

Hearing Screening in Neonates receiving Vancomycin in the Neonatal Intensive Care Units

Thesis

*Submitted for the Partial Fulfillment of
Master Degree in Pediatrics*

By

Waad Mohamed Alsayed Al shazly

M.B.B.Ch

Faculty of Medicine, Cairo University

Under Supervision of

Prof. Dr. Mona Mohsen Al Attar

Professor of Pediatrics

Faculty of Medicine, Cairo University

Prof. Dr. Dalia Ahmed Khairy AbdelLatif

Professor of Pediatrics

Faculty of Medicine, Cairo University

Dr. Amira Maged Al Shennawy

Assistant Professor of Audiology

Faculty of Medicine, Cairo University

Faculty of Medicine

Cairo University

2014

Acknowledgment

Before all, Thanks to Allah.

I would like to express my profound gratitude to Prof. Dr/ Mona Mohsen Al Attar, Professor of Pediatrics, Faculty of Medicine, Cairo University for her valuable advises and support and for dedicating much of her precious time to accomplish this work,

My special thanks and deep obligation to Prof. Dr/ Dalia Ahmed Khairy, Professor of Pediatric, Faculty of Medicine, Cairo University for her continuous encouragement and supervision and kind care.

I am also grateful to Prof. Dr/ Amira Maged Al Shennawy, Assistant Professor of Audiolgy, Faculty of Medicine Cairo University for her kind care.

I would like to express my special thanks to my colleagues for supporting me and helping me to finish this work,

Waad Shazly

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

إِنَّ السَّمْعَ وَالْبَصَرَ وَالْفُؤَادَ
كُلُّ أُولَئِكَ كَانَ عَنْهُ مَسْئُولا

صدق الله العظيم سورة الإسراء
آية (36)

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List of Abbreviations

Abb.	Meaning
A-ABR.....	Automated –Auditory brainstem response
ABR.....	Auditory Brainstem Response
AD	Auditory dyssynchrony
AN.....	Auditory neuropathy
ANSD.....	Auditory neuropathy spectrum disorder
APGAR.....	Appearance,pulseations,grimace,activity,respiration
BBB.....	Blood brain barrier
CBC.....	Complete blood count
CDC	Centers for Disease Control
CMV.....	Cytomegalovirus
CNS	Central nervous system
CoNS.....	Coagulase negative staphylococci
CPAP	Continuous positive airway pressure
CS.....	Cesarean section
CSF	Cerebrospinal fluid
CX26	Connexin 26
DM	Diabetes mellitus
DPOAE.....	Distortion product Otoacoustic emission
ECMO.....	Extracorporeal membrane oxygenation
FDA.....	Food and drug adminstration
GA.....	Gestational age
Hb	Hemoglobin
HL.....	Hearing loss
HRR	High Risk Registerar
HTN.....	Hypertension
ICH	Intracranial He
IDM.....	Infant of diabetic mother
JCIH	Joint Committee on infant hearing
MAS.....	Meconium Aspiration Syndrome
MIC.....	Minimum inhibitory concentration
MRSA.....	Methicillin-resistant Staphylococcus aureus
MRSE	Methicillin-resistant Staph epidermidis

List of Abbreviations (Cont...)

Abb.	Meaning
MV	Mechanical ventilation
NICU	Neonatal Intensive Care Unit
NJ.....	Neonatal jaundice
NS	Neonatal sepsis
NVD.....	Normal vaginal delivery
OAE	Otoacoustic emissions
OTOF.....	Otoferlin
Plt.....	Platelets
PPHN	Persistent Pulmonary Hypertention of Newborn
PROM.....	Premature rupture of membranes
RBS.....	Random blood sugar
RDS.....	Respiratory Distress Syndrome
SNHL.....	Sensory-neural hearing loss
SOAE.....	Spontaneous Otoacoustic Emissions
TDM.....	Therapeutic drug monitoring
TLC.....	Total leukocyte count
TM.....	Tympanic membrane
TOAE.....	Transient Otoacoustic Emissions
TTN.....	Transient Tachypnea of Newborn
UNHS.....	Universal Neonatal Hearing Screening
VLBW	Very low birth weight

ABSTRACT

Background: Hearing impairment is the most common congenital defect, acquired hearing loss may develop as side effect of using ototoxic drugs.

Aim of the work: To assess the effect of vancomycin on hearing of newborns admitted to NICU. **methods:** this case control study included 100 neonate (50 received vancomycin) and (50 didn't receive vancomycin). History, investigations done during admission& OAE tests were done. **Results:** OAE tests were normal in both groups indicating vancomycin not ototoxic. **conclusion:** Using vancomycin is not ototoxic to neonates when used in standard dose and duration.

Key words: ototoxicity , vancomycin , hearing loss , neonate, OAE

INTRODUCTION

Pre-lingual hearing impairment is a silent pathology causing serious consequences on the acquisition and development of language abilities (*Ghirri et al., 2011*). It is the most common congenital defect. Current Universal Hearing Screening (UNHS) statistics indicates an overall hearing loss rate 1-3 every 1,000 live births and 2-4 every 100 in NICUs. Studies revealed that 95% of all newborns with permanent hearing loss have parents with normal hearing (*Papacharalampous et al., 2011*).

In Egypt, there have been no national surveys on prevalence of hearing loss, but one of the hospital-based academic studies done 2010 using Otoacoustic Emissions (OAE) test found that 2.5% of all neonates suffered from hearing loss (*Hamid et al., 2010*).

Cause of permanent hearing loss in childhood varies, but most common cause is the genetic congenital hearing loss (HL), it constitutes 60% of all causes and classified into non syndromic and syndromic (HL).

Acquired congenital hearing loss is another type, it implies that a perinatal event has led to deafness as an isolated finding or as part of a more generalized illness. It is either an infective type as in cases of maternal infections, especially linked to German measles and CMV, or a non-infective type as in cases of harmful perinatal events such as prematurity, birth hypoxia and neonatal jaundice (*Saeed et al., 2009*).

Beside the congenital causes, acquired hearing loss may develop as a complication of diseases as otitis media, bacterial meningitis, measles,

and mumps or as side effect of using ototoxic drugs such as aminoglycosides and vancomycin.

Many experts do not consider vancomycin to be an ototoxic drug (*Raybek, 2006*), but some researchers suggested that high dose therapy may pose a significant risk (*Forouzesht et al., 2009*), others stated that vancomycin may produce synergistic effect when administered in combination with aminoglycosides aggravating their ototoxicity (*Rybak, et al., 2009*).

OAE test used in this study is a simple, objective, reliable and a non-invasive test. It requires outer and middle ear to be disease free to function properly. It measures the emissions produced normally in the cochlea by mechanical vibration of the normal outer hair cells of inner ear in response to a sound stimulus. It is to be noted that this device can only test up to the level of cochlea, hence babies with neurological disorders associated retro cochlear pathology can be missed by OAE testing (*Lam, 2003*).

According to recommendations of The Joint Committee on Infant Hearing 2007, screening should be completed by 1 month of age, and diagnosis by 3 months, to allow for intervention and treatment by 6 months of age for best prognosis (*Finitzo et al., 2000*).

AIM OF THE WORK

The aim of this work was to assess the effect of vancomycin on hearing of newborns admitted to NICUs using OAE test.

Chapter 1

ANATOMY AND PHYSIOLOGY OF HEARING

Sounds are atmospheric pressure waves created by moving objects, as their movement alternately compresses then decompresses the surrounding air to create a pressure wave that propagates outward. We perceive these pressure waves as sounds; the wave frequency reflects its pitch. The ability to perceive sound requires the energy of sound waves to be converted into an electrical signal, a process that occurs within the inner ear and relies on sensory hair cells (*Preston and Thad, 2012*).

Anatomy of the ear:

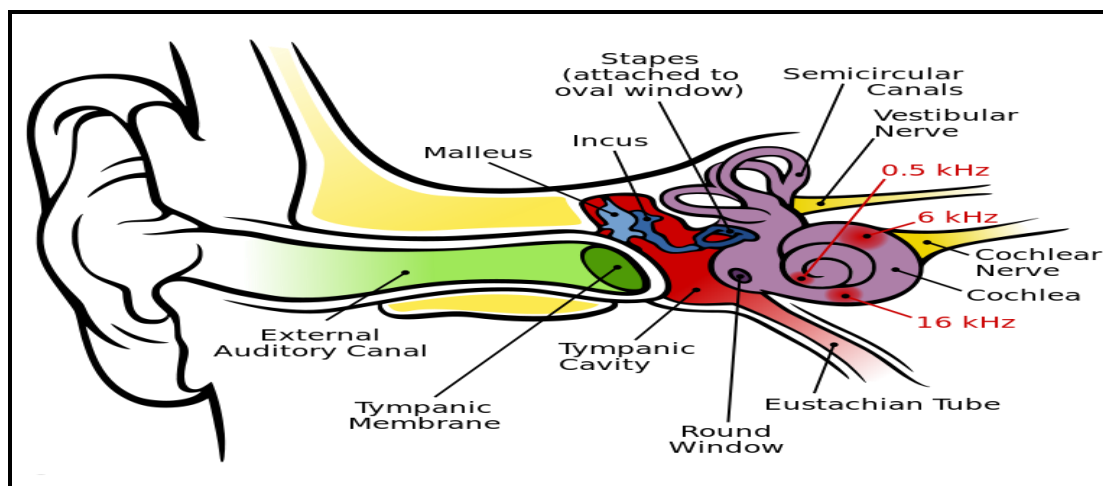


Fig. (1): Anatomy of external, middle and inner ear (*Chittka and Brockmann, 2005*).

The ear is composed of external, middle ear (tympanic) with malleus, incus, and stapes, and inner ear (labyrinth) with semicircular canals, vestibule and cochlea (Fig. 1).

External ear

The auricle and the external acoustic meatus (external auditory canal) compose the external ear. The external ear functions to collect and amplify sound, which then gets transmitted to the middle ear. The asymmetric shape of the external auricle introduces delays in the path of sound that assist in sound localization (*Newton and Vallely, 2006*).

▪ Auricle:

The concha surrounds the opening to the external auditory meatus (external auditory canal), whereas the auricle consists of root/crus of helix, helix, antihelix, scaphoid fossa, triangular fossa, crura of antihelix (superior, inferior), antitragus, lobule and tragus (*James et al., 2009*).

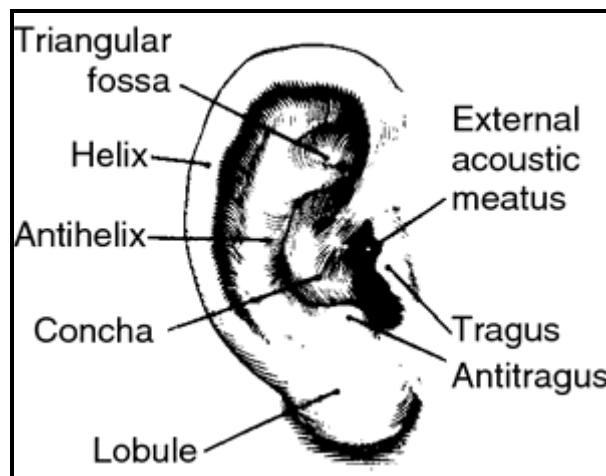


Fig. (2): External ear (*James et al., 2009*).

- The arterial supply of the auricle is composed of the posterior auricular artery, the anterior auricular branch of the superficial temporal artery, and the occipital artery. Veins accompany the corresponding named arteries.
- The sensory innervation of the external ear has been well studied and is composed of the following:

External acoustic meatus (external auditory canal):

The external acoustic meatus (external auditory canal) is formed by cartilage and bone. The canal measures about 4 cm in length (from the tragus) to the tympanic membrane and is curved in an S shape. The mandibular condyle sits anterior to the bony portion of the external acoustic meatus. The mastoid air cells sit behind the bony portion of the canal.

- Sensory innervation to the external acoustic meatus consists of both the auriculo-temporal nerve (from the mandibular branch of the trigeminal nerve) and the auricular branch of Vagus (Arnold nerve). Also the tympanic plexus offers some contributions.
- The arterial supply includes the posterior auricular artery, deep auricular branch of the maxillary artery, and the superficial temporal artery (**Netter, 2010**).

Middle ear (tympanic cavity):

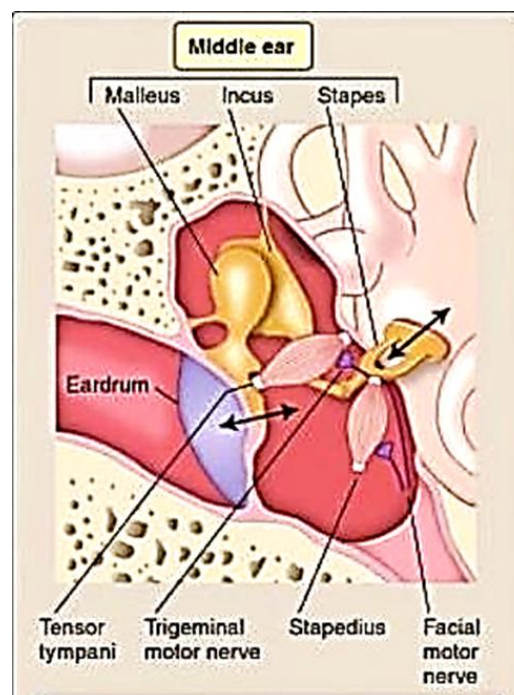


Fig. (3): Middle ear (*Robin and Thad, 2012*).