





RESEARCH PAPER

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## Insufficient knowledge and inappropriate practices of emergency doctors towards tetanus prevention in trauma patients: a pilot survey

Yong Liu <sup>a\*</sup>, Xichao Mo <sup>b\*</sup>, Xiaxia Yu <sup>c</sup>, Jinxin Wang<sup>a</sup>, Jinfei Tian<sup>a</sup>, Jun Kuang<sup>d</sup>, and Jie Peng<sup>b</sup>

<sup>a</sup>Intensive Care Unit, Shenzhen Hospital, Southern Medical University, Shenzhen, PR China; <sup>b</sup>Department of Infectious Diseases, Nanfang Hospital, Southern Medical University, Guangzhou, PR China; <sup>c</sup>Department of Biomedical Engineering, Health Science Center, Shenzhen University, Shenzhen, PR China; <sup>d</sup>Department of Thoracic Surgery, Shenzhen Hospital, Southern Medical University, Shenzhen, PR China

### ABSTRACT

China has a shocking number of tetanus cases in the world, but little research has investigated doctors' knowledge of and practices in tetanus prophylaxis, especially tetanus vaccination. To this end, we conducted a pilot study on 197 emergency doctors using a mixed method of web-based (163; 82.8%) and paper-based (34; 17.2%) surveys. There was no difference between the two groups except for the percentage of doctors receiving a tetanus booster in the past 10 years and the responses to question 11. Surprisingly, only 28.9% of doctors had received formal training on tetanus immunization and only 21.3% had themselves received a tetanus vaccine booster in the past 10 years. Furthermore, only 14.2% of the respondents confirmed the availability of the tetanus vaccine in their respective institutions. Finally, the correct rates and Tetanus-immune-globulin (TIG)-only option rates for questions 11–15 were unsatisfactory. Our results showed that most emergency doctors' knowledge and practices strayed from the recommendations of Advisory Committee on Immunization Practices (ACIP): 1) TIG alone for most trauma patients instead of vaccine was an overused treatment approach. 2) Most of the emergency doctors lacked formal training on and knowledge of tetanus vaccination. 3) Even the emergency doctors themselves were not properly vaccinated. 4) The tetanus vaccine was only available in a small number of the respondents' institutions. The findings of this study suggest an urgent need to improve this dire situation.

### ARTICLE HISTORY

Received 31 May 2019  
Revised 22 July 2019  
Accepted 3 August 2019

### KEYWORDS

Knowledge and practices; emergency doctors; tetanus prevention; tetanus vaccine; tetanus immune globulin

### Introduction

Tetanus is a fatal infectious disease with mortality rates ranging between 10% and 80%. Despite routine childhood tetanus vaccination for nearly a century and high coverage levels in children over the last 50 years, it remains globally endemic.<sup>1,2</sup> Nevertheless, tetanus is preventable through vaccination and post-exposure prevention.<sup>3</sup>

According to extrapolations of prevalence and incidence statistics for tetanus by the US Census Bureau International Database, China has a shocking number of tetanus cases (191 cases estimated in 2004, almost 4 times higher than the number of cases in the USA).<sup>4</sup> Furthermore, the Chinese literature frequently reports cases of tetanus among adults and pregnant women.<sup>5</sup> Seroprevalence data indicated that low antibody levels are common in young adults but decrease with increasing age, further suggesting poor compliance with booster recommendations.<sup>6</sup> In developed countries, fewer than 50 cases of tetanus (all types, i.e., neonatal, maternal and others) are reported annually.<sup>4</sup> All primary care and emergency clinics provide post- and pre-exposure tetanus immunization to non-immunized individuals, along with booster shots to previously immunized adults. According to the Advisory Committee on Immunization Practices (ACIP)<sup>7,8</sup> and Chinese native guidelines including *Chinese expert consensus on tetanus immunization*<sup>9</sup> and *Expert consensus for the prevention*

*and management of the accidental tetanus in adult patient in China*,<sup>10</sup> five doses are recommended during childhood, with a sixth given during adolescence. Subsequently, additional doses are recommended every 10 years or post-exposure. However, until 2018, the Chinese expert consensus on tetanus immunization<sup>9</sup> and Expert consensus for the prevention and management of the accidental tetanus in adult patient in China were published. Before that in mainland China, the China National Immunization Programme (CNIP) only provides tetanus immunization to children under 7 years old without any payment, but not adults; while this study was undertaken before the publish of the consensus during November 2015 and April 2016.<sup>9–11</sup> As a result, numerous adolescents and adults remain unprotected and susceptible to tetanus due to a lack of further booster immunization approximately 5–10 years after the completion of childhood tetanus vaccination.

Research has shown that health workers play a critical role in the delivery of vaccinations, including the tetanus vaccine. To a large extent, positive knowledge, attitudes and practices toward vaccination can support a higher vaccine uptake level in the population.<sup>12–15</sup> However, insufficient knowledge, attitudes formed by misconceptions and inappropriate practices regarding the prevention and treatment of tetanus are not rare among doctors.<sup>16–19</sup>

**CONTACT** Jie Peng  [pjie138@163.com](mailto:pjie138@163.com)  Nanfang Hospital, Southern Medical University, No.1838 North Guangzhou Avenue, Baiyun District, Guangzhou, Guangdong 510515, China

\*These authors contributed equally to this work.

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To date, no related research has been conducted in mainland China, and we know little about doctors' tetanus-related knowledge level and practice patterns. Hence, we hypothesized a gap between the understanding of Chinese doctors and ACIP recommendations regarding tetanus immunization.

## Materials and methods

### Study design

A survey-based, cross-sectional survey was conducted on emergency doctors in mainland China to assess their knowledge and practices regarding tetanus immunization in trauma patients. The project was approved by the Shenzhen Hospital of Southern Medical University and was granted a waiver of ethical review.

### Data collection and sampling

The study consisted of two groups: a web-based and a paper-based group. Participants in the web-based group were recruited between November 2015 and April 2016 through advertisements and email invitations via the DXY forum ([www.dxy.cn/bbs](http://www.dxy.cn/bbs)), which is China's largest online community for doctors. To alleviate selection bias in web survey, field interviews were also undertaken. Emergency doctors in Shenzhen were selected from a convenience sample of attendees at the 2015 Annual Conference of Emergency Medicine held by the Shenzhen Society of Emergency Medicine. The target sample size was calculated using the formula  $n = \frac{z^2 \times \hat{p}(1-\hat{p})}{\epsilon^2}$ , where  $z$  is the  $z$  score,  $\epsilon$  is the margin of error, and  $\hat{p}$  is the population proportion. At the confidence level of 95%,  $z$  was 1.96.  $\hat{p}$  was assumed to be 0.5 due to the lack of previous statistics in China and  $\epsilon$  was assumed to be 10%. Accordingly, a minimum of 97 respondents were required.

### Questionnaire

Knowledge of recommendations and practices on tetanus prophylaxis in trauma patients was assessed by a 15-question survey that can be divided into three sections: basic information about the doctors (questions 1–4), tetanus immunization information among doctors and their institutions (questions 5–9), and knowledge and practices of tetanus immunization in trauma patients (questions 10–15) based on ACIP recommendations.<sup>20–22</sup> For details on ACIP recommendations, see Appendix 1. For details on the questionnaire, see Appendix 2.

Knowledge and practices assessment were scored as the sum of correct responses to questions 10–15 in the survey. A response was defined as correct if it was valid (i.e., supported by ACIP recommendations). The unanswered questions were scored as incorrect.

### Statistical analysis

Data analysis was performed in Empower for R software. Continuous variables were summarized by their means and standard deviations. All continuous variables were tested for normal distributions with the Kolmogorov–Smirnov test. Student's  $t$ -test was used to compare the means of continuous variables and normally distributed data; otherwise, the Mann–Whitney  $U$ -test

was applied. Categorical variables were expressed in percentages and compared using Pearson's  $\chi^2$  test. A regression analysis was eventually conducted to assess the relative influence of independent variables on the scores. All  $P$ -values were two-tailed and considered statistically significant when less than 0.05.

## Results

### Characteristics of respondents

A total of 197 ( $n = 97$ ) questionnaires were collected and analyzed, of which 163 (82.8%) were online questionnaires collected through the emergency board in the DXY forum and 34 (17.2%) were paper questionnaires collected in Shenzhen between November 2015 and April 2016. Table 1 describes the general characteristics of the respondents. Most (84.8%) of the respondents were male and more than 40.0% were aged between 30 and 40. A total of 94.9% were from non-primary hospitals, and 91.4% held a 5-year or higher college degree (57.4% graduates and 34.0% postgraduates). No significant differences were observed between the web- and paper-survey groups.

### Tetanus vaccination training, tetanus booster uptake and tetanus vaccine supply

As shown in Table 2, only 28.9% of the doctors had received formal training on tetanus immunization, and most were not aware of the standard immunization schedules against tetanus. In addition, only 21.3% of respondents had themselves received a tetanus vaccine booster in the past 10 years and 14.2% confirmed the availability of tetanus vaccine in their respective institutions. The paper-based group had a slightly higher rate of doctors receiving a tetanus vaccine booster in the past 10 years (35.3%).

Table 1. Background characteristics of the study population.

Characteristics	Total N = 197	Online survey N = 163	Paper survey N = 34	<i>P</i>
Gender				0.306
Male	167(84.8%)	136 (83.4%)	31 (91.2%)	
Female	30(15.2%)	27 (16.6%)	3 (8.8%)	
Age group (years old)				0.168
20–30	42(21.3%)	39 (23.9%)	3 (8.8%)	
30–40	81(41.1%)	65 (39.9%)	16 (47.1%)	
40–50	61(31.0%)	50 (30.7%)	11 (32.4%)	
>50–60	13(6.6%)	9 (5.5%)	4 (11.8%)	
Organization type				0.534
Primary hospital	10(5.1%)	9 (5.5%)	1 (3.0%)	
Non-primary hospital	187(94.9)	154(94.5)	33(97.0%)	
Education level				0.532
Less than 5-year college	17(8.6%)	15 (9.2%)	2 (5.9%)	
5-year or more college	180(91.4%)	148 (90.8%)	32 (94.1%)	

Non-primary hospitals include secondary hospitals, tertiary hospitals, and international clinics.

Table 2. Tetanus vaccination training, doctors receiving a tetanus booster and tetanus vaccine supply.

Characteristics	Total N = 197	Online survey N = 163	Paper survey N = 34	<i>P</i>
Tetanus vaccination training	57(28.9%)	49 (30.1%)	8 (23.5%)	0.536
Doctors receiving a tetanus booster in the past 10 years	42(21.3%)	30 (18.4%)	12 (35.3%)	0.029
Supply of tetanus vaccine	28(14.2%)	22 (13.5%)	6 (17.6%)	0.528

### Knowledge and practices of tetanus immunization

Findings on the respondents' knowledge and practices regarding tetanus prophylaxis in trauma patients are presented in Table 3. The practices followed by most respondents differed significantly from the ACIP recommendations with unsatisfactory correct rates of questions 11–15 (11: 8.1%, 12: 41.1%, 13: 41.1%, 14: 12.1% and 15: 12.1%). Furthermore, an over-treatment with tetanus immune globulin (TIG) was observed, as indicated by the high rates of choosing TIG-only options (11: 69.5%, 12: 35.0%, 13: 49.7%, 14: 50.8% and 15: 49.7%). There was no statistically significant difference between the groups except that the paper-based group had a slightly higher rate of correct responses (26.47%) to question 11.

### Regression analysis

The regression model could not be successfully built due to absence of any independent variables in the survey that significantly affected the score. The details are shown in Appendix 3.

### Discussion

The main findings of our survey regarding the knowledge and practices of emergency doctors toward tetanus immunization for trauma patients in mainland China were: 1) TIG alone for most trauma patients instead of the vaccine was an overused treatment approach. 2) Most of the emergency doctors lacked formal training on and knowledge of tetanus vaccination. 3) Even the emergency doctors themselves were not properly vaccinated. 4) The tetanus vaccine was only available in a small number of the respondents' institutions.

We found no significant differences between the web- and paper-based groups, except in terms of the percentage of doctors receiving a tetanus booster in the past 10 years and the responses to question 11, which may be due to the small sample size. According to the Law on Practicing Doctors of the People's Republic of China, doctors who have earned their degrees from 3-year colleges are eligible to appear for the China National Medical Examination, provided they fulfill

certain criteria. In fact, only 48% of the practicing doctors held a degree above college level in 2014.<sup>23,24</sup> Therefore, although 8.6% of the total respondents had education level below 5-year college, the results of the survey are valid and representative of mainland China.

The average score of respondents for questions 11–15 was  $1.10 \pm 0.86$ , indicating lack of compliance with the ACIP guidelines due to insufficient knowledge. In most cases, TIG instead of vaccine is given to trauma patients, regardless of the wound status (clean or dirty), history of primary tetanus vaccine (complete, incomplete or unclear) and the time since the most recent dose (more or less than 5 years). This finding is consistent with the statements in Chinese native guidelines showing that prophylaxis with TIG is a routine practice among Chinese doctors.<sup>9</sup> In fact, ACIP<sup>7</sup> and Chinese native guidelines<sup>9,10</sup> including *Chinese Expert Consensus on Tetanus Immunization* and *Expert Consensus for the Prevention and Management of the Accidental Tetanus in Adult Patient in China* clearly recommend TIG or vaccines based on the wound type, the immune status of patients and so on rather than always using TIG.

This finding is consistent with the review of Fu Lijun,<sup>25</sup> which concluded poor knowledge of tetanus preventive strategies among most health workers. Fu et al. also criticized misconception held by Chinese doctors regarding passive immunization for tetanus prophylaxis in trauma patients as well as the overuse of TIG. Other studies also found that booster vaccination was not accepted as an efficient or economic measure for tetanus prevention in mainland China, where TIG was used as the primary measure for post-exposure prophylaxis.<sup>26</sup> However, all of these arguments were based only on reviews or comments rather than articles with data supporting tetanus vaccine usage.

Multiple factors account for the inadequate knowledge and poor practices of emergency doctors in our research. We failed to build a regression model since no variables significantly affected the scores. However, this also reflected the homogeneity of the score distribution and further supported our findings as universal, regardless of gender, age, education,

**Table 3.** The knowledge and practice patterns of emergency doctors in mainland China in terms of tetanus prophylaxis in trauma patients.

Characteristics	Total N = 197	Online survey N = 163	Paper survey N = 34	P
<b>Score</b>	1.10 ± 0.86	1.05 ± 0.87	1.35 ± 0.77	0.06
<b>Question 11</b>				
Correct (Tdap or Td4 without TIG)	16 (8.1%)	7 (4.3%)	9 (26.5%)	0.001
Only TIG or immunoglobulin if allergy	137 (69.5%)	124 (76.1%)	13 (38.2%)	
<b>Question 12</b>				
Correct (only wound care)	81 (41.1%)	67 (41.1%)	14 (41.2%)	0.994
Only TIG or immunoglobulin if allergy	69 (35.0%)	62 (38.0%)	7 (20.1%)	
<b>Question 13</b>				
Correct (TAT or TIG with vaccine)	83 (42.1%)	73 (44.8%)	10 (29.4%)	0.099
Only TIG or immunoglobulin if allergy	98 (49.7%)	83 (50.9%)	15 (44.1%)	
<b>Question 14</b>				
Correct (only wound care)	24(12.2%)	17 (10.4%)	7 (20.6%)	0.144
Only TIG or immunoglobulin if allergy	100(50.8%)	87 (53.4%)	13 (38.2%)	
<b>Question 15</b>				
Correct (tetanus-containing vaccine)	24 (12.2%)	17 (10.4%)	7 (20.6%)	0.144
Only TIG or immunoglobulin if allergy	98(49.7%)	84(51.5%)	14(41.2%)	

Question 11: Clean and minor wound and receiving incomplete DTaP series for patients aged 11 years and older

Question 12: Clean and minor wound and receiving complete DTaP series for patients aged 11 years and older

Question 13: Dirty or deep wounds but with unclear history of tetanus vaccine

Question 14: Dirty or deep wounds and complete 3-dose primary series with an interval of 5 years or more from last dose

Question 15: Dirty or deep wounds and complete 3-dose primary series (any tetanus-containing vaccine) with an interval less than 5 years from last dose

hospital institution, etc. The misconception held by Chinese doctors may be due to the different strategies undertaken by the Chinese government. The Chinese healthcare system focuses on improving institutional delivery rate rather than post-exposure vaccinations as recommended by the ACHS. There is also no immunization schedule for special populations, such as adolescents and pregnant/childbearing-age women, in mainland China in our research periods.<sup>27</sup> Therefore, since the absence of specific guidelines by CNIP, the doctors are not fully aware of the immunization schedule for tetanus. Furthermore, only 21.32% of respondents in our survey had received a tetanus booster in the past 10 years. Although doctors are not classified as a high-risk group by Chinese native guidelines,<sup>9,10</sup> their poor vaccination rates call for urgent improvement in their knowledge and practices.

Another factor that hinders the appropriate management of tetanus prophylaxis after trauma might be the tetanus vaccination system followed in mainland China. Currently, vaccination programs are implemented by the CDC, whereas post-exposure prophylaxis is performed by hospitals with a limited supply of tetanus vaccine.<sup>28</sup> In the present survey, most doctors reported a lack of tetanus vaccine in the local institutions and elsewhere, since it is provided by CDC for pediatric immunization schedules and not for adults. A previous review and discussion<sup>27,29</sup> also noted lack of availability of DTaP (a vaccine that helps children younger than age seven develops immunity to three deadly diseases caused by bacteria: diphtheria, tetanus, and whooping cough) for children older than 6 years. Thus, there is an urgent need to review the current health-care policies.

A single TIG application does not provide a lasting immunity to tetanus, since the incubation period of tetanus ranges from 24 h to several months, whereas the antitoxin confers immediate passive immunity for only 10 to 15 days. Thus, the effective concentration of TIG may be lost during the incubation period.<sup>30–32</sup> Hence, post-exposure prophylaxis with TIG alone in the absence of an immune response is not preferred.

The current overuse of TIG in mainland China not only results in a temporary immunity to tetanus, thus exposing potential risk of tetanus in future, but can also lead to considerable waste of limited medical resources, serious social and medical consequences, including anaphylactic shock and even death. In fact, between 1993 and 2012, 82 cases of tetanus antitoxin-induced anaphylactic shock were reported in the China Scientific Journal Database according to a search with the keywords “anaphylactic shock” “anti-tetanus serum” “tetanus antitoxin” or “adverse reactions”.<sup>33</sup> In contrast, only two such cases were identified with the same keywords in the PubMed database. These findings may indirectly reflect the fact that the widespread use of TIG in mainland China may have severe consequences. In addition, since it is derived from animal blood, TIG may carry the risk of pathogen transmission such as HIV and hepatitis. Therefore, it is urgent to increase doctors’ knowledge of correct tetanus prevention and to avoid the overuse of TIG in mainland China.

Based on the findings of this survey, it is not far-fetched to surmise that the seroprevalence of tetanus antibody in the adult population of mainland China is not high. In fact, Chunhuan Zhang<sup>34</sup> reported a seroprevalence of only 31.3% among adults older than 20 years in Guangzhou, China. Similarly, Yaqun Qiu<sup>35</sup>

reported a seroprevalence of only 18.6% among the migrant workers in Shenzhen, China; the samples were from two large cities in China. This dire situation must be urgently improved.

There still exist some issues about tetanus vaccine should be addressed. A considerable debate is surging in western countries about a more appropriate vaccine formulation for Tetanus boosters. ACIP recommends that booster doses of Td should be administered every 10 years in adolescents and adults.<sup>7,8</sup> However, as data from their countries showing that pertussis infection continues to be endemic among adolescents and adults<sup>36</sup> and the safety and immunogenicity of Tdap vaccines are promising comparing with Td, some experts support the feasibility of a shift from decennial Td to decennial Tdap booster vaccination.<sup>37,38</sup> The Chinese guidelines also recommend the same in adolescents and adults as ACIP, but there lack native data to support or argue. We direly need to raise a lot of work in agenda to improve the situation.

A few limitations of the study should be mentioned. First, the sample was limited in size and may not represent other regions in mainland China. Second, the causal relationship of knowledge and practices with the incidence of improper tetanus treatment could not be confirmed due to the cross-sectional nature of the survey. Third, our survey did not address the attitudes of the respondents, which may represent a lack of information. Moreover, two possible biases could have been introduced due to the convenient sampling of the respondent: a) social desirability bias (i.e., some answers may have been given because they were viewed as more ‘acceptable’ rather than because they were ‘true’) and b) selection bias (i.e., as the survey population was self-selected, it is reasonable that the final sample included physicians who were more interested in tetanus-related issues, and therefore more likely to perform/recommend tetanus vaccination following official statements and recommendations). Nevertheless, based on the role of a first and pilot study in China, the design of our study with two groups of data allows the findings to be checked against each other. This helps ensure the reliability of the results and lay the foundation for subsequent large-scale research.

In conclusion, we observed a considerable lack of knowledge regarding tetanus vaccination recommendations among emergency doctors in mainland China. Unlike other countries, TIG is used as the post-exposure tetanus prophylactic rather than immunization, most likely due to the current CNIP guidelines and the unavailability of tetanus vaccines across hospitals. Our findings provide the impetus for updating the CNIP guidelines, in order to accommodate adults and special groups such as adolescents and pregnant women, and avoid unnecessary TIG administration. In addition, the tetanus vaccines have to be made available in all hospitals. Chinese native guidelines were published after our survey and expressed similar concerns. We can conduct another survey in the future and hope that the situation will improve after the publication of our native guidelines.

## Acknowledgments

The authors are grateful to the participants who gave of their time to collect the questionnaire for this study. Thanks, Dr Jinhai Luo, Dr Ronggui Lv and Dr Shaolong Leng for their dedicated work on collecting research data.

## Authors' contributions

Dr Liu Yong contributed to the study design, analysis, and principal drafting of the manuscript. Dr Xichao Mo contributed to the analysis, and principal drafting of the manuscript. Dr Xiaxia Yu, Jinxin Wang, Jinfei Tian, and Jun Kuang contributed to the implementation of this project, analysis and drafting the manuscript. Dr Jie Peng is responsible for the study design, team organization and coordination, and drafting the manuscript.

## Availability of data and material

The datasets used and analyzed during this study are available from the first author on reasonable request.

## Consent for publication

Not applicable.

## Disclosure of potential conflicts of interest

No potential conflicts of interest were disclosed.

## Ethics approval

The project was approved by the Shenzhen Hospital of Southern Medical University and was granted a waiver of ethical review.

## Funding

The authors would like to thank the support from the Startup funding for Youth Faculty of Shenzhen University Grant [2018009].

## ORCID

Yong Liu  <http://orcid.org/0000-0002-5208-888X>  
 Xichao Mo  <http://orcid.org/0000-0002-2736-7502>  
 Xiaxia Yu  <http://orcid.org/0000-0003-4811-5125>

## References

- WHO. Tetanus vaccines: WHO position paper – February 2017. *Wkly Epidemiol Rec*. 2017;92(6):53–76. PMID:28185446.
- Macera CA. Introduction to epidemiology: distribution and determinants of disease. San Diego (USA): Cengage Learning; 2012.
- Thwaites CL, Loan HT. Eradication of tetanus. *Br Med Bull*. 2015;116:69–77. doi:10.1093/bmb/ldv044.
- US Census Bureau PE. Statistics by country for tetanus. Sutland (USA): United States Department of Commerce; 2003 Jun 20 [accessed 2019 Apr 3]. [http://www.cureresearch.com/t/tetanus/stats-country\\_printer.htm](http://www.cureresearch.com/t/tetanus/stats-country_printer.htm).
- Lin J, Li D. Retrospective evaluation of 4352 adults with tetanus in China. *Chin J Pract Surg (China)*. 1989;9:159–62.
- Zhang Q, Han F, Nie Q, Ren H, Zhang B, Liu Q, He Q, Shao Z. Seroprevalence of antibodies to pertussis and diphtheria among healthy adults in China. *J Infect*. 2011;63(6):441–46. doi:10.1016/j.jinf.2011.07.018.
- Centers for Disease Control and Prevention. ACIP Charter. Atlanta (USA): U.S. Department of Health & Human Services; 2018 Jun 5 [accessed 2019 Apr 3]. <https://www.cdc.gov/vaccines/acip/committee/charter.html>.
- Broder KR1, Cortese MM, Iskander JK, Kretsinger K, Slade BA, Brown KH, Mijalski CM, Tiwari T, Weston EJ, Cohn AC, et al. Preventing tetanus, diphtheria, and pertussis among adolescents: use of tetanus toxoid, reduced diphtheria toxoid and acellular pertussis vaccines recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR Recomm Rep*. 2006;55(RR-3):1–34. PMID: 16557217.
- China Trauma Rescue and Treatment Association, Peking University Trauma Medicine Center. Chinese expert consensus on tetanus immunization. *Chin J Surg(China)*. 2018;56(3):161–67. doi:10.3760/cma.j.issn.05295815.2018.03.001.
- Nei S, Zhao X, Yu X. Expert consensus for the prevention and management of the accidental tetanus in adult patient in China. *J Clinl Emergency(China)*. 2018;19(12):801–08. doi:10.11855/j.issn.0577-7402.2018.12.01.
- World Health Organization. China National Immunization Programme. Geneva(Switzerland); 2018 Jul 25 [accessed 2019 Apr 3]. [https://www.who.int/vaccine\\_safety/initiative/communication/network/china\\_nip/en/](https://www.who.int/vaccine_safety/initiative/communication/network/china_nip/en/).
- Ricco M, Razio B, Panato C, Poletti L, Signorelli C. Knowledge, attitudes and practices of agricultural workers towards tetanus vaccine: a field report. *Ann Ig*. 2017;29(4):239–55. doi:10.7416/ai.2017.2156.
- Ricco M, Cattani S, Casagrande F, Gualerzi G, Signorelli C. Knowledge, attitudes, beliefs and practices of occupational physicians towards vaccinations of health care workers: A cross sectional pilot study in North-Eastern Italy. *Int J Occup Med Environ Health*. 2017;30(5):775–90. doi:10.13075/ijomeh.1896.00895.
- Betsch C, Wicker S. Personal attitudes and misconceptions, not official recommendations guide occupational physicians' vaccination decisions. *Vaccine*. 2014;32(35):4478–84. doi:10.1016/j.vaccine.2014.06.046.
- Kirupakaran J, Meloche C, Upfal M. Practices and attitudes of michigan-based occupational physicians regarding adult immunization. *J Occup Environ Med*. 2018;60(11):1034–41. doi:10.1097/JOM.0000000000001420.
- Zaki S, Usman A, Tariq S, Shah S, Azam I, Qidwai W, Nanji K. Frequency and factors associated with adult immunization in patients visiting family medicine clinics at a Tertiary Care Hospital, Karachi. *Cureus*. 2018;10(1):e2083. doi:10.7759/cureus.2083.
- Akmatov MK, Rubsamn N, Deyneko IV, Karch A, Mikolajczyk RT. Poor knowledge of vaccination recommendations and negative attitudes towards vaccinations are independently associated with poor vaccination uptake among adults - Findings of a population-based panel study in Lower Saxony, Germany. *Vaccine*. 2018;36(18):2417–26. doi:10.1016/j.vaccine.2018.03.050.
- Ozsisik L, CalikBasaran N, Oz SG, SainGuven G, DurusuTanriover M. Perceptions and attitudes of patients about adult vaccination and their vaccination status: still a long way to go? *Med Sci Monit*. 2017;23:3178–84. PMID: 28662014.
- Collange F, Verger P, Launay O, Pulcini C. Knowledge, attitudes, beliefs and behaviors of general practitioners/family physicians toward their own vaccination: A systematic review. *Hum Vaccin Immunother*. 2016;12(5):1282–92. doi:10.1080/21645515.2015.1138024.
- CDC. Diphtheria, tetanus, and pertussis: recommendations for vaccine use and other preventive measures. Recommendations of the immunization practices advisory committee (ACIP). *MMWR Recomm Rep*. 1991;40(RR-10):1–28. PMID: 1865873.
- Kretsinger K, Broder KR, Cortese MM, Joyce MP, Ortega-Sanchez I, Lee GM, Tiwari T, Cohn AC, Slade BA, Iskander JK, et al. Preventing tetanus, diphtheria, and pertussis among adults: use of tetanus toxoid, reduced diphtheria toxoid and acellular pertussis vaccine recommendations of the Advisory Committee on Immunization Practices (ACIP) and recommendation of ACIP, supported by the Healthcare Infection Control Practices Advisory Committee (HICPAC), for use of Tdap among health-care personnel. *MMWR Recomm Rep*. 2006;55(RR-17):1–37. PMID: 17167397.
- World Health Organization. The world health report 2006 - working together for health. Geneva(Switzerland). [accessed 2019 Apr 3]. <https://www.who.int/whr/2006/en/>.
- Commission NHaFP. China health and family planning statistical yearbook. Beijing (China): Peking Union Medical College Press; 2015.

24. Zhu J, Li W, Chen L. Doctors in China: improving quality through modernisation of residency education. *Lancet*. 2016;388(10054):1922–29. doi:10.1016/S0140-6736(16)00582-1.
25. Yang G, Wang C. Misunderstanding of the passive tetanus immunization. *J Trauma Surg (china)*. 2014;16:94–96.
26. Tang L, Jin Y, Wang J, Zhang YY, Yu YJ. Investigation of epidemiology and analysis of tetanus prevention in 781 cases of surgical trauma. *Chin J Biol*. 2013;26:1644–45,1651.
27. Ning G, Wu D, Li J, Li Y, Yi Z. Global immunization schedules, vaccination coverage rates and incidences of diphtheria, tetanus and pertussis, 2010–2014. *Chin J Vaccines Immunization(China)*. 2016;22:159–64.
28. Adiyek E, Ozgultekin A, Turan G, Iskender A, Canpolat G, Pektas A, Ekinci O. Non-invasive mechanical ventilation after the successful weaning: a comparison with the venturi mask. *Rev Bras Anesthesiol*. 2016;66(6):572–76. doi:10.1016/j.bjan.2014.11.006.
29. Zheng J, Cao L, Guo S, Zhang X, Lu L, Wang L, Hu Y, Cao L, Yuan P, Cui J, et al. Immunization coverage of the national immunization program vaccines at the township level, based on a survey conducted by provincial CDCs in China, 2013. *Chin J Vaccines Immunization*. 2014;20(6):492–8, 546.
30. Farrar JJ, Yen LM, Cook T, Fairweather N, Binh N, Parry J, Parry CM. Tetanus. *J Neurol Neurosurg Psychiatry*. 2000;69(3):292–301. doi:10.1136/jnnp.69.3.292.
31. ACIP. Recommendations of the Advisory Committee on Immunization Practices (ACIP): use of vaccines and immune globulins for persons with altered immunocompetence. *MMWR Recomm Rep*. 1993;42(RR-4):1–18. PMID: 8474421.
32. ACIP. Diphtheria, tetanus, and pertussis: recommendations for vaccine use and other preventive measures. Recommendations of the Immunization Practices Advisory committee (ACIP). *MMWR Recomm Rep*. 1991;40(RR-10):1–28. PMID: 1865873.
33. Zhang X, Liu Y. Tetanus antitoxin induced anaphylactic shock: case review. *Chin J Pharmacoepidemiol(China)*. 2013;22:274–5,281.
34. Zhang CH, Wu YJ, He Q. The serological surveillance of tetanus antibodies among Guangzhou people in 2016. *J Trop Med(China)*. 2018;9:1242–45.
35. Qiu YQ, Chen QQ, Yu QH, Mou J, Lin LQ, Chen YJ, Zhuo F, Yuan Q, Sun SH. Surveillance on tetanus antibody levels of 1 003 migrant factory workers in Shenzhen. *J Trop Med(China)*. 2010;6:719–21.
36. Brandon D, Kimmel M, Kuriyakose S, Kostanyan L, Mesaros N. Antibody persistence and safety and immunogenicity of a second booster dose nine years after a first booster vaccination with a reduced antigen diphtheria-tetanus-acellular pertussis vaccine (Tdap) in adults. *Vaccine*. 2018;36(42):6325–33. doi:10.1016/j.vaccine.2018.08.051.
37. Thierry-Carstensen B, Jordan K, Uhlving HH, Dalby T, Sørensen C, Jensen AM, Heilmann C. A randomised, double-blind, non-inferiority clinical trial on the safety and immunogenicity of a tetanus, diphtheria and monocomponent-acellular pertussis (Tdap) vaccine in comparison to a tetanus and diphtheria (Td) vaccine when given as booster vaccinations to healthy adults. *Vaccine*. 2012;30(37):5464–71. doi:10.1016/j.vaccine.2012.06.073.
38. Tomovici A, Barreto L, Zickler P, Meekison W, Noya F, Voloshen T, Lavigne P. Humoral immunity 10 years after booster immunization with an adolescent and adult formulation combined tetanus, diphtheria, and 5-component acellular pertussis vaccine. *Vaccine*. 2012;30(16):2647–53. doi:10.1016/j.vaccine.2012.02.013.

**Appendices**  
**Appendix 1.**

**Table A1.** Tetanus prophylaxis guidelines.

	Clean and minor wound	TIG? All other wounds	TIG?
For Children Aged 6 Weeks through 6 Years			
Vaccination history			
Incomplete DTaP series	Give DTaP (if minimum interval met since last dose)	Give DTaP (if minimum interval met since last dose)	Yes
Complete DTaP series	No further action required	No further action required	No
For Children Aged 7 through 10 Years			
Vaccination history			
Incomplete DTaP series	Clean and minor wound Give Tdap (preferred) or Td	TIG? All other wounds No Give Tdap (preferred) or Td4	TIG? Yes
Complete DTaP series with an interval of 5 years or more from last dose	No further action required	No Aged 7–9 years: Give Tdaged 10 years: Give Tdap (preferred) or Td4	No
Complete DTaP series with an interval of less than 5 years from last dose	No further action required	No further action required	No
For Persons Aged 11 Years and Older			
Vaccination history			
Incomplete 3-dose primary series (any tetanus-containing vaccine) with an interval of 5 years or more from last dose	Clean and minor wound Give Tdap (preferred) or Td4	TIG? All other wounds No Give Tdap (preferred) or Td	TIG? Yes
Complete 3-dose primary series with an interval of 5 years or more from last dose	No further action required for wound care Tetanus-containing vaccine booster is recommended at least every 10 years	No Give Tdap (preferred) or Td	No
Complete 3-dose primary series (any tetanus-containing vaccine) with an interval less than 5 years from last dose	No further action required for wound care	No further action required for wound care	No
TIG: Tetanus immune globulin			
DTaP: a vaccine that helps children younger than age 7 develop immunity to three deadly diseases caused by bacteria: diphtheria, tetanus, and whooping cough. It is given at 2 months, 4 months, 6 months, 15–18 months, and 4–6 years.			
Tdap: a booster immunization containing a lower concentration of diphtheria and pertussis toxoids than DTaP. Tdap is given at age 11. Adolescents and adults who have not yet received it should receive one dose of Tdap at the time of their next tetanus booster.			
Td: a vaccine against tetanus and diphtheria only, recommended every 10 years thereafter.			

## Appendix 2.

### Tetanus questionnaire (in English)

#### Informed consent and confidentiality of interviews

Good morning/afternoon, Mr/Mrs \_\_\_\_\_. We are from “KAP of Doctors in China Regarding Tetanus Prevention in Trauma Patients” research group. We are working on a project concerned with Tetanus Prevention in which you could participate/participated. This study aimed to assess the knowledge and practice (KAP) of doctors regarding tetanus prevention in trauma patients and to subsequently develop advocacy efforts to improve clinical doctors’ tetanus immunization training. Now, the project is just starting. The interview will take about half an hour. All the information we obtain will remain strictly confidential and your answers and name will never be revealed. Also, you are not obliged to answer any question you do not want to, and you may stop the interview at any time.

The objective of this study is to assess the knowledge and practice (KAP) of doctors regarding tetanus prevention in trauma patients. This is not to evaluate or criticize you, so please do not feel pressured to give a specific response and do not feel shy if you do not know the answer to a question. I am not expecting you to give a specific answer; I would like you to answer the questions honestly, telling me about what you know, how you feel, the way you live and how you prepare food. Feel free to answer questions at your own pace. For questions 11–15, the options highlighted in red are the ones recommended by ACIP (The color was only shown as the reference not to the respondents.).

TIG: Tetanus immune globulin

DTaP: a vaccine that helps children younger than age 7 develops immunity to three deadly diseases caused by bacteria: diphtheria, tetanus, and whooping cough. It is given at 2 months, 4 months, 6 months, 15–18 months, and 4–6 years.

Tdap: a booster immunization containing a lower concentration of diphtheria and pertussis toxoids than DTaP. Tdap is given at age 11. Adolescents and adults who have not yet received it should receive one dose of Tdap at the time of their next tetanus booster.

Td: a vaccine against tetanus and diphtheria only recommended every 10 years thereafter.

Do you agree to participate in this interview?

Yes \_\_\_ No \_\_\_ If yes, continue to the next question; if no, stop the interview.

Do you have any question before we start? (Answer questions).

May I start now?

\*Q1 How old are you?

- 20–30
- 30–40
- 40–50
- 50–60
- > 60

\*Q2 What is your gender?

- Male
- Female

\*Q3 What is the hospital type you worked?

- Primary hospital
- Non-primary hospital (including secondary hospital, tertiary hospital, international clinic)

\*Q4 what is your education level ?

- Less than 5-year College
- 5-year or more College

\*Q5 Did you receive tetanus vaccine training?

- Yes
- No

\*Q6 Did you receive WHO tetanus guideline training?

- Yes
- No

\*Q7 Did you receive tetanus boost injection in recent 10 years?

- Yes
- No

\*Q8 Have you give consultation in recent half year ?

- Yes
- No



\*Q9 Does your hospital have tetanus vaccination in stock?

- Yes
- No

Q10 Will you query about the history of tetanus vaccination?

- Yes
- No

\*Q11 For patients aged 11years and older with Clean and Minor Wound and receiving Incomplete DTaP series or unclear history, what you will do?

- TAT:TIG instead in case of allergy
- Give Tdap (preferred) or Td4 without TIG
- No further action required for wound care. Tetanus-containing vaccine booster is recommended at least every 10 years
- Combination of TAT or TIG with Tetanus-containing vaccine

\*Q12 For patients aged 11years and older with Clean and Minor Wound and receiving complete DTaP series, what you will do?

- TAT:TIG instead in case of allergy
- Give Tdap (preferred) or Td4 without TIG
- No further action required for wound care. Tetanus-containing vaccine booster is recommended at least every 10 years
- Combination of TAT or TIG with Tetanus-containing vaccine

\*Q13 For patients aged 11years and older with dirty or deep wounds and incomplete 3-dose primary series, what you will do?

- TAT:TIG instead in case of allergy
- Give Tdap (preferred) or Td4 without TIG
- No further action required for wound care. Tetanus-containing vaccine booster is recommended at least every 10 years
- Combination of TAT or TIG with Tetanus-containing vaccine

\*Q14 For patients aged 11years and older with dirty or deep wounds and Complete 3-dose primary series with an interval of 5 years or more from last dose, what you will do?

- TAT:TIG instead in case of allergy
- Give Tdap (preferred) or Td4 without TIG
- No further action required for wound care. Tetanus-containing vaccine booster is recommended at least every 10 years
- Combination of TAT or TIG with Tetanus-containing vaccine

\*Q15 For patients aged 11years and older with dirty or deep wounds and Complete 3-dose primary series (any tetanus-containing vaccine5) with an interval less than 5 years from last dose, what you will do?

- TAT:TIG instead in case of allergy
- Give Tdap (preferred) or Td4 without TIG
- No further action required for wound care. Tetanus-containing vaccine booster is recommended at least every 10 years
- Combination of TAT or TIG with Tetanus-containing vaccine

### Appendix 3.

The regression models were built without significant *P* value no matter line regression or logit regression. Due to the fact of low score, we tittered the cutoff value to 4 as the pass line (total score 10). The univariate regression indicated that the type of hospital and gender may influence the pass ration but be insignificant when control for other variables such as age and education.

#### Regression analysis of associations of pass (cut off 4 in total 10) with gender, hospital type, and other variables.

Independent variable	Univariate regression				Multivariate logistic regression		
	OR (95% CI)	P	aβ (95% CI)	P	OR (95% CI)	P	
Gender	Male	1	0.045 <sup>b</sup>	0.446(−1.000−0.992)	0.109	1	0.504
	Female	1.977(1.014–3.856)		1		1.360(0.552–3.351)	
Age group (years old)	20–30	1	0.689	1	0.468	1	0.198
	30–40	0.832(0.367–1.883)		−0.194(−0.862–0.474)		0.751(0.322–1.751)	
	40–50	0.727(0.303–1.747)		−0.325(−1.029–0.379)		0.653(0.262–1.630)	
	More than 50	0.406(0.078–2.096)		−0.864(−0.979–0.250)		0.325(0.059–1.800)	
Education	Less than 5-year college	0.848(0.284–2.535)	0.768	−0.027(−0.919–0.865)	0.952	0.808(0.254–2.572)	0.718
	5-year or more college	1		1		1	
Hospital type	Joint venture hospital	2.17(1.100,4.688)	0.047 <sup>b</sup>	0.451	0.175	1.92(0.683,5.445)	0.228
	Non-joint venture hospital	1		1		1	
Training	Yes	0.874(0.430–1.776)	0.709	0.003(−0.550–0.555)	0.993	0.872(0.393–1.935)	0.737
	No	1		1		1	
WHO guideline	Yes	1.163(0.600–2.256)	0.654	0.080(−0.449–608)	0.767	1.326(0.636–2.763)	0.452
	No	1		1		1	

aLine regression

<sup>b</sup>with a *P* value <0.05