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Otogenic Tetanus in Children – A Systematic Review and Analytical Study

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Authors' contributions

This work was carried out in collaboration between all authors. Author SG did the study design and wrote the protocol. Authors GMV and SS managed the statistical analysis and literature searches while analyses of study was done by author SG. All authors read and approved the final manuscript.

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ABSTRACT

Background: Otogenic tetanus may follow ear suppuration or ear injury. Straightforward diagnosis may not be possible if the otolaryngologist is not familiar with the entity; infrequently it may masquerade complications of otitis media as well. Practical difficulty in evaluation and management of otogenic tetanus due to the paucity of available literature prompted us to undertake this systematic review.
Aims: To compile the available data on otogenic tetanus by literature review; to encompass and analyze the varied perspectives of this enigmatic condition.
Methodology: PubMed/MEDLINE database supplemented with relevant search in world wide web using Google/ Google scholar were used as data sources for obtaining relevent articles on the topic; duplicate publications and studies on tetanus other than otogenic origin were excluded. Extracted and shortlisted articles were abstracted, analyzed and collated.
Results: Otogenic tetanus is commoner in children; it is the commonest sub type of tetanus in post-

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neonatal age group. Chronic otitis media is the major suppurative ear disease predisposing to otogenic tetanus though acute ear suppuration has also been implicated. Tetanus resulting from ear trauma runs a more severe course. Mortality in otogenic tetanus was found to be significantly lower compared to generalized tetanus.

Conclusions: Being aware of the condition is primarily important in diagnosis and management of otogenic tetanus. Immunization history need be elicited in all children developing otitis media. Prompt primary immunization, appropriate booster doses, meticulous care of the discharging ear and proper treatment ear injury are essential preventive strategies.

Keywords: Otogenic tetanus; otitis media; ear injury; tetanus immunization.

1. INTRODUCTION

Tetanus is a vaccine preventable neurological disease caused by anaerobic, gram positive, spore-forming bacteria *Clostridium tetani*, resistant to heat, desiccation, and disinfectants capable of prolonged survival in soil, animal intestines, and feces. Open contaminated wound in the skin often allows access of spores and consequent release of the exotoxin into the human body which is responsible for the disease pathogenesis [1]. Despite committed efforts and targeted campaign by the World Health Organization with a goal to eradicate it, tetanus is still reported, mainly from the developing countries [2]. Otogenic tetanus is a subtype of cephalic tetanus, usually limited to the muscles and nerves of the head and neck, but can also progress to a more generalized form. It usually is the result of tetanus spores gaining entry into the middle ear of otitis media through a tympanic membrane perforation [3]; inflamed and devitalized tissue present in the middle ear cleft provides the perfect anaerobic environment well suited for the containment and perpetuation of the organism. [4,5]. Otogenic tetanus may also result from contaminated ear injuries or attempted ear surgeries with unsterile instruments, especially in non-Immunized [6,7,8]. This condition is much more common in children and has been reported to be the commonest sub-type of tetanus in the post-neonatal age group [9,10,11]. The otolaryngologist may not be very familiar with the entity to make a straight forward diagnosis. Before classical symptoms like trismus sets in, the initial presentation may be neurological, masquerading complications of otitis media. Early identification is all the more important since without initiating prompt management mortality may ensue. The practical difficulty in evaluation and effective management is also due to the paucity of literature available on the condition, be it academic texts or journal publications which can act as a ready reference. In this study we have attempted to compile the available data on otogenic tetanus in children by literature review to encompass and analyze the varied perspectives on this enigmatic condition.

2. METHODS

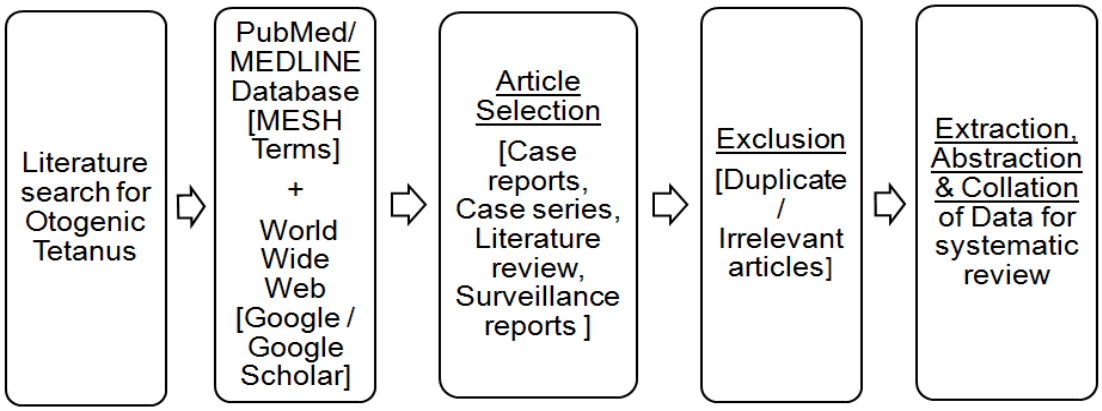
2.1 Data Sources

A PubMed/MEDLINE database search for articles published combining the terms otogenic [All Fields] AND ("tetanus" [MeSH Terms] OR "tetanus"[All Fields] OR "tetanus toxoid"[MeSH Terms] OR ("tetanus"[All Fields] AND "toxoid"[All Fields]) OR "tetanus toxoid" [All Fields]) yielded 19 references. The keywords were selected to find core articles that would address the incidence, epidemiology, presentations and management of otogenic tetanus. This was supplemented with search in World Wide Web using search engine Google/Google Scholar for relevant articles and web sites, for available evidence; the total data were compiled and analyzed (Table. 1).

2.2 Study Selection

We reviewed literature for articles published on otogenic tetanus with specific emphasis on pathophysiology, presentation, management and prevention. The retrieved articles included case reports, case series, literature review, or surveillance reports. Inclusion criteria were articles in English language providing case reports, case series or literature review on otogenic tetanus. Specific care was taken to focus on recent literature by targeting articles published during the last 20 years during data extraction. Duplicate publications, studies missing relevant data and papers reporting cases of tetanus other than otogenic origin were excluded. Data searches and selection of relevant articles were done independently by the first two authors (SG, GMV) after application of inclusion and exclusion criteria; short listed

Table. 1. Flowchart showing method of data collection for the systematic review



articles were verified by the third author (SS). Data were extracted, abstracted and collated from the shortlisted articles by the first author (SG) to draft the study; relevant data included period of study, number of cases, demographic information, immunization status, predisposing causes, clinical presentations, preventive strategy, and management outcomes. These were rechecked for accuracy independently by the second and third authors (GMV, SS). This was then reviewed and critically edited by all three authors together to prepare the final draft, resolving any discrepancies through mutual discussion and consent.

3. RESULTS

Otogenic tetanus, though thought to be very rare, is an entity which is neglected in majority of academic literature in Otorhinolaryngology; it doesn't figure in the discussion on general complications of Otitis Media as well. A Google search in World-Wide-Web yielded 639 results in Google books. However, information contained in majority of these book references obtained had no direct bearing on the search subject. With this background, a Pubmed search was performed on otogenic tetanus to find 19 articles published in indexed journals. With advanced MEDLINE search on the same yielded further 17 articles. Of these 22 items were shortlisted, the observations and analysis of which is being discussed.

The first reported case of Otogenic Tetanus was in 1934 by Vener & Bower [3] in the journal of the American Medical Association. A $4^1/_2$-year-old boy who developed otorrhea following cold, presented with trismus and was diagnosed to have tetanus; despite aggressive management he succumbed to cardio-respiratory failure and died 36 hours' post-admission. *Clostridium tetani* was isolated in culture of the ear discharge, reported after 5 days. The authors concluded this to be a case of tetanus following acute otitis media (AOM) since there was no antecedent history of trauma and postulated the boy to be a carrier activated by the preceding respiratory infection.

Another report of otogenic tetanus in British medical journal 1965 by Boyle et al. [4] involved a 49-year-old unimmunized woman employed in a factory manufacturing horse-hair upholstery filling, admitted with 3 day history of pain and trismus having external otitis in right ear and chronic otitis media (COM) in the left ear. She had no recent injury but had attempted superficial mopping of the ears when discharging. Presence of *Clostridium tetani* was reported from both ear swabs. The patient was treated with ICU care, anti-tetanus-serum, tetanus-antitoxin, antibiotics and tracheostomy to make full recovery; repeat ear swabs were negative. The occupation of the patient working with horse-hair was suggested as the causative factor, but difficult to prove. The authors also pointed out that otogenic tetanus resulting from trauma to the ear runs a more severe course with acute, severe and generalized convulsions than tetanus supervening on pre-existing suppurative ear disease.

Sykes et al. [5] reported a 9-year-old boy with COM right ear since the age of four developing tetanus within 3 days after falling into a duck pond; the ear which had been dry started discharging again and *Clostridium tetani* was grown in culture. They concluded that the contamination during submersion in the duck

pond was the route of entry and short incubation period due to proximity of ear to the central nervous system.

Tetanus also has been reported after ear injury without prior history of ear suppuration. Kulkarni et al. [6] reported a 5-year-old boy developing tetanus, 4 days after foreign body in the ear, focusing on issues during general anesthesia for removal; the authors concluded that volatile anesthetic agents could be safely used in such patients. Lyons and Rybak [7] reported an 18-month-old child who presented with classical features of tetanus, presumably following wax removal 1 week back which had resulted in minor trauma to the external canal.

Possibly one of the largest case series, Patel and Mehta [8] conducted a study on 8697 patients diagnosed with tetanus at King Edward VII Memorial Hospital Bombay between 1954-1968, by analysis of treatment records. Despite being the single most common cause, injury could not be identified in more than 50%; of these only 22 cases were found to be otogenic in origin since they supervened on otorrhea. Mortality in otogenic tetanus was found to be significantly low (less than 1%) in this series.

A case series by Geeta et al. [9] studied the advantage of Intrathecal tetanus immunoglobulins in the management of tetanus in 66 patients treated between 1999-2004; the portal of entry was otogenic in 58% of the cases. Majority of study population were children below 5-years in whom 77% were otogenic. Interestingly, in older patients' injury was the commoner cause of tetanus. The authors emphasized prompt treatment of childhood ear infections as one of the key preventive measures against otogenic tetanus. Similarly, Tullu et al. [10] shared their experience of 40 tetanus cases from pediatric intensive-care-unit K.E.M-Hospital, Mumbai, India, admitted between 1996-1998. 45% cases were otogenic and observed to be the commonest mode of acquiring post-neonatal tetanus; in contrast, post-injury tetanus was commoner above 6-years of age. Instillation of oil, introduction of unclean fingers or contaminated objects into ear with COM were thought to be contributory. Mortality was observed to be less in otogenic group compared to others (22% vs 45%), but could not be statistically supported. Mortality was also found to be higher among patients undergone tracheostomy. The authors recommended verifying tetanus immunization in all children presenting with otitis media. In another retrospective study children admitted with tetanus between 2009-2010, were reviewed at Lady-Hardinge Medical College, New Delhi, India by Mishra et al. [11]. 45 cases of neonatal tetanus and 77 cases of post-neonatal tetanus were studied. Otogenic route was observed to be the commonest mode of infection in post-neonatal tetanus and constituted 58.4% cases. Improving immunization and prompt treatment of otitis media were suggested as the main preventive strategies to be focused.

Specific studies targeted at otogenic tetanus has allowed in depth analysis of the entity including survival. In a study by Mahoney [12], 67 patients diagnosed as otogenic tetanus were hospitalized at the Mama-Yemo hospital, Zaire, Nigeria between 1975-1976. All patients had COM without evidence of any complications other than otorrhoea; otologic procedures or injury were ruled out as added predisposing causes. Though the care for all 620 tetanus cases admitted during this period were in similar lines, survival rate was found to be slightly better among otogenic tetanus than the general group (83% vs 79%). Unfavorable growth conditions for the organism in the ear, decreased toxin production and consequent poor absorption was postulated to explain low mortality. Mortality rates were found to be more among the patients who had tracheotomy; sedation sufficient to eliminate muscle spasms and need for tracheotomy was proposed to improve survival. Low mortality of only 4% was also observed in a study conducted by Akinbohun et al. [13] among 25 children with otogenic tetanus between 2001-2005 at University-Hospital, Ibadan, Nigeria. 84% of patients with COM had otorrhea and perforated tympanic membrane while 12% had external otitis and intact tympanic membrane. None of the patients were fully immunized. The Onset period ranged from 2-5 days; disease with shorter onset period ran a more severe course and poor treatment response. The authors concluded that otitis media predisposes to tetanus among children and emphasized eliciting immunization history in all pediatric ear infections. Tympanoplasty with or without mastoid exploration were advocated in select patients to prevent recurrence of ear suppuration, a major risk factor in otogenic tetanus.

Ugwu and Okolugbo [14] retrieved and analyzed case records of 4 unimmunized patients who presented with otogenic tetanus at the pediatric ward of the Central-Hospital, Warri, Nigeria in

2008. Predisposing causes were untreated COM, traumatic removal of a foreign body and treatment of ear discharge with native gin. Early referral to otorhinolaryngologist was advised for children with COM or foreign body ear with emphasis on complete immunization of pediatric population.

A case control study on clinical and bacteriological profile in otogenic tetanus was done by de Souza et al. [15] in 1992 at Bombay, India. The study population comprised of 22 patients, none fully immunized; 17 developed tetanus following a single episode of AOM while remaining 5 after COM. 2 patients with AOM had intact, congested and bulging tympanic membranes, suggesting purulent middle ear exudate. Remaining 20 patients had central perforations with purulent pulsatile discharge. In addition to *Clostridium tetani*, coexisting aerobic infection was revealed in 85% of the cultures; vast majority (59%) of aerobic organisms involved were staphylococcus aureus. Authors concluded that tetanus resulting from otitis media is not an indication for surgery.

A total of 391 children with COM were studied for demographic, clinical and bacteriological profile by Melaku et al. [16] in 1999 at Addis Ababa, Ethiopia. Apart from the routine complications of COM like meningitis and mastoiditis, tetanus was also reported here as a complication, though of relatively low incidence. Commonest bacterial isolates cultured was Proteus (37.7%) followed by Staphylococcus aureus, Pseudomonas aeruginosa, and Gram negative enterics. Co-amoxiclav, Gentamicin, and Kanamycin were the only drugs to which most of the pathogens were sensitive. Selective use of antibiotics and continuous aural cleansing was hence advocated by the authors. Tetanus presenting as a complication of COM also has been reported by Adeel et al. [17]. A 12-year-old girl with bilateral COM presented with palatal paralysis, trismus and stiffness, not responding to antibiotics. No specific complications of otitis media could be detected by investigations including CT. There was history of tetanus vaccination, but no booster doses were taken. On clinical suspicion, tetanus antitoxin with immunoglobulins were administered to which she readily responded; culture of ear discharge was later reported positive for *Clostridium tetani*.

In the 16-year retrospective study of 2071 patients with COM managed in the department of Otorhinolaryngology, University-College-Hospital, Ibadan, Nigeria, between 1997-2012 by Ogunkeyede et al. [18], 66 patients were diagnosed with otogenic tetanus; about half of the cases actually presented during the last 5 years, indicating a significant rise in incidence. Majority of patients were children. Ear discharge lasted on the average for 89 days with no active management. Applying traditional home remedy made up of leaves, animal dander and feather into the ear or of use of herbs, charcoal, honey, cigarette, methylated spirit or deodorant in the discharging ear resulted in inoculation of tetanus spores. Partial immunization was attributed to lack of, proximity to health care delivery, awareness among parents and funds due to poverty. Development of tetanus in some despite being fully immunized was attributed to frequent power outage in Nigeria, making it difficult to preserve the vaccines in the requisite 0-4^{0}C. Apart from the anti-tetanus treatment, proper ear toilet and topical antibiotics, significantly 23 patients needed mastoidectomy; Mortality was high (8 patients). The authors concluded that otogenic tetanus is a major problem in developing countries and emphasized booster vaccination between 11-18 years in adolescents and once in 10 years in adults in view of the disease even in immunized. Health education on ear hygiene was recommended as preventive measure. A case of tetanus in 31-year-old male with a protective tetanus antibody level was reported by Vollman et al. [19] to highlight importance of thorough history and physical examination ruling out other causes in guiding tetanus management; adequate serum levels antibody levels should not preclude diagnosis, since such patients are not immune to tetanus.

Sharma and Kapoor [20] reported treating a 2-year-old girl in Rohtak, Haryana, India who relapsed twice after near complete recovery from otogenic tetanus. Alhaji et al. [21] described recurrent otogenic tetanus in a four-year-old unimmunized boy following recurrent otitis media within 11months highlighting the importance of primary immunization with boosters and need for active immunization before discharge.

Galletti et al. [22] in an analysis of published literature of ENT involvement in zoonotic diseases found otogenic tetanus included among zoonotic diseases involving ear in both adults and children. Farrar et al. [23] in their article on neurological aspects of tropical diseases observes ear piercing as one of the myriad range of injuries causing tetanus along with intramuscular injections, acupuncture and toothpicks; otitis media has been mentioned as

the predisposing cause among infections. Ganesh et al. [24] reported the successful detection of *Clostridium tetani* from ear discharge of a 2-year-old child diagnosed with otogenic tetanus using tetX specific primers targeting the *Clostridium tetani* neurotoxin. The sample for the same was obtained based on the culture results of the ear discharge, Gram staining and virulence testing by genotyping confirming diagnosis of tetanus.

4. DISCUSSION

Otogenic tetanus as an entity is now confined more to the developing world, though there were frequent reports from developed countries earlier [3,4,5]. More than 80% of recent reports and case series are from Africa and Asia. This has been linked to socio-economic factors, level of personal and environmental hygiene and lack of awareness on prompt treatment of ear infections [10,14,18]. Most importantly it may also reflect the level of immunity of the population due to defects in the planning and execution of immunization programs in the developing world. It is not rare, as it was thought to be in older scientific literature. The incidence was less than 1% of the total tetanus cases as per older case series [6]. In stark contrast, according to more recent reports it is the commonest mode of transmission of tetanus, and in some series more than 50% was observed to be otogenic in origin [7,8,9]. This huge difference and increase in the reported incidence may possibly be due to the enhanced recognition of the entity and identification of ear suppuration as possible mode of transmission of tetanus; this might have led to specifically seeking history of otitis-media or ear injury in patients diagnosed with tetanus.

Otogenic tetanus is commoner in the pediatric age group. In fact, it was the commonest mode of acquiring tetanus in the post neonatal pediatric population as per reports [9,10,11]. The incidence of otogenic tetanus however was found to decline with increasing age in these studies; in older patients tetanus was predominantly noted to follow injury [9]. Presumably this discrepancy may be explained by the immune status and frequency of middle ear infections among the pediatric age group and increased frequency of outdoor activities in older individuals making them more prone for injury.

Two forms of otogenic tetanus has been identified in literature. Tetanus supervenes on pre-existing suppurative ear disease in one and the other results from direct trauma to the ear; the former being more common and the latter runs a more severe course [4,5,6,7,14]. COM is the major suppurative ear disease predisposing to otogenic tetanus; contamination of the exposed middle ear being the commonest mode of entry of the organism here. It was suggested that myriad range of practices (Table 2) resulting in introduction of the organism into the discharging ear could be the prime inciting factor especially among children [10,14,18]. Devitalized tissue in the inflamed middle ear and mastoid in an anaerobic environment provides the perfect growth medium for *Clostridium tetani* to thrive and release exotoxins resulting in clinical manifestations of tetanus [12]. Tetanus has also been identified and reported as a routine complication of COM, though the incidence of such reported cases were low [16,17]. Presentations like palatal palsy or trismus, not attributable to any known complication of COM and unresponsive to the routine treatment, responded readily to tetanus immunoglobulin and antitoxin confirming the diagnosis. Conversely, neurological symptoms and signs of tetanus can masquerade other known complications of otitis media when presentations are similar.

Otogenic tetanus also has been reported after AOM and otitis externa, though less common than chronic infections [3,4,13,15]. Tetanus has been reported following acute middle ear suppuration even within an intact tympanic membrane. There are studies where more than 75% of patients developing otogenic tetanus were following acute infections [15]. Coexisting aerobic organisms have been identified along with *Clostridium tetani* in the middle ear and this suggests that clostridium per se was not responsible for AOM. A carrier state triggered by predisposing upper respiratory infection has been postulated as the possible mechanism of otogenic tetanus in AOM [3]. *Clostridium tetani* has also been reported to exist in the ear canal of 20% of population living in the tropics as a commensal, and hence the possibility of triggering off tetanus following external otitis.

Clostridium tetani has been isolated by culture of ear discharge in majority of reports and this confirms the otogenic origin [3,4,5,15,17]. Quicker isolation of and successful detection of *Clostridium tetani* from ear discharge has also been made possible by employing tet-X specific primers targeting the *Clostridium tetani* neurotoxin [24]. However, added aerobic bacteria isolated by culture in such patients are responsible for pathogenesis and propagation of the primary ear suppuration [15,16]. It was mixed

flora in COM highly resistant to the commonly used antibiotics. In AOM the isolate was predominantly staphylococcus aureus. These findings attain significance in the management of the primary ear condition.

Otogenic tetanus considered to be an example of zoonotic disease involving the ear both in adults and children, and *Clostridium tetani* has been classified as a bacterial agent responsible for zoonotic infection in humans as per published literature [22]. Contact with animal dander and other products, either accidental or occupational, have been implicated in the transmission of the disease in reports. Acquiring otogenic tetanus after occupational exposure to horse hair while working in upholstery industry and contamination of ear wound following fall into a duck pond are examples [4,5].

Apart from suppurative ear disease otogenic tetanus has also been noticed to occur following a myriad range of ear injuries. Tetanus resulting from trauma to the ear has been suggested to run a more severe course as compared to tetanus following ear infections which runs a subtler course [4]. Reported causes include foreign body related injury, traumatic removal of foreign body, wax removal, ear pricking, probing the ear and other traumatic insults [6,7,9,14,23]. Use of unsterile instruments for ear procedures or contamination of fresh wounds created by such injuries were found to be the inciting factors. Tetanus was observed to follow even trivial injuries like superficial mopping of the ear in patients with pre-existing ear infections like external otitis and otitis media [4].

Immunization history did have a bearing on probability of developing otogenic tetanus; in majority of the case reports and case series patients were unimmunized or partially immunized [4,10,11,13,14,21]. Issues with health care delivery in remote localities, inadequate funds for transportation and lack of parental awareness where cited as the prime reasons responsible in the developing world. Since ear infections were the commoner mode of acquiring tetanus in the pediatric age group, it has even been suggested that immunization history need be meticulously elicited in all children presenting with ear suppuration [10,13]. However, it was found that even fully immunized children developed tetanus after injury [18,19]. Quality and storage of the tetanus vaccine also has been implicated here in the maintaining efficacy of immunization. To retain potency, vaccines need be stored at a temperature between 0-4℃, since heat can denature them and cause immunization failure. Since childhood vaccination does not confer lifelong protection with disease even in immunized, it has been suggested that adolescents and adults should receive booster shots [18,21]. Since unimmunized mothers where identified in majority of neonatal tetanus, immunization during pregnancy needs special attention to prevent newborn infection.

Incubation period and the period of onset are directly related to disease severity and treatment response in otogenic tetanus, since they are indicative of the quantity of toxin released and distance travelled within the nervous system [5,13]. They hence have prognostic significance; while patients with a longer onset period developed milder form of tetanus responsive to treatment, those with shorter onset period ran a more severe course and poor treatment response. Meticulous history and physical examination to rule out other causes should guide diagnosis when there is concern for a tetanus infection; adequate serum levels of antibody do not preclude the diagnosis of tetanus and such patients are not immune to tetanus infection [19].

Management of otogenic tetanus has been on similar lines to that of general tetanus; Tetanus antitoxin, Tetanus immunoglobulin and antibiotics; smaller percentage of patients required sedation, muscle relaxants, and artificial respiration via endotracheal intubation or tracheostomy [4,13,18]. Local ear toilet to clear off the stagnant secretions and debris from the external canal and middle ear is essential; appropriate culture directed antibiotics should be initiated to cover co-existing aerobic organisms [15,16,18]. Surgical treatment of the middle ear and mastoid by tympanoplasty and mastoidectomy has been advocated in COM for disease clearance to prevent re-infection [13,18]. Since the mechanism of developing otogenic tetanus is different, surgery has not proposed as a management option in AOM.

Since injury related otogenic tetanus follows even trivial ear procedures like wax clearance or foreign body removal, caution should be exerted to prevent inadvertent injury and if needed done under GA; aseptic precautions and proper sterilization of all instruments used in the ear is mandatory since tetanus has been reported even after superficial mopping of the ear. In the event of patient sustaining injury, proper wound care and antibiotic therapy is essential to prevent entry of *Clostridium tetani*. Early referral to the

otorhinolaryngologist for ear infections and situations requiring aural manipulation has been recommended as an essential preventive measure [14]. This is more important in children since otogenic tetanus is commoner in pediatric population. Meticulous aural toilet to clear secretions and atraumatic method of ear procedures for foreign body and wax removals are possible only during specialist care of the ear.

Contrary to traditional belief mortality in otogenic tetanus (Table 2) was actually found to be less than generalized tetanus in many studies [8,10,12,13]. Unfavorable conditions for the growth of the organism in the ear with decreased or delayed production of the toxin and consequent poor absorption was postulated to explain the low mortality observed in otogenic tetanus. Survival rates were hence better in children with otogenic tetanus as compared to the generalized disease [12]. Mortality in otogenic tetanus was found to be directly related to shorter period of onset, long duration of spasms, increasing severity of tetanus and presence of complications. Interestingly in some studies mortality rates were found to be more among the patients who had undergone tracheotomy [10,12]. This may not be directly related to the surgery, but may reflect the disease severity as such, which made tracheostomy necessary. Unsurprisingly, sedation sufficient to eliminate muscle spasms and maintain the patient sleeping was suggested in increasing survival rates, arguing a significant reduction in the need for tracheotomy.

Otogenic tetanus also have been found to relapse after near complete treatment resulting in uncertainty and confusion in continuation of therapy [20,21]. This again highlights the importance of primary tetanus immunization with adequate booster doses given at appropriate intervals. Meticulous treatment of the middle ear suppuration should also be part of active management to eliminate the focus of possible reinfection.

Table 2. Relevant studies on otogenic tetanus to show predisposing causes and mortality

Sl no.	Author(s) & country	Patients with otogenic tetanus	Predisposing cause(s)	Mortality
1	Patel and Mehta [8] (India)	22	COM, Ear injuries	Low mortality (less than 1%)
2	Geeta et al. [9] (India)	38	COM	NR
3	Tullu et al. [10] (India)	18	COM, Instillation of oil, Introduction of unclean fingers or contaminated objects in the ear	Lower mortality than non-otogenic cases (22% vs 45%)
4	Mishra et al. [11] (India)	45	COM	NR
5	Mahoney [12] (Nigeria)	67	COM	Lower mortality than general group (17% vs 21%)
6	Akinbohun and Ijaduola [13] (Nigeria)	25	COM, EO	Low mortality (4%)
7	Ugwu and Okolugbo[14]	4	COM, FB, Use of native gin in the ear	Nil
8	deSouza et al. [15] (India)	22	COM & AOM	NR
9	Ogunkeyede et al. [18] (Nigeria)	66	COM, Use of traditional home remedy of leaves, animal dander, feather, herbs, charcoal, honey, cigarette sticks, methylated spirit or deodorant in the ear	High mortality (12.1%)

Abbreviations: COM – Chronic Otitis Media, AOM – Acute Otitis Media, EO – External Otitis, FB – Foreign Body, NR – Not Reported

5. CONCLUSIONS

Understanding the pathophysiology and judicious treatment has been generally attributed to the craft of the attending physician and it's no different in otogenic tetanus. Impact of this condition may vary in the context of socioeconomic status of the population and efficacy of the public health system in the affected areas. Thus, a greater threat has been identified in the underdeveloped and the developing countries than in the developed world. It is important that the treating physicians increase the awareness of this condition to avoid serious diagnostic pitfalls. The following conclusions were made from the analysis of literature search on this enigmatic condition.

1. There is marked increase in reported incidence of otogenic tetanus during the past decade and majority of patients are children; incidence declines dramatically with increasing age.
2. Most common predisposing cause is COM but can follow AOM or otitis externa; each with different pathogenesis. *Clostridium tetani* isolated by culture of ear discharge confirms diagnosis. History of tetanus immunization should be hence elicited in all children presenting with otitis media, especially in developing countries.
3. Otogenic tetanus has been reported following a myriad range of ear injuries and run a more severe course as compared to that following infections; deeper wounds carry a greater risk as compared to superficial abrasions.
4. Otogenic tetanus is classified as a zoonotic disease since contact with animal products has been implicated in the transmission.
5. Prompt childhood immunization with adult booster doses every 10 years and during pregnancy is essential in prevention. Potency of the vaccine need be ascertained by ensuring ideal storage temperatures in primary health care institutions.
6. Mortality rate in otogenic tetanus is less than in generalized tetanus; survival rates are much better in children. Shorter Incubation period and onset period are poor prognostic factors to decide disease severity and treatment response.
7. Management principles of otogenic tetanus are on similar lines to that of generalized tetanus; however local aural toilet should be an essential part of treatment to remove stagnant secretions and debris from the ear. Management of the predisposing ear condition is prudent for disease clearance.
8. Atraumatic techniques and meticulous care to use well sterilized instruments should be followed in all surgical manipulations of the ear to prevent injury related otogenic tetanus.
9. Early ENT referral should be encouraged for scientific treatment of ear infections and ear injuries since inadequate treatment has been reported to cause relapse of otogenic tetanus.
10. Health education of the public is prudent on the need for primary tetanus immunization, appropriate booster doses, care of the discharging ear and prompt treatment for ear injury.

CONSENT

It is not applicable.

ETHICAL APPROVAL

All authors hereby declare that all experiments have been examined and approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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