

Measles-induced Hearing Loss: Pattern, Diagnosis, and Prevention among Children in Ekiti State, Southwest Nigeria

Abstract

Background: Measles-induced hearing loss is an otologic tragedy. In this study, we looked into the hypothesis that measles-induced hearing loss may exhibit specific pattern the knowledge of which may guide clinicians on its diagnosis and prevention among children. **Objective:** The objective of the study was to describe the pattern, diagnosis, and prevention of measles-induced hearing loss among children. **Materials and Methods:** This is a retrospective study of children with measles-induced hearing loss in two tertiary hospitals. **Results:** In all, 112 children with measles-induced hearing loss were studied. Majority (92.8%) were struck by the auditory shutdown at age 0.5–5 years. Most (87.5%) of the measles-induced hearing losses were sensorineural with 73.5% of them being profound, bilateral, and irreversible. Majority were not diagnosed early due to a lack of visible or palpable diagnostic features. Majority (70.5%) of the children were not vaccinated against measles. Features suggestive of encephalitis were commonly associated with the profound sensorineural hearing loss. About 10% concomitantly used ototoxic antibiotics at the acute stage of the measles infection. About 84% of the children were deaf and dumb. **Conclusion:** This study shows that measles-induced hearing loss often affects children around the age of speech acquisition leaving the victims deaf and dumb. Late diagnosis is characteristic of the auditory shutdown. The need to scale up effective antimeasles vaccination among children is hereby stressed. Routine postmeasles hearing assessment of victims is a practicable step to identify early those that require prompt rehabilitation with hearing aid or cochlear implant.

Keywords: Antimeasles immunization, bilateral, irreversible, measles-induced sensorineural hearing loss, profound, rehabilitation

Introduction

Measles is a highly contagious viral disease.^[1,2] It is transmitted through airborne droplets from the nose, mouth, or throat of an infected individual.^[2] Although there are safe and effective vaccines against measles, large outbreaks continue to occur in many countries.^[3-7] In a 5-year review of measles cases in Nigeria, Ibrahim *et al.* found a total of 131,732 cases recorded between January 2012 and September 2016.^[6] Earlier on, Oyefolu *et al.* had recorded 35,500 cases of clinically diagnosed measles in a 10-year retrospective study of measles morbidity and mortality trend in Nigeria.^[7] Studies have shown that children with measles are vulnerable not only to short but also long-term complications. According to Center for Disease Control and Prevention, ear infections occur in about 1 in 10 measles cases and permanent loss of

hearing can result.^[8] Furthermore, in addition to measles causing ear infections, can result in encephalitis^[8,9] and about 30% of individuals affected with measles infections also suffer ear infections with possible central auditory damage and children are the most vulnerable.^[8,9] Therefore, measles-induced hearing loss may be peripheral and/or central in origin. It is noteworthy that there is a nexus between hearing and normal speech development in children. As reported, infants and young children are typically “bathed in language” by their caregivers during the first months of life. Such stimulation, often called motherese, serves to nurture proper language development.^[10] Also observed is that a child learns to talk only because people in the immediate environment speak to each other and to the infant.^[11]

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The socioeconomic implication of measles-induced hearing loss is better appreciated by noting the roles of hearing in humans. According to the World Health Organization, “Of all the senses, it is hearing which fundamentally facilitates communication and fosters social interactions, allowing people to forge relationships, participate in daily activities, be alerted to danger and experience life events.”^[12] Apart from precipitating social isolation, measles-induced hearing loss could prevent the victims from attaining educational milestones. Sometimes, in the developing countries, the grown-up victims become destitute and may resort to street begging. In view of these unsavory sequelae, there is the need for timely diagnosis and treatment of measles-induced hearing loss among the vulnerable in the society. In cases where the hearing loss cannot be reversed, timely diagnosis and effective rehabilitation can ensure speech and auditory competence for the affected child. In view of these observations, we, therefore, embarked on this study to investigate the hypothesis that measles-induced hearing loss is likely to exhibit specific pattern the knowledge of which may facilitate timely diagnosis and rehabilitation among children.

Materials and Methods

Study setting

This study was conducted at the pediatric and otorhinolaryngology departments of two tertiary hospitals in Ekiti State, Southwest Nigeria.

Study design and data collection

This was a retrospective analysis of records of children with measles-induced hearing loss seen at the pediatrics and otolaryngology departments of the institutions over a 10-year period between January 2009 and December 2018. The information retrieved were the documented sociodemographic data, presenting complaints, past medical history, pregnancy and birth history, family and social history, records of immunization, age at which measles infection occurred, and symptoms of the measles. The case definitions of measles were as described and recorded by the attending physicians based on the World Health Organization (WHO) case definition criteria^[8,9] using symptoms, illness history, physical examination, and outcome of laboratory investigations following presenting complaints by mothers/caregivers who accompanied the child to the hospital or as was directly observed by the clinicians at the time of consultation. Also noted were, the age at which the measles-induced hearing loss was discovered, age of and if there was speech acquisition, educational milestones, details of otoscopic findings, audiometric hearing assessment including pure tone audiometry (PTA) and tympanometry, treatments received, and sources of referral as recorded. Records of objective audiometric tests such as auditory brain stem response and otoacoustic emission were also noted in some cases

where subjective tests such as PTA were not reliable. In compliance with the standard practice, only those screened with the PTA had bone conduction performed on them. The Triveni TAM-50 was noted to have been used for the PTA measurements using sign language for the deaf and dumb. The 250, 500, 1000, 2000, 4000, and 8000 Hz were used as threshold levels in the ear and all were performed in a quiet room. The degree of hearing loss file was classified according to the WHO grading as mild (26–40 db), moderate (41–60 db), severe (61–80 db), and profound (≥ 81 db). www.who.int/pbd/deafness/grades_of_hearing. PNG? ua = 1. The treatments received previously by the patients and sources of referral as recorded in their case files were also noted. Those from who additional information is required were contacted for the information. One would have preferred the American Speech-Language-Hearing Association (ASHA) and British Society of Audiology (BSA) grading system; however, the WHO grading system adopted for this study was the record in their case files. Furthermore, the use of the ASHA and BSA grading systems would not have swayed the outcome of this study otherwise

Exclusion criteria

Excluded were children with measles and hearing loss suspected to be congenital from their records in the “at-risk register” in our center which showed them to have earlier failed hearing screening before the onset of the measles affection. Also excluded were children whose mothers gave a history of lack of response such as “moro reflex” or “distraction” to sound stimuli and lack of rudimentary speech such as Echolalia or intentional speech since birth till the time of our study.

Ethical consideration

Ethical clearance was obtained from the institutions’ Ethics and Research Committees.

Data analysis

This was done using Statistical Program for the Social Sciences (SPSS) software version 17.0 (SPSS Inc., Chicago, IL, USA 2008) using descriptive statistics and level of significance was set at $P < 0.05$.

Results

In all, records of 112 children with measles-induced hearing loss were analyzed. There were 77 (68.8%) males and 35 (31.25%) females, given male:female ratio of approximately 2:1. Majority 92 (82.1%) were prelingual children with age range between 0.5 and 9 years, mean 2.1 ± 1.6 years at the time they had measles infection and possibly, the suspected auditory shutdown. Their ages at otologic review however range from 6 to 15 years with a mean and median of 9.95 and 10.14, respectively. Ninety-eight (87.5%) children had sensorineural hearing loss (SNHL), 10 (8.9%) had isolated conductive hearing

loss; 2 unilateral and 8 bilateral; and 4 (3.6%) had bilateral mixed hearing loss. Of the 98 cases of SNHL, 72 (73.5%) were profound, 7 (7.1%) were severe, while 19 (19.4%) were moderate. One (10.0%) of the conductive hearing loss was severe, 5 (50.0%) were moderate, and 4 (40.0%) were mild. The severe conductive hearing loss noted was an incidental finding and was recorded as such. This could be of research interest in future. Three (75.0%) of the mixed hearing losses were profound, while 1 (25.0%) was severe [Figure 1]. All the profound SNHL were bilateral. Features suggestive of encephalitis [Figure 2] were noted in 66 (60%) of the cases commonly among those with the profound, bilateral SNHL. Most (70.5%) of the children were not vaccinated against measles [Table 1]. Eleven (9.8%) of them concurrently abused ototoxic antibiotics during the bouts of the measles attack. Ninety-four (83.9%) were deaf and dumb. Forty-seven (42%) were out of school, while 65 (58%) were institutionalized in the school for the deaf.

Table 1: Sociodemographic characteristics of the children

Criteria parameters	Frequency (n=112), n (%)
Age at measles infection (years)	
0.5-1	32 (28.6)
2-3	56 (50.0)
4-5	16 (14.2)
6-7	6 (5.4)
8-9	2 (1.8)
Age at otolaryngologic review (years)	
6-7	34 (30.4)
8-9	19 (16.9)
10-11	21 (18.8)
12-13	20 (17.9)
14-15	18 (16.0)
Gender	
Male	77 (68.8)
Female	35 (31.2)
Measles vaccination status	
Vaccinated	33 (29.5)
No vaccination	79 (70.5)

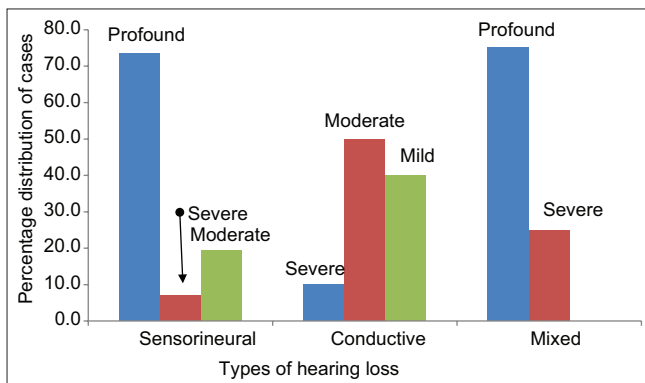


Figure 1: Distribution of the types and severity of the measles-induced hearing loss

The summary of the causal and effect relationships between type/pattern of hearing loss and associated measles infection, clinical, and sociobiologic related factors is shown in Table 2.

Discussion

Despite the great disability, it imposes on its victims; measles-induced hearing loss is largely underreported. This perhaps might be due to poor recognition and lack of research interest in this otologic catastrophe. While it is important to report on the mortalities and case fatalities of measles, it is equally paramount to research into its otologic sequelae as they could serve as important epidemiological indices of measles in the community.

This study, which attempts to describe the auditory consequences of measles, observed that measles-induced hearing loss mostly affects children who are under the age of 5 years. As the study showed, the age of the victims at the onset of the measles-induced hearing loss ranged between 0.5 and 9 years with majority being under 5 years. This concurs with previous reports that measles and its consequences commonly affect children who are below or equal to the age of 5 year. According to Ibrahim *et al.*, measles affects mostly under 5-year-old children.^[6] Furthermore, Oyefolu *et al.* reported that measles often pitches its tent with children under the age of 5 years.^[7] Interestingly, this is the optimal age for speech acquisition among children. As noted by researchers, a speech readiness period extends from birth to the 5th year of life, when the child acquires the ability to develop speech as a method of communication.^[11] Since hearing is a prerequisite to attain normal speech developmental milestones, the occurrence of measles-induced hearing loss at this critical period would not only make the victim deaf but also dumb. This was the finding in this study as 83.9%

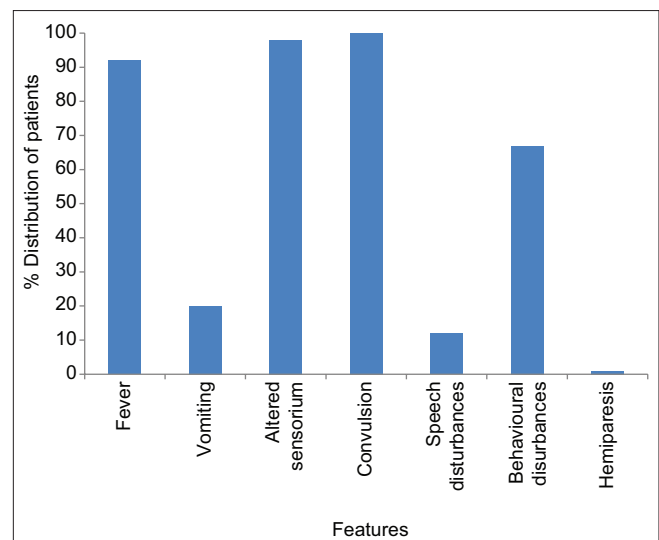


Figure 2: Distribution of the features of measles-induced encephalitis among those with sensorineural hearing loss

Table 2: Characteristic features of measles-induced hearing loss

Criteria	Characteristics	Remarks
Type of hearing loss	Sensorineural	Most common
Degree of hearing loss	Profound (>80 db)	Commonly
Laterality	Bilateral	Often
Peak age of onset	<5 years	
Clinical markers at onset	Nil	No symptoms/signs (hidden)
Age at diagnosis	>5 years	When patient fails to acquire speech
Risk with measles-induced encephalitis	High	
Feature of encephalitis	Present	Convulsion (mostly in those with profound SNHL)
Risk with lack of immunization	High	
Impact on speech acquisition	Causes dumbness	Mostly in prelingual victims
Prognosis	Irreversible	Mostly

SNHL: Sensorineural hearing loss

of the studied population was deaf and dumb as at the time of their otologic assessment.

Majority (87.5%) of the measles-induced hearing losses in this study were sensorineural. Furthermore, 73.5% of the sensorineural hearing loss was profound and bilateral. This is in keeping with the data from other studies that measles contributes significantly to the development of profound SNHL among children in the developing countries.^[13-16] It was observed that the profound SNHL in the present study were commonly found among those with features suggestive of encephalitis. Whether this association is coincidental or consequential could not be ascertained in this study. However, previous studies have described encephalitis and profound SNHL as important sequelae of measles affectation among children.^[17-19] Although the definitive diagnosis of measles-induced encephalitis is made by brain biopsy,^[20] the diagnoses in this study were essentially clinical based on symptoms and signs. The symptoms and signs, according to Fisher, typically consist of fever, headache, and altered level of consciousness.^[20] A unique symptom recorded in the present study was the occurrence of convulsion in all the cases with profound SNHL. This is quite significant particularly among children who are too young to complain of headache or other subjective symptoms. The association between convulsion and profound SNHL has been described in the literature.^[13,21] Therefore, convulsion as a cardinal symptom of encephalitis could be highly suspicious of future development of SNHL and could therefore be used to prognosticate and triage children affected by measles for their risk(s) of SNHL, especially in resource-limited settings where modern diagnostic tools are generally lacking. Hence, high index of suspicion among those with measles-induced convulsive episodes therefore may improve the diagnostic yield, thereby averting other downstream sequelae. However, this hypothesis and the diagnostic roles of other features of measles-induced encephalitis in SNHL warrants further study.

Ten of the victims in this study had isolated conductive hearing loss caused by measles-induced ear infections. As

noted by the Centre for Disease Control and Prevention, ear infections occur in about 1 in 10 measles cases and permanent loss of hearing can result.^[8] Often, the ear infection which usually is superimposed by bacterial sepsis manifests clinically as acute otitis externa and/or media. In addition to causing middle ear destruction, the otitis media may spread to the inner ear and brain to cause sensorineural hearing loss. This pathological involvement of the middle ear and the inner ear with or without the brain causing, respectively, conductive and sensorineural hearing loss may account for some cases of mixed hearing loss seen among some victims in this study. However, it seems the sensorineural component of the mixed hearing loss is a cochlear rather than retrocochlear lesion or both because none of the mixed hearing loss had features suggestive of encephalitis or brain involvement. Although, this could be occurrence per chance since our records did not differentiate the sensorineural part of the mixed hearing loss into the cochlear and retrocochlear components as to know if the brain is involved or not. Thus, it would be a good research effort to investigate if the mixed hearing loss is a spectrum involving the middle, the inner ears, and the brain or if the involvement of those segments is mutually exclusive. Of note, however, is the tendency for some cases of the measles-induced ear infections to become chronic. This tendency for chronicity could be due to parental negligence. As observed by Okafor, acute ear infections are often neglected by parents while looking around for a local remedy.^[22] Furthermore, the negligence might be due to the parents' belief that ear discharge is innocuous particularly if it coincides with teething. This ear discharge-teething myth among parents had been reported in the literature.^[23] The need for parents to seek early treatment for acute ear discharge is hereby stressed.

A major challenge observed in the present study was late diagnosis with the majority coming to the fore, years later on account of failure to acquire speech. This is consistent with Dunmade and Ijaluola that most cases of deafness among children are not diagnosed until they had failed to acquire speech.^[14] The reasons for this diagnostic lacuna

include: The fact that measles-induced hearing loss affects mostly children who are unable to speak of the auditory pathology, the lack of visible and palpable physical signs that makes hearing loss a “hidden disability” and ignorance among parents of the nexus between hearing and speech acquisition. Therefore, parents oblivious of the existence of underlying hearing loss tend to delay in consulting health-care giver until such a time when the victim is found to be deaf and dumb. To prevent this laxity, parents could be taught on how to test the hearing of their children post-measles by simple distraction test using cup and spoon to distract the attention by the strike of a metallic spoon against a stainless cup after initial attraction of the child say by breastfeeding. Failure to respond to the sound produced by the cling should arouse suspicion of hearing loss and the need for medical evaluation. Furthermore, routine postmeasles hearing assessment by the otorhinolaryngologist is a practicable step that may be of value for the timely diagnosis and rehabilitation of those with the measles-induced hearing loss.

Majority (70.5%) of cases in this study were not vaccinated against measles. This shows how susceptible unvaccinated children could be and may reflect a low level of immunization against measles particularly in the rural areas. Oluwadare, in the same geographical zone, has reported that poor infrastructures and inadequate manpower in the rural communities were the challenges of uptake of antimeasles immunization by children. As observed; “Neither, at the community level, is there evidence of rumors or scare stories that are deterring parents from taking their children for routine immunization but people living in remote and physically and ethnically isolated settlements tend to be marginalized within Ekiti State.”^[24] This marginalization and consequent low immunization coverage may be responsible for measles outbreaks in the study setting. Nothing drives home this point than the observation in the USA that the recent measles outbreak in the country was fuelled by low vaccination coverage,^[25] thus making the USA lawmakers to enact laws safeguarding measles vaccination.^[26] Authorities in Nigeria can also borrow a leaf from the practice in the USA.

It is however important to note that “nominal” vaccination does not confer on children absolute protection against measles and its otologic sequelae. This is evident by the occurrence of measles-induced hearing loss in 29.5% of children who in this study, were already vaccinated against measles. Such paradoxical event in apparent immunized children may be due to primary or secondary vaccine failure or other vaccine-related inadequacies and individual’s biologic factors that may be responsible for the failure to achieve immunization following vaccination. The occurrence of vaccine failures has been reported in the literatures.^[27-32] Thus, there is a need for paradigm shift from quantitative to both quantitative and qualitative vaccination of children against measles. A simple,

cost-effective mechanism should be designed to verify “on-the-spot” seroconversion through the use of point-of-care/testing diagnosis, after vaccination of children to certify if the vaccination is effective or not. To this end, the authors propose a future research on the use of noninvasive techniques such as digital wrist sensors or a patch to detect antimeasles-specific immunoglobulin similar to that proposed for myocardial diseases.^[33]

A diagnostic quandary noted in this study was the difficulty at identifying the true cause of the measles-induced hearing loss among those with comorbid ototoxicity. As found, about a tenth of the victims had been treated with ototoxic antibiotics by quacks who; in most cases are the first contacts in emergencies in most resource-poor settings of developing countries. These practices have been ascribed to ignorance; poverty and the ease with which antibiotics can be bought over the counter without appropriate prescription in Nigeria. As observed by Olajuyin *et al.*, over-the-counter dispensing of drugs without prescription is a common phenomenon in the study setting.^[34] The situation is even made worse by the dispensing of drugs without diagnosis in the patent medicine shops. Unfortunately, the unguided use of ototoxic antibiotics in febrile illnesses such as measles may be synergistic to the otologic effect of the febrile condition. In such circumstances, it becomes a dilemma to know whether it was the febrile condition or the ototoxic drug that caused the hearing loss. Although, the use of antibiotics has been found to reduce certain complications of measles,^[35] the need to be cautious in the use of ototoxic antibiotics in children with measles cannot be overemphasized. Furthermore, routine serum assay of the ototoxic antibiotics in those on hospital admission must be carried out to ensure that dosage is kept within safety margin.

Conclusion

This study shows that measles-induced hearing loss often affects children around the age of speech acquisition leaving the victims deaf and dumb. Late diagnosis is characteristic of the auditory shutdown. The need to scale up effective anti-measles vaccination among children is hereby stressed. Routine post-measles hearing assessment of victims is a practicable step to identify early those that require prompt rehabilitation with hearing aid or cochlear implant.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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