Wounds at risk of tetanus: unexpected prevalence of immunization in a patient cohort

Gaia Bavestrello Piccini (✉ gaia.bavestrellopic01@universitadipavia.it)

UVC Brugmann - Site Victor Horta <https://orcid.org/0000-0002-5618-7404>

Jean-Christophe Cavenaile

UVC Brugmann - Site Victor Horta

Maria Antonietta Bressan

Fondazione IRCCS Policlinico San Matteo

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Abstract

Background

Tetanus is an acute and potentially fatal disease caused by *Clostridium Tetani*, an extremely resilient pathogen. The bacterium can contaminate traumatic wounds which account for approximately 5.4% of all visits to the Emergency Department. According to several surveillance programs, the incidence of clinical tetanus in Italy is ten-fold higher than in other industrialised countries. In 2010, Italy accounted for 57 of the 74 confirmed cases reported in the European Union.

Methods

The study analysed data from 1094 patients who presented to the Emergency Department of the Fondazione IRRCS Policlinico San Matteo between April 2016 and November 2017 with wounds potentially at risk for infection with *Clostridium Tetani*.

Results

Data showed that, in conformity with the literature, the elderly (> 60 years old) constitute a high-risk category, with 219 unprotected individuals out of 238. Also, among patients aged more than 60 years old, there was a statistically significant difference between female and male patients. From the comparative analysis of the data however, it was surprisingly found that even younger patients are lacking protective immunity.

Conclusions

When considering other medical systems, both European and non-European ones, and analysing their guidelines for the prevention of tetanus infection, the necessity of adopting a well-defined algorithm becomes evident. This, also in order to avoid the excessive administration of prophylaxis, as well as to allow to put in place the necessary preventive measures for each patient. This study highlights the need for a better patient and clinician awareness, and an improvement in record keeping and management of the documentation related to the vaccinations. The analysed data also suggests the need for conducting awareness campaigns on the topic of vaccines and vaccine preventable infections. Patients should be made aware of the importance of keeping track of their own immunization status, and of remembering the date of the last administration of the vaccine or, of carrying around their vaccination card.

Background

Tetanus is an acute and potentially fatal disease caused by infection with the microorganism *Clostridium Tetani*, a spore-forming gram-positive bacterium which is commonly found in the soil of warm and moist areas and may be carried in the intestinal tracts and faeces of humans and animals. These bacteria can get in contact with the internal environment of the human body through a cut, a puncture wound, a burn or a scratch in the skin, which may be superficial ^[1].

In Italy between 2001 and 2009, a total of 594 tetanus cases were notified, with an average annual incidence of 1.0/1,000,000 population. The mean annual number of reported deaths was 21. Moreover, the incidence of clinical tetanus in Italy is ten-fold higher than in other industrialized countries, likely due to higher susceptibility levels in Italy ^[2]. In 2010, Italy accounted for 57 of the 74 confirmed cases reported in EU and has been continuously reporting the highest number of tetanus cases since 2006, ranging between 53 and 64 cases per year ^[3, 4].

Although according to a more recent analysis from the European Centre for Disease Prevention and Control there was a decrease in the reported incidence between 2010 and 2014 ^[5], a further increase was observed in 2015, according to a World Health Organization (WHO) survey ^[6].

Such a trend is probably due to the fact that the introduction of the “universal” vaccination campaign for all infants has led to an 86% reduction between the mid-1950s and the present days ^[7]. Today in Italy tetanus affects only subjects who are either unvaccinated or inadequately vaccinated, unfortunately, these subjects account for a sizable proportion of the general population.

Methods

Study design

We conducted a retrospective observational study to evaluate the prevalence of vaccination against tetanus in the patient population, as well as to evaluate the coherence between anamnestic data and laboratory findings.

Setting

The study was conducted at Fondazione IRCCS (Istituto di Ricovero e Cura a Carattere Scientifico) Policlinico San Matteo. This Hospital is affiliated with the Faculty of Medicine of the University of Pavia (Italy) and is one of the largest teaching hospitals in Italy, hosting every year hundreds of medical students performing clinical rotations.

Participants

The study included patients presenting to the Emergency Department (ED) between April 2016 and November 2017, with wounds potentially at risk for tetanus infection.

Of the 1094 patients taken into account, 474 (43.33%) were excluded from the study, due to the incompleteness of the digital records, therefore only 620 (56.67%) patients were included in the study.

Study protocol

Data on the consecutive ED visits in the aforementioned period, were extracted from electronic patient records using a standard data collection form.

Patients have been subdivided according to their age into 4 categories: 0-18, 19-45, 46-60, 60+. Since the study was carried out between 2016 and 2017, the subdivision was done considering the age on the 31/12/2016. Age and nationality have not been considered as exclusion criteria but have been kept into consideration for the subsequent analysis of the results. Exclusion criteria were severely bleeding wounds in need of immediate surgical intervention, and inability to provide a reliable history (i.e. psychiatric disease, dementia or confusion, patient in traumatic shock, unconsciousness).

The type of wound was also recorded, in order to determine the main categories of wounds at higher risk for contamination with C. Tetani.

A register of Microsoft Excel was then utilized in order to collect all the data for subsequent epidemiological and statistical analysis.

Comparisons between some of the proportions were performed using a two-sample test for equality of proportions with continuity correction.

Tetanus Quick Stick

The immune status of patients was determined through the use of the Tetanus Quick Stick™ (TQS, Gamma, Angleur, Belgium), a point of care testing which allows to conclude whether patients dispose of protecting levels of circulating antibodies against tetanus.

The Tetanus Quick Stick (TQS) is an immunochromatographic test, which utilizes a combination of tetanus toxoid coated on the solid phase together with a tetanus toxoid dye conjugate, for the rapid detection of anti- tetanus antibodies in human serum, plasma or whole blood ^[8]. It is indicated for:

- the determination of the real immune status,
- the identification of unprotected individuals,
- prevention of side reaction due to unnecessary vaccination,
- the follow up of vaccinated immunodeficient patients

The TQS has been evaluated in several ED worldwide and it has been put in comparison with the gold standard ELISA. Its sensitivity and specificity have been estimated to be 76 to 88% and 97 to 100% respectively ^[9, 10, 11], therefore, it can be considered as a reliable tool for screening patients that do not need to receive anti-tetanus prophylaxis ^[12]. There are no contraindications to this test ^[13].

Results

The dataset contained 620 individuals:

- 355 males and 265 females;
- 586 Italians and 34 foreigners.

Out of 620 patients, 114 were not tested with the Tetanus Quick Stick, therefore for some analyses, only the sample constituted by the remaining 506 patients (81.61%) was used.

The statistical analysis of the data has been performed through the Welch two sample t-test.

Some categories of patients have been found to be at higher risk, for example the elderly (> 60 years old), with 219 individuals which tested negative out of the 238 tested. Data revealed a statistically significant difference (p-value = 0.0001) between patients aged less than 60 years of age, and those older than 60 years of age (Table 1).

Age	No TQS	Negative TQS	Positive TQS	TOTAL
60+	33	219	19	271
46-60	27	101	24	152
19-45	40	103	25	168
0-18	14	11	4	29
Total	114	434	72	620

Table 1: TQS results according to age

Moreover, among patients aged more than 60 years old, there was a significant difference between female and male patients, with 130 female patients who tested negative and 5 female patients who tested positive, while among the male patients, 89 tested negative and 14 tested positive (Table 2). This difference was found to be significant (p-value = 0.0095) from a statistical point of view, according to the results of the two-sample test for equality of proportions with continuity correction.

	Negative TQS	Positive TQS
Female	130	5
Male	89	14
TOTAL	219	19

Table 2: TQS results according to gender in patients aged >60

From the analysis of the data however, when taking into consideration the number of patients for every age range who presented with wounds to the ED (Figure 1), it possible to see that even younger patients are lacking protective immunity (Figure 2, Table 3).

Age	TOTAL	Tested with TQS	% of negative TQS
60+	271	238	92%
46-60	152	125	80%
19-45	168	128	80%
0-18	29	15	73%

Table 3: *Percentage of unprotected patients, according to age*

Discussion

As reported by other authors, the most important factor associated to a lower immunity rate, was found to be increased age ^[2, 14, 15]. The reason for this, is probably due to a combination between the lack of systematic vaccination before 1962, increased life expectancy and lack of administration of the recommended tetanus booster, the decline of tetanus protective antibody level as age increases, and deficient immune response to vaccine associated with immunosenescence ^[13, 14, 16, 17, 18, 19].

These data confirm the fact that the elderly are the population more at risk since they are less covered by the vaccine (Table 17), and we can therefore say that the analysed group of patient is representative of the Italian reality as described by the Italian Ministry of Health ^[15].

For what concerns the category of patients older than 60 years, it is possible to denote a difference among males and females for what concerns the immunization rates (Figure 3).

In particular, a slightly higher percentage of male patients of this class (12%) were protected against tetanus, with respect to female patients (3.7%). In the next years, in Italy, this finding could undergo a significant change, with a reduction in the difference between males and females aged 60 years or more.

This, due to the fact that the Military Service is not obligatory anymore since 2005 ^[20], but also to the introduction of the obligatory vaccination schedule introduced in 1968 ^[21], and to the more recent law ^[22, 23], which reaffirms that for the individuals of age comprised between 0-16 years old, a series of vaccinations has to be rendered mandatory and administered without charge.

Therefore, there will be a greater homogeneity between older males and females.

The lower rates of protection present even among the younger patients, might be due to factors such as a lack of knowledge about the importance of prevention of this disease through a complete cycle of vaccinations, as well as a lack of awareness on the necessity to receive boosters once completed the primary immunization series. This is probably a consequence of the fact that tetanus is currently one of the most underestimated and less well-known possible complication of a wound.

Another issue which could be important when considering high risk groups populations, is the one of immigration.

Even though Pavia is not as cosmopolitan as other cities that have been taken into account by other studies, such as Rome and Brussels, the increase in the number of migrants from other countries in which the healthcare system is not so developed, may be partially responsible for the decrease in vaccination coverage over the next years. In this study, it was not possible to underline major differences for what concerns the difference in immune coverage among patients of different nationalities, due to the small sample of foreign patients (34 units). However, this investigation could be an interesting topic on which to conduct subsequent researches.

In order to increase the prevalence of immunization among the patients, prevention should be done, as suggested by the Ministerial Circular concerning the recent Decree Law ^[24], by promoting vaccinations both in new-borns, and in more aged patients who however didn't complete the primary vaccination schedule. A better compliance to vaccine coverage, has also been demonstrated to be associated to fewer hospital admissions in children ^[25].

Prevention should be done both through notifications under the form of letters, emails, leaflets, but also in a more direct way in occasion of accesses to the hospital, or to the cabinet of the General Practitioner.

Patients should also be made aware of the importance of keeping track of their own immunization status, and of remembering the date of the last administration of the vaccine, and if necessary, the date of the following booster. Moreover, it would be extremely important to also instruct patients on the topic of vaccines and vaccine preventable infections, stressing how some of these infections could quickly lead to major complications, and eventually result in the death of the individual, and to teach patients how to be more responsible of their own health status.

Conclusion

When considering the scattered prevalence of immunisation in the population, the necessity of adopting a well-defined algorithm, in order to minimize the error and ensure the best possible care, becomes evident.

Improvements could be done at several levels. First of all, hospitals should adopt protocols as well as effective and cost saving tools. The healthcare personnel of course should also receive the necessary training in order to put into use in the most effective way these new tools and algorithms. Pharmaceutical companies should be continuously stimulated to discover the best and most effective way to help the diagnostic and therapeutic processes. Ultimately, also patients should become an active party in ameliorating the system, by having a more comprehensive knowledge of their health status.

All this would be important especially for this particular condition, which as this study demonstrated, does not discriminate among individuals of different age, gender, and nationality.

Lastly, as demonstrated from the collected data and the epidemiological information on the trend in incidence of tetanus infection and in prevalence of vaccinated individuals in Italy, it is extremely important not to consider this infection as “eradicated”, and to never let the guard down on this disease which lurks in the shadow of our mistakes.

List Of Abbreviations

ED: Emergency Department

TQS: Tetanus Quick Stick

POCT: Point Of Care Testing

WHO: World Health Organization

IRCCS: Istituto di Ricovero e Cura a Carattere Scientifico

EU: European Union

Declarations

Ethics approval: Informed consent of the patients was deemed not necessary because of the retrospective design, and therefore exemption of ethical approval was granted by the Ethics Committee of the San Matteo Hospital

Consent to participate: Not applicable (retrospective study)

Consent for publication: Not applicable

Availability of data and material: The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests: The authors declare that they have no competing interests

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Authors' contributions: GBP: Designed the study, analysed and interpreted data. JCC: Designed and supervised the study, edited multiple manuscript drafts. MAB: collected data. All authors have read and approved the manuscript.

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Figures

Figure 1

Subdivision of patients accessing the Emergency Department for wounds in age classes

Figure 2

TQS results with regards to age class of patients

Figure 3

TQS results according to gender in patients aged >60