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## Tetanus vaccines and its effect on experimental animals specially mice

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### Abstract

The toxoids are prepared from *C. tetani* toxins by inactivating them using formalin. The toxins were extracted from *C. tetani* by culturing them in broth and then incubated in fermentation medium to produce the toxins. The toxins were then filtered by use of filter paper. In this study the effect of toxins was observed on mice's by injecting them intramuscularly. The toxin shows no effect when injected in low dose such as 0.1 micro liters but when the doses increased the symptoms starts to appear. The symptoms of toxin on mice's were muscle spasm, paralysis and eventually death for leaving them untreatable. The toxoids prepared from these toxins were also tested on rabbits for checking its potency. The vaccinated animal sera was then taken and checked the immune response i.e. antitoxins in the sera of vaccinated animals. As doses of toxoids increased the immune response appeared was high. Thus these toxoids can be used as a vaccine for the treatment of tetanus.

**Keywords:** Tetanus Vaccines, Rabbits, Mice and Guinea pigs

### Introduction

Tetanus was first described before more than 3000 years ago in Egypt later it was spread globally; Tetanus was a fatal disease and burning health problem before the discovery of passive immunization in 1893 and discovery of active vaccination in 1923. It is still the major health problem in developing countries. The mortality rate of tetanus in each year is about 1 million deaths cases, in which the most common cases are neonatal tetanus which is about 400 000 death cases in new born babies [1]. Tetanus is caused due to toxin produced by *Clostridium tetani* which mainly affect the neurons. The genera of *Clostridium tetani* is clostridia which is a large group of anaerobic gram positive bacteria these bacteria are rod shaped and spore forming. They are mostly present everywhere in environment, and are also a part of the intestinal flora of domestic animals such as horses, chickens, and even also found in humans intestines. These bacteria produce endospores which are in rod shaped but wider than rod shaped bacteria, due to which their shape appear like drumstick. The most common and severe diseases caused due to the toxins produced by this group of bacteria are tetanus of which the causative agent is *C. tetani*, and botulism which is caused due to the toxins of *C. botulinum*. *Clostridium tetani* is obligate anaerobic rod shaped flagellated bacteria which lose their flagella after the production of spores [2]. Spores of *C. tetani* become lethal after boiling for at least 15 minutes but it can't ensure that all spore of tetani will kill on boiling, some spores even after boiling survive. Ensure a safe technique for killing all spores and acquiring sterility is autoclaving at 120 °C, for 15 minutes. *C. tetani* causes localized infections. Spores of *C. tetani* are responsible for causing infections not only spores causing infection additionally, they get transmitted to body via contamination of wounds and also sometimes transmitted from getting injuries by contaminated objects [3]. Once the toxin of tetani reached and invade the neurons of a person then the anti-toxin cannot be effective to neutralize the action of these toxins. The gene of these toxins are encoded and present on a 75 kilo base plasmid which produce these toxin as a single polypeptide chain having molecular weight of 150 000 [4,5]. When *C. tetani* or its spores transmitted to body it starts the production of toxins inside the body and these toxins adhere in the central nervous system of infected persons, where it affect i.e. inhibit the function of neurotransmitters, such as glycine and gamma

aminobutyric acid, Due to which the nerve impulses become affected and causing paralysis and lockjaw etc [6]. The neonatal tetanus cases occurs due to unhygienic practices during the birth of baby, mostly the spores transmitted at a time of cutting of umbilical cord or dressing after delivery if the instruments used for such purposes are contaminated by spores of tetani. It is a fatal disease for newborns, its fatality rate in new born babies are up to 70 to 100% [7]. The tetanus disease in newborn babies is the main cause of deaths of babies in most of the countries having the mortality rate in hospitalized patients are up to 55 percent to 86 percent [8].

The neonatal tetanus cases are only preventable by maternal immunization with tetanus toxoid. By maternal immunization about 725,000 cases of neonatal tetanus prevented each year but still about 270,000 newborns death cases and 30,000 women death cases occurs due to tetanus worldwide [9, 10]. Initial studies on immunization against tetanus shows that use of both intrathecal anti-tetanus serum (ATS) or tetanus immunoglobulin (TIG) are effective [11] but the recent studies shows that intrathecal tetanus immunoglobulin treatment is more effective for both mild and moderate tetanus cases.

Maternal and Neonatal Tetanus (MNT) prevention and control is to decrease the neonatal cases up to 1 or less than 1 out of 1000 live births each year worldwide. The main 3 strategies for controlling MNT cases as recommended by Who/Unicef/Unfpa are: vaccinate all pregnant women in high risk area by at least 2 doses of tetanus toxoid (TT2) while vaccinate all childbearing age women by giving them of at least 3 doses of tetanus toxoid (TT3) and promoting the hygienic practices during the delivery of all pregnant women. The tetanus cases in the United States was dramatically decreased by the use of tetanus toxoid and improving the wound management from 560 cases (1947) to 48 cases in 1987 which was a record low cases (Pan American Health Organization, 2002; CDC, 2000). *C. tetani* spores are ubiquitous so for protection of all age groups from tetanus it is necessary to maintain subsequent antitoxin levels by means of taking appropriate timed boosters. It is thought that the immunization from tetanus toxoid remain persists for at least ten years (CDC, 1991). Protection from tetanus disease is acquired by development of neutralizing antibodies against tetanus toxin. The minimum protective level from tetanus is having at least 0.01 IU/mL of tetanus antitoxin in serum [12].

### Types of Tetanus Vaccines

The tetanus vaccines are in multiple combination of tetanus toxoid with diphtheria toxoid and pertussis antigen in a specific concentration to prevent diphtheria, tetanus, and pertussis diseases globally. The vaccines used for prevention of tetanus are in different types some are single used only for tetanus TT while some are combined with diphtheria toxin DT used for prevention of both tetanus and diphtheria. One dose of DT vaccines contains 6.7 to 25Lf diphtheria toxoid and 5 to 7.5Lf tetanus toxoid which are mainly used in children for primary immunization and boosting. While Td vaccine is used in adults for boosting and primary immunization which contains low dose of diphtheria i.e. less than 2Lf/dose but having a similar dose of tetanus toxoid as mentioned above.

Some tetanus vaccines are combination of tetanus toxoid, diphtheria toxoid and pertussis antigen. DTP vaccines are used for control of three diseases which are diphtheria, pertussis and tetanus. They are available in various forms and are given in 0.5 mL doses. The most common forms of

DTP vaccines are five which are DTwP, DTaP, Tdap, DT, and Td. Three forms of these vaccines which are DTwP, DTaP and DT are used for the children which are younger than 7 years, while the other two forms which are Tdap and Td are used for individuals which are 7 years or older than 7 years. The lower case mentioned in above vaccines names such as "d" and "p" shows that the concentration of diphtheria and pertussis toxoids in these vaccines are reduced as compared to other which is in combination. These reduced concentrations of one from other are due to prevent adverse effects in adults. While the alphabets such as "an" in "ap" in names of above vaccines indicates that the pertussis toxoids are a cellular.

### Methodology

For diphtheria and tetanus vaccine the potency and amount of toxoid were recorded in International Units (IU) and in Limits of Flocculation (Lf). The potency test for all of these toxoids was carried out in experimental animals which were mice's, rabbits and guinea pigs.

### Preparation of Tetanus Toxoid

The first step for production of tetanus toxoid vaccine is to prepare the tetanus toxins and then inactivate them so that we can get the tetanus toxoid. For preparation of tetanus toxins the *C. tetani* was cultured in NIH Islamabad Pakistan b using BHI broth. This BHI broth also contains 0.5 percent east extract+0.5 percent NaCl+2 percent glucose at a ph of 7.4. The *C. tetani* was inoculated in such broth and then incubated at 37 degree centigrade for overnight. The next day after incubation the cultured *C. tetani* was inoculated in fermentation medium so that we get the toxins of *C. tetani*. When we inoculate the cultured bacterial strain in fermentation medium they are placed again in incubator for at least 5 to 7 days. After incubation the toxins present in this media was purified and filtered for further use by testing them on experimental animals [13].

The purified toxin was then inactivated for preparation of toxoid and which then we may use it for immunization against tetanus. The toxin was inactivated by addition of Formalin and incubating at 30 to 45 °C [14]. We may add the formalin to fermentation medium having tetanus toxin before filtering toxin from fermentation medium and then filtered them b use of filter paper so we get the toxoid but by using such step the toxin if you want to test will not extracted because b use of formalin the toxin become inactivated in that medium.

After use of formalin the toxin become inactivated and it can b use for immunization purposes against tetanus. The filtered toxoid was added b glycerin and aluminium phosphate or hydroxide. The glycerin was used for the purpose of preservation while aluminium phosphate or hydroxide was used as adjuvant [15].

The prepared toxoid now was able to use for immunization purposes they were tested first on experimental animals for checking its potency test

### Experimental Animals

The animals used for this study were mice, pigs and rabbits at NIH Islamabad Pakistan. The toxin which we filtered at early stage was used for its pathogenicity on our experimental animals. The toxin was injected to mice at very low concentration and after some time the action of toxin by injecting it into mice was noted. These mice become paralysed due to such toxin and leaving them for some more

time the mice died due to these toxins. Due to appearance of paralysis symptoms it proves that these toxins are neurotoxins i.e. affecting the neurons of mice and they become paralysed.



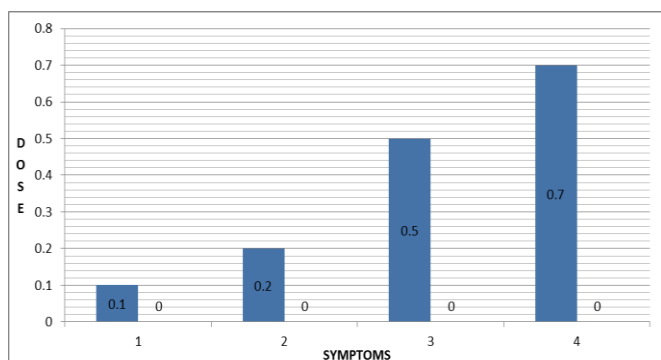
The prepared toxoid was also injected intramuscularly to mice rabbits and pigs for checking its potency and clarifying that whether we can use these prepared toxoid as vaccine for immunization or not. After injecting the doses of these toxoid to experimental animals the serum were then taken from these animals used for our experiment after some days and tested for presence of immune response that whether the immune response activated against them or not.

**Table 1:** Symptoms appeared in mice's due to different doses of tetani toxin enlisted in Table 1

Dose	Symptoms	
0.1 micro liter	Normal	No death
0.2 micro liter	Weight loss	15-20 percent died
0.5 micro liter	Muscle spasm	Died in Week
0.7 micro liter	Paralyzed	All died in 48 hours

**Results**

The toxins were injected in low dose and in high dose from 0.1 to 0.7 micro liters to mice's having 21 gram weights for observing its effect on them. After injecting the toxin intramuscularly to mice's in low dose, the mice's shows no symptoms and was normal for about 24 hours. After 24 hours the mice's shows muscle spasm, weight loss and paralysis. The mice's which were injected by low dose of toxin were leaved for some more time and after week about 15 to 20 percent of mice's become dead due to low dose of toxins. Some mice's were injected by high dose of toxin due to such high dose the mice's become dead within 24 to 48 hours as.



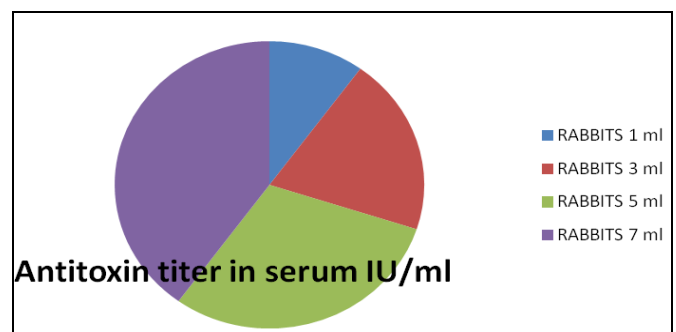
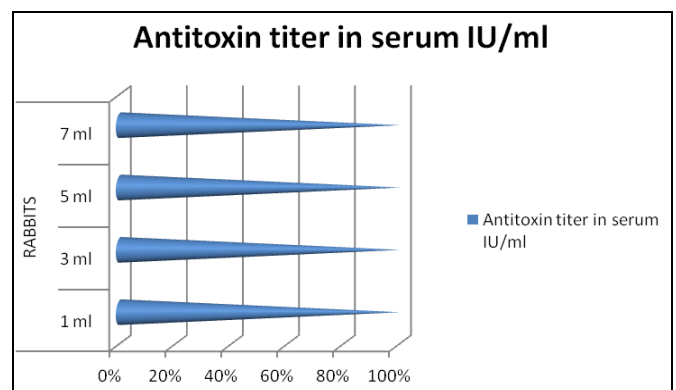
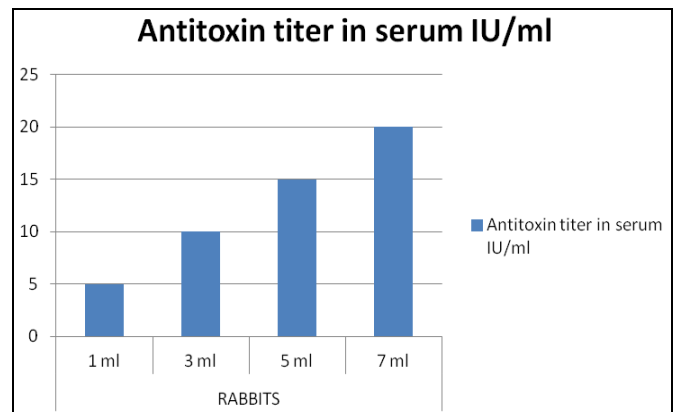
After injecting toxin to experimental animals and the symptoms appeared due to these toxins. Then the prepared toxoid was injected intramuscularly or subcutaneously to them and leaving them for 24 hours and then observed the effect of toxoid against these toxins. The toxoid become

neutralizes the symptoms appeared due to toxins when injected earlier. But if injected after some time of symptoms the toxoids cannot be able to neutralize them.

The toxoids were also injected to normal rabbits having weight of 2 to 3 kg. After injecting the different doses at different interval of time of prepared toxoids to these animals the sera of these animals were taken and these vaccinated sera were tittered for measuring the immune response of body against this toxoid and preventing the tetanus as shown in table 2

**Table 2:** Titer of antitoxins measured in serum of vaccinated animal

Animal	Doses	Antitoxin titer in serum IU/ml
Rabbits	1 ml	5
	3 ml	10
	5 ml	15
	7 ml	20



**Discussion**

Tetanus is an acute and fatal disease which is caused due to the toxins of *C. tetani*. Different types of vaccines are present for acquiring immunization against tetanus disease. These types of vaccines are based on combination of tetanus toxoid with diphtheria toxoid and pertussis antigen and also based on the concentration of these combinations by WHO, 2005, [7]. For the preparation of tetanus toxoid the toxin of *C. tetani*

required so for this purpose the *C. tetani* was cultured in liquid medium and incubated for overnight then the cultured bacteria were again incubated in fermentation medium so that the toxin from these cultured bacteria extracted for the preparation of toxoid. For such purpose the formalin was added to fermented medium so that the extracted toxins become neutralized and filtered for further usage. The glycerin and aluminum phosphate or hydroxide was added to filtered toxoid for preservation and as adjuvant for use of immunizing the body against *C. tetani*.

The extracted toxins were tested on mice's having weight of about 21 gm and observe its effect on the body. The effect of these toxins were mainly on neurons and the symptoms which were appeared in low dose of toxin was paralysis while leaving them for some more time without treating or in high dose these mice's become dead.

The prepared toxoid were also tested on rabbits and guinea pigs after injecting them in different doses for different interval of time the vaccinated sera were observed for immune response appeared due to these toxoids. The study shows the positive results of these toxoids when prepared and injected against the affected animals from toxin of *C. tetani* b removing the paralysis and weakness within 48 hours.

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