 vaccinations three cases of tetanus, two of which are very doubtful, are reported by Dr. George G. Groff.

4. *The use of a shield to protect the vaccination wound has recently become quite common and has been blamed for the occurrence of tetanus.*—The shield has, however met with violent and perhaps justifiable condemnation, on the ground that the pressure of its edges and of the adhesive plaster bandages by which it is held in place obstruct the lymphatic circulation and increase the severity of the wound and the danger of infection, also that the shield induces anaerobic conditions, so that by some the occurrence of tetanus has been blamed upon the shield. Upon looking over the reported cases, however, we find so few in which shields were used that they seem to have no influence upon the occurrence of the complication.

THE RELATION OF TETANUS TO THE VACCINE VIRUS.

With the evolution of vaccination as a prophylactic measure certain changes in technique have been gradually introduced. Thus bovine virus has now displaced the arm-to-arm and human scab vaccinations previously practised, and within the last quarter of a century the use of human virus has been almost entirely given up. Can it be that the danger from tetanus has something to do with the bovine virus? In a few of the early cases drawn from the literature tetanus followed the use of human virus. That the bovine virus is at fault seems possible when we consider that it is only in the last half-century that cases of tetanus have occurred, yet it can scarcely be at fault in itself, as bovine virus is the only form employed in Belgium, Germany, France, and other European countries where no tetanus has occurred. While it is suggestive that the first cases of tetanus reported in the literature make their appearance about the time bovine virus began to come into general use, it is not true that the number of reported cases increased in proportion to the popularity of the bovine virus, for from 1852, when the first case I have found makes its appearance in the literature, until 1901 only isolated cases are reported, usually at intervals of years.

The next step in the evolution of vaccination was the improvement in the quality of the virus, suggested by Copeman in 1891, by which glycerine was permitted to act for some time upon the virus for the purpose of destroying the undesirable micro-organisms it contained. By the use of the glycerine a bacteria-free virus may thus be secured. This improved virus made slow but steady progress, until at the present time it has attained the greatest popularity and bids fair to replace all other forms. It is used almost exclusively in Europe and has made very large inroads into America.

The glycerinated virus is so new, having been in use but 10 years and in common use little more than five years, that we are scarcely able to express a positive opinion regarding its advantages and disadvantages. The advantage of having the contaminating bacteria destroyed by the glycerine is indisputable; the disadvantage of occasionally having the glycerine act so long that the specific germs of vaccinia are killed and the virus made inert is also indisputable. That at times when the demands upon the manufacturer are exceptionally great the virus mixed with the glycerine might be placed upon the market before the necessary time had elapsed for the contained bacteria to be killed is a somewhat grave danger. These possibilities have somewhat lessened the confidence with which the preparation is received and used by many practitioners.

When we come to investigate the cases of tetanus concerning which information is at hand we are somewhat

startled to find that a large number of them have succeeded the employment of this supposedly best and most refined preparation. This point will be discussed below.

It must also be pointed out that the epidemics of tetanus which are the subject of this paper occurred at a time when an almost unprecedented demand for virus taxed the output of the manufacturers to their utmost and must have tempted them to market "partly refined" goods. It is not impossible that it was insufficient contact with the glycerine that permitted tetanus bacilli to remain alive in the virus, though as glycerine fails to kill tetanus spores it is doubtful whether this is the chief or sole error.

TABLE VI.—*Showing the Relation of Tetanus to the Make of the Virus.*

Viruses.	Dry.	Glycerinated.		Totals
		Points.	Tubes.	
E .. ..	3	10	17	30
A ... ..	2	—	—	2
D ... ..	0	—	2	2
W ... ..	0	1	—	1
S ... ..	0	—	3	3
I ... ..	1	—	—	1
G ... ..	1	—	—	1
—	7	11	22	40
Proportion..	7	33		

*Relationship to particular brands of virus.*—When an attempt is made to determine whether the employment of any particular brand or make of virus is succeeded by an unusually large number of cases of tetanus we discover that while an occasional case of tetanus has succeeded the use of the virus of nearly all of the large manufacturers, the great majority of the cases of 1901 have succeeded the use of a particular brand of virus and make us suspect that the tetanus bacilli were contained within it.

The brands of virus to be considered are called E, D, A, S, W, I, St. and Wd. Those called E, A, and D are the products of the largest American manufacturers who it is not improbable do about an equal amount of business. It is safe to say that these vaccines are all made with the exercise of as great amount of skill as present knowledge permits. No care or expense is spared to have these products perfect. We find, however, a remarkable discrepancy in the results following their employment—a discrepancy that leads me to conclude that the tetanus bacillus is contained in the virus and distributed with it. Careful examination of the accompanying table will show the disproportion of cases.

The occurrence of 30 cases of tetanus after the employment of virus E suggests that tetanus germs were present in it in larger proportions than in any other, though the occurrence of only 30 cases following the use of millions of doses of this virus indicates that the number of tetanus organisms present is small and the occurrence of the cases in groups that their distribution is irregular.

*The occurrence of cases in groups.*—In this connexion must be pointed out as interesting and significant the groups of cases that have occurred from time to time. Thus in Cleveland, Ohio, during 1901 we note the occurrence of four cases: in Camden, New Jersey, during October, November and December, 1901, the occurrence of 11 cases; at Atlantic City, about the same time, five cases; and in Philadelphia and vicinity nearly at the same time about 25 cases (and rumours). If we analyse the cases we find one vaccine (virus E) chiefly if not exclusively implicated. The most instructive group of cases that I have been able to study occurred in the Philadelphia Hospital. In this institution with nearly 4500 inmates there was a threatened epidemic of small-pox depending upon the admission of a case of small-pox from the street. After one or two cases had developed within the institution it was decided to vaccinate every inmate, and the resident physician went systematically through the institution, vaccinating sick and well alike. The institution was thus vaccinated with the exception of the Men's Insane Department, the greater number of the inmates of which were obliged to wait a few days until a new consignment of virus

arrived. With this new consignment (virus E) they were then all vaccinated. Upon looking up the statistics of the hospital we find that in the insane departments, male and female, no case of spontaneous traumatic tetanus had developed within 12 years. It is, in fact, not known that there ever has been a case of traumatic tetanus developed within the walls of the institution, but this cannot be determined as the records prior to 12 years ago were destroyed by fire. Succeeding the vaccination, however, a group of tetanus cases, confined exclusively to the Men's Insane Department, occurred. Here five typical cases with trismus and opisthotonos and every marked symptom of the disease occurred, all being followed by death, four from trismus itself and one from pneumonia occurring immediately after a cessation of the spasms. The occurrence of this outbreak occasioned much alarm, so that every suspicious vaccination wound observed was thoroughly excised and treated antiseptically. After this excision of the wounds 11 additional cases developed trismus and muscular rigidity, though after the administration of enormous doses of anti-toxin they all recovered. In going carefully over the details of these cases I find that with one very doubtful exception (vaccinated with E or A) every patient who developed tetanus was vaccinated with the same virus which had caused tetanus at Cleveland, Camden, Atlantic City, and elsewhere (virus E). As the diagnosis of the 11 cases that recovered is somewhat questionable I have included them among the *rumours* and have not introduced them into the statistical tables. Should it be suggested that the occurrence of the cases of tetanus in groups depends upon the popularity of the virus in certain districts, as Philadelphia, Camden, and Atlantic City, where it was almost exclusively used, and that in these districts some telluric, atmospheric, or other condition prevailed, causing them to be more predisposed to tetanus than the country in general, the idea should be at once dispelled by a few moments' consideration of the statistics presented. Thus, if we deduct from the 30 cases succeeding the use of virus E, the six positive cases occurring in Camden, the seven positive cases occurring in Philadelphia, and the three positive cases occurring in Cleveland, there remain against this virus a total of 14 cases, which is greater than the sum total of all the cases referable to all the other viruses produced in the country, thus showing that even where the cases are scattered and not in groups virus E has four times as many cases against it as any other virus and more cases than all the other viruses put together.

In the accompanying table 40 cases are presented with exact information concerning the make and form of virus employed. Of these 40 cases, 30 follow the employment of virus E, 10 follow the use of all other forms combined, and no single other virus has a higher number than three. This seems to show quite convincingly that there is something about virus E that is different from the others. In addition to these 40 cases with complete details I have eight additional cases in which it is known that one or the other of two viruses was used but in which it cannot now be certainly determined which of the two it was.

TABLE VII.—*Cases of Disputed Virus where One or the Other of Names are Given.*

Cases.	E	A	D	W	Wd	St
25	1	—	—	1	—	—
29	1	—	1	—	—	—
45	1	—	—	—	—	1
56	1	1	—	—	—	—
71	1	1	—	—	—	—
72	1	1	—	—	—	—
73	1	1	—	—	—	—
91	—	—	1	—	1	—
—	7	4	2	1	1	1

We find that in the cases of this group vaccine E figures in seven. If we assume, which it would be fairly justifiable to do, that in all of these cases virus E was used, then the disproportion is changed from E 30 to all others 10 (30 : 10), to E 37 to all others 10 (37 : 10), thus making matters worse. If, however, we proceed on the reverse order and admit that

E may be erroneously charged with these cases we find the proportion E 30 to all others 18 (30 : 18), so that matters are but little improved for virus E. Comparing E with the other viruses made by equally large houses the disproportion is, of course, much more striking than when comparing it with the sum of all others, thus —

E 30 (without disputed cases)...	} D 2.
E 37 (with disputed cases) ...	
E 30 ... ..	} A 2.
E 37 ... ..	
E 30 ... ..	} S 3.
E 37 ... ..	

It certainly seems impossible that if the viruses were of equally good quality such a disproportion as 30 : 2 and 30 : 3 could persist.

TABLE VIII.—Table of Comparisons.

Viruses.	Known.	Disputed.
E	30	7
A	2	4
S	2	0
D	3	2
W	1	1
Wd	0	1
St	0	1
G	1	0
M I	1	0

If we refer to the chronological table given it becomes apparent that it is only occasionally that outbreaks of tetanus following vaccination occur. The scattered cases in the literature and the few cases observed to occur after the employment of viruses of all makes may depend upon secondary infection. In the few cases contained in the literature in which tetanus succeeded arm-to-arm vaccination this is very probably true, but it is impossible for this explanation to apply in the sudden appearance of 24 cases (without rumours) that developed during November, 1901. The only explanation that appeals to me is that while secondary infection of vaccination wounds occurs very rarely and while tetanus bacilli are contained in bovine vaccine in numbers large enough to produce tetanus occasionally, sometimes through accidents or carelessness unusually large numbers of tetanus bacilli get into the virus with resulting epidemics such as the one which is here considered. Granting the possibility of this it becomes of prime importance that the utmost precaution should be exercised in preparing the virus, and if possible that some new method should be adopted by which its manufacture shall be carried out without the possibility of danger of this kind.

*Dry and glycerinised viruses.*—The respective influence of dry and glycerinised virus upon the causation of tetanus is shown by reference to Table VI., where it is shown that seven cases followed the use of dry points, 11 the use of glycerinised points, and 22 the glycerinised tube virus. This proportion (seven to 33) appears to be convincingly in favour of the dry virus, but we find an error resulting from virus E. All three forms of virus E have been followed by tetanus in the respective proportions of dry points three, to glycerinised points 10, and glycerinised tube virus 17. If we entirely omit virus E from the consideration we find the totals of all other viruses to be :—

Dry points ... ..	4	} = 4 : 6
Glycerinised points ... ..	1	
Glycerinised tubes ... ..	5	

The proportion of four dry to six glycerinised is about correct when we remember that the glycerinised is the popular virus at the present time. This seems to show that there is no important disproportion in favour of dry over glycerinised virus as regards the occurrence of tetanus.

*The source of the tetanus bacilli in virus.*—When we consider the distribution of the tetanus bacillus in nature we find it in the soil chiefly whereon it has been well fertilised and in manure. The tetanus bacillus is, no doubt, frequently swallowed by herbivorous animals in browsing upon the surface of the ground, and the anaerobic conditions for its growth being excellent we find that the intestines of

herbivorous animals commonly contain large numbers of the bacilli which escape with the evacuations to be again deposited upon the soil in increased numbers. The first source of danger, therefore, by which vaccine virus can be contaminated is the manure of the calf, the next source the dusts arising from the dry manure and the soil, both of which may be brought into the stables with the hay or upon the animals.

When large hay-fed animals are employed for the manufacture of virus the manure is certainly a source of danger, but in stables where sucking calves are used for the purpose fewer tetanus bacilli are present in the excrement. However, Huddleson found them present in the faeces of 8 per cent. of the small calves used in the laboratory of the Health Department of New York. It is evident that from these sources opportunities for the entrance of tetanus germs into the vaccine virus occur, but as a matter of fact no one has yet succeeded in finding them in the virus. This indicates that their number must be so small that in the distribution of the virus in tubes and on points hundreds or thousands of tubes escape where one is contaminated. It must be unusual for many tetanus germs to be implanted at the time of vaccination but no doubt such implantations can and do occur.

*The incubation period.*—The period of incubation or ordinary traumatic tetanus varies from a few hours to several weeks (see chart), according to statistics derived from the study of a large number of cases.

TABLE IX.—Tetanus Cases, showing Incubation Period.

Shortest period ... ..	6 days.
Longest period ... ..	39 „
Average... ..	22 „

For points—

Shortest period ... ..	16 „
Longest period ... ..	30 „
Average... ..	23 „

For glycerine virus—

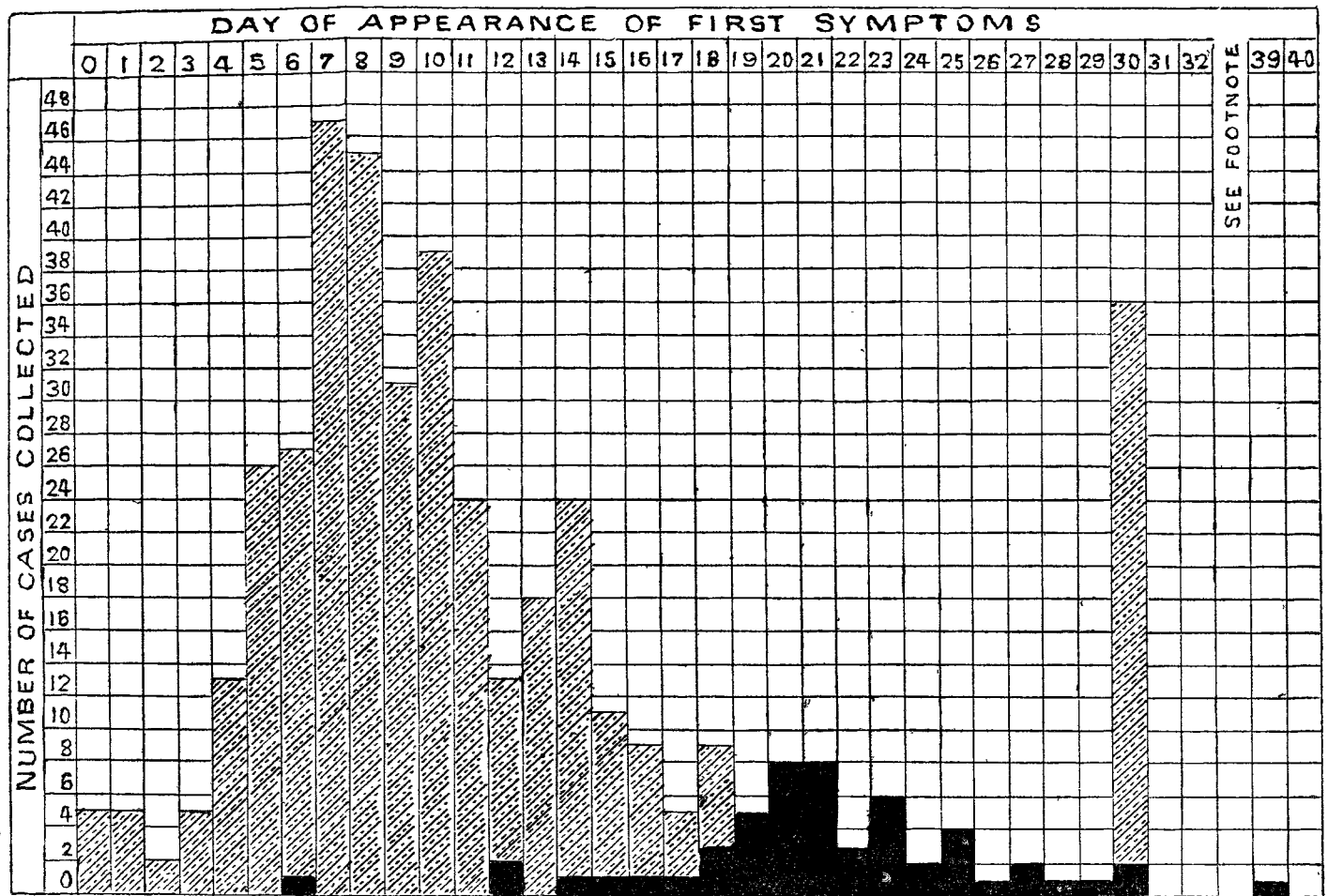
Shortest period ... ..	6 „
Longest period ... ..	39 „
Average... ..	22 „

The usual incubation period varies from seven to nine days. In the vaccination cases—that is, in cases of tetanus following vaccination—we find the shortest period of incubation to be six days, the longest 39 days, and the average 22 days. It is thus seen that tetanus following vaccination appears on the average about two weeks later than ordinary traumatic tetanus. This is the chief weak point in my argument and I think that if this error could be eliminated it would at once be conceded that the remaining facts are indisputable. The prolonged incubation is usually interpreted to signify that the infecting organism entered the vaccination as a secondary infection. In truth, however, how rarely do superficial ulcerations become infected with tetanus. Did anyone ever hear of a sudden paroxysmal outbreak of 61 cases of tetanus in one year following the infection of leg-ulcers, furuncles, mosquito bites, &c, even when cleanliness was not observed?

I think after the statistical demonstration that this secondary infection theory must be looked upon as a misinterpretation and that the fact probably is that the tetanus bacillus being ingrafted into the skin at the time of vaccination fails to find suitable conditions for its growth until the development of the vaccine lesion paves the way for it by the local destruction of tissue. This enables us to add to the usual period of incubation an additional period (a couple of weeks), during which the wound has been prepared for the implanted organisms to grow, thus bringing the entire period to the length usually observed in the vaccination cases. An examination of Table IX. shows that no difference exists between dry vaccine on points and glycerinised virus regarding the length of the incubation period.

In nearly every case in which I have succeeded in securing details I learned that the vaccination “took well.” This may not be without significance, though it may be interpreted in several ways. It may mean that those vaccinations in which marked local lesions occur are those in which secondary infection has the best chance of occurrence. If so, it means that severe vaccination lesions are dangerous and that mild viruses should be used, the multiple insertion of a mild virus being preferable to a single insertion of an active virus. It may also mean that the lesion was caused by an impure virus in which the tetanus bacillus might be contained as well as other organisms. Lastly, and I think truly, it





*Period of incubation.*—The columns in light shading represent cases of traumatic tetanus (337 in number); the black columns represent cases of vaccination tetanus (54 in number). In the original diagram the eight vertical columns with the headings 31 to 38 inclusive were blank; five of these were omitted in the reproduction, as above indicated, for economy of space.

may mean that it is only when such local lesions occur that the *implanted* tetanus bacilli can find conditions suitable for their development.

Reference is again to be made to the chronological development of the cases, by which it will be observed that the majority of cases occur at times when, because of agitation concerning small-pox, the demands for virus are great. This being the case, it is not impossible that vaccine viruses are sometimes marketed prior to the time when the action of the glycerine has extinguished the life of the bacteria in the virus and with less than the customary precautions regarding excellence of quality.

#### CONCLUSIONS.

The following conclusions seem justifiable. 1. Tetanus is not a frequent complication of vaccination. 2. The number of cases observed during 1901 was out of all proportion to what had been observed heretofore. 3. The cases are chiefly American and occur scattered throughout the eastern United States and Canada. 4. The cases have nothing to do with atmospheric or telluric conditions. 5. A small number occurred after the use of various viruses. 6. An overwhelming proportion occurred after the use of a certain virus (E). 7. The tetanus organism is in the virus in small numbers, being derived from the manure and hay. 8. Occasionally through carelessness or accident the number of bacilli becomes greater than usual and may lead to the epidemic occurrence of tetanus. 9. The future avoidance of the complication is to be sought for in greater care in the preparation of the vaccine virus.

NOTE.—Since writing the above the final proof needed to complete the argument seems to be given by Dr. Robert M. Willson who contributed to the Philadelphia County Medical Society on April 23rd, 1902, the information that he had discovered tetanus bacilli in large numbers in a vaccine virus made about the time of the epidemic of 1901. This bacillus, which was microscopically demonstrated to the society, was virulent for the small laboratory animals.

Philadelphia.

## A SUCCESSFUL CASE OF GASTRECTOMY FOR CARCINOMA OF THE PYLORUS AND LESSER CURVATURE OF THE STOMACH.

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THE operation of gastrectomy is on its trial. Mr. W. Watson Cheyne and Mr. F. F. Burghard in their recently published "Manual of Surgical Treatment," say: "Although the entire stomach has been removed for cancer with temporary success, we cannot think that the number of cases in which this can be done will be large; nor do we look upon the operation as at all a favourable one." They do not even describe the operation, as "if the growth be sufficiently large to warrant such a severe procedure, it is practically beyond hope of immunity from recurrence."

In the following case the operation as performed was not such a very severe procedure, and though it remains to be seen whether the growth will recur there is reason to believe that it has been radically removed. It seems to me that in all cases of gastric carcinoma, where operation is advisable at all, gastrectomy is indicated, as, it having been proved that the stomach is not essential for digestion, the more complete its removal the greater should be the probable immunity from recurrence, while the risk is not proportionally increased. If at all possible, it is, however, wise, for physiological reasons as well as for ease in operation, to leave a small portion of healthy stomach.

As compared with pylorotomy the operation as performed in this case was easier and took less time, because there was less stomach surface to suture. The cut edges were easily and rapidly brought together with continuous silk sutures (through all the coats) and then the duodenum was implanted