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Lauren E. Pasko

The Graduate Center, City University of New York

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A GUIDE TO PHARMACOLOGY FOR AUDIOLOGISTS
by
LAUREN E PASKO

A capstone research project submitted to the Graduate Faculty in Audiology in partial fulfillment
of the requirements for the degree of Doctor of Audiology, The City University of New York
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This manuscript has been read and accepted for the Graduate Faculty in Audiology in satisfaction of the capstone project requirement for the degree of Au.D.

Date

Brett Martin, Ph.D., CCC-A
Faculty Mentor/Advisor

Date

Dorothy DiToro, Au.D., CCC-A
Donald A. Vogel, Au.D., CCC-A
Executive Officers

THE CITY UNIVERSITY OF NEW YORK

ABSTRACT

A GUIDE TO PHARMACOLOGY FOR AUDIOLOGISTS

by
LAUREN E PASKO

Advisors: Brett A. Martin, Ph.D. and Carol A. Silverman, Ph.D.

Objective: The purpose of this research is to develop a pharmacology guide for Audiologists and Audiology students to promote patient-centered care in audiology.

Introduction: Clinical audiology doctoral (Au.D.) graduate programs provide little education to audiology students on the topic of pharmacology. In order to provide optimal, patient-centered care, the Audiologist must be familiar with commonly prescribed medications, the conditions that they are used to treat, and their effects on the body. Knowledge of patient medication use can help the Audiologist orient their practice to the present health condition of the patient. An evidence-based guide for audiologists and audiology students on the 25 most commonly prescribed medications in the United States is presented. This guide was developed to enhance patient-centered clinical practice for Audiologists and Audiology students using knowledge of common medications and the implications of medication use.

Methods: Using a list from the ClinCalc online Drugstats database, the 25 most commonly prescribed medications in the United States in 2019 were gathered. A chart was compiled using information from PDR.net: Providers Digital Reference to include rank of prescription, drug generic name, drug class(es), description of drug, mechanism of action, treatment uses, off-label uses, and drug adverse reactions including: vestibular side effects, tinnitus side effects, ear side effects, cognitive side effects, visual side effects and other audiotically-relevant side effects.

Results: The guide is compiled and included as a link in table format. Additional tables are

included to show frequency of drug class, generic name and treatment uses, frequency of vestibular side effects, frequency of tinnitus side effects and frequency of ear side effects.

Dissemination: This chart is to be presented in fulfillment of the Doctor of Audiology capstone project at the CUNY Graduate Center. A digital copy will be provided to all faculty and student attendees of the capstone presentation and can henceforth be used at student clinical sites.

Discussion: After dissemination, this chart is intended for clinical use by faculty and students to aid in clinical decision-making and promote patient-centered clinical care.

Key Words: “audiology,” “pharmacology,” “medication,” “medicine,” “patient-centered” “patient-centered care,” “side effects,” “ototoxicity,” “cognition,” “vision,” “tinnitus,” “vertigo,” “hearing loss,” “prescriptions” “dizziness.”

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INTRODUCTION

Certification Requirements for Audiologists

The American Speech Language Hearing Association (ASHA) defines an Audiologist as an expert in providing services in the prevention, diagnosis and evidence-based treatment of hearing and balance disorders for people of all ages (American Speech-Language-Hearing Association, n.d.). Audiologists provide services which minimize the negative impact of hearing and balance disorders and work towards improving outcomes and quality of life for their patients. Audiologists must be skilled in identification, assessment, management, treatment, prevention and education of hearing and balance disorders as they relate to professional work (American Speech-Language-Hearing Association, n.d.).

In order to determine the present level of education on pharmacology in audiology for graduate students, a recently published introductory clinical audiology book was searched for the key words, “medication” and “drug.” The book is titled “Clinical Audiology an Introduction,” and was published in 2021 (Stach & Ramachandran, 2021). The word “medication” appeared in the text ten times. Four of the ten appearances are in reference to ototoxic medications and the mechanism by which they affect the ears and hearing. Three of the appearances are in reference to medical treatment of hearing loss, including treatment of otitis media. The word “medication” was used two times to refer to the effects of drugs on the vestibular system, and it was used one time in reference to a list of case history questions (Stach & Ramachandran, 2021).

The word “drug,” was used thirty-six times throughout the duration of the text (Stach & Ramachandran, 2021). Most of the references were in explanation of ototoxicity and the effects of chemotherapy on the cochlea. Additionally, there were references to the Food and Drug

Administration, drugs as a treatment for ear disease or hearing loss and drug use during pregnancy and its effects on fetal and infant development (Stach & Ramachandran, 2021).

Audiologists are credentialed by the Council for Clinical Certification in Audiology and Speech-Language Pathology (CCFC), which has the responsibility of defining the standards for clinical certification and applying those standards in granting certification to applicants (Clinical Certification in Audiology and Speech-Language Pathology of the American Speech-Language-Hearing Association, 2018). In order to obtain a Certificate of Clinical Competence in Audiology (CCC-A), an applicant must meet the five standards defined by the CCFC which went into effect on January 1, 2020 (Clinical Certification in Audiology and Speech-Language Pathology of the American Speech-Language-Hearing Association, 2018). Standard I, Academic Qualifications, states that applicants must submit verification of a doctoral degree from a program which is accredited by the Council on Academic Accreditation (CAA) (Clinical Certification in Audiology and Speech-Language Pathology of the American Speech-Language-Hearing Association, 2018). Standard II, Knowledge and Skills Outcomes, requires the applicant to have acquired knowledge and skills in specified areas of practice (Clinical Certification in Audiology and Speech-Language Pathology of the American Speech-Language-Hearing Association, 2018). There are six areas of practice identified which include: Foundations of Practice, Prevention and Screening, Audiologic Evaluation, Counseling, Audiologic Rehabilitation Across the Lifespan, and Pediatric Audiologic (Re)habilitation (Clinical Certification in Audiology and Speech-Language Pathology of the American Speech-Language-Hearing Association, 2018). Of these standards, the following are identified as related to the knowledge of pharmacology:

A2. Effects of pathogens, and pharmacologic and teratogenic agents, on the auditory and vestibular systems

A7. Applications and limitations of specific audiologic assessments and interventions in the context of overall client/patient management

A9. Implications of biopsychosocial factors in the experience of and adjustment to auditory disorders and other chronic health conditions

B1. Educating the public and those at risk on prevention, potential causes, effects, and treatment of congenital and acquired auditory and vestibular disorders

B3. Participating in programs designed to reduce the effects of noise exposure and agents that are toxic to the auditory and vestibular systems

C1. Gathering, reviewing, and evaluating information from referral sources to facilitate assessment, planning, and identification of potential etiologic factors

C2. Obtaining a case history and client/patient narrative

D1. Identifying the counseling needs of individuals with hearing impairment based on their narratives and results of client/patient and/or caregiver responses to questionnaires and validation measures

D2. Providing individual, family, and group counseling as needed based on client/patient and clinical population needs

E2. Identifying the need for, and providing for assessment of, concomitant cognitive/developmental concerns, sensory-perceptual and motor skills, and other health/medical conditions, as well as participating in interprofessional collaboration to provide comprehensive management and monitoring of all relevant issues

E7. Developing and implementing individualized intervention plans based on clients'/patients' preferences, abilities, communication needs and problems, and related adjustment difficulties

E22. Counseling clients/patients regarding the audiologic significance of tinnitus and factors that cause or exacerbate tinnitus to resolve misconceptions and alleviate anxiety related to this auditory disorder (Clinical Certification in Audiology and Speech-Language Pathology of the American Speech-Language-Hearing Association, 2018).

Standard III, Verification of Knowledge and Skills, states that the applicant must have completed supervised clinical practicum under an experienced ASHA certified Audiologist (Clinical Certification in Audiology and Speech-Language Pathology of the American Speech-Language-Hearing Association, 2018). Standard IV, Examination, states that the applicant must pass the national Praxis examination, and Standard V, Maintenance of Certification, states that those who hold certification must demonstrate continuing professional development, adherence to the ASHA code of ethics and maintain payment of annual dues and fees (Clinical Certification in Audiology and Speech-Language Pathology of the American Speech-Language-Hearing Association, 2018). Certification in audiology requires the certification applicant to have a general understanding of drugs and their effects on the patient.

The study of basic pharmacology is necessary for the audiologist. As per standard A2, audiologists must know the effects of pathogens, and pharmacologic and teratogenic agents, on the auditory and vestibular systems (Clinical Certification in Audiology and Speech-Language Pathology of the American Speech-Language-Hearing Association, 2018). In partial fulfillment of this requirement, audiologists must be familiar with commonly prescribed medications which have potential effects on the auditory and vestibular systems. Prescription medications may have main effects or side effects that cause changes in the patient's auditory or vestibular system. To practice well and ethically, the audiologist must be aware of these potential changes.

Standard A7 requires that the audiologist understands applications and limitations of specific audiological assessments and interventions in the context of overall client/patient management (Clinical Certification in Audiology and Speech-Language Pathology of the American Speech-Language-Hearing Association, 2018). Knowledge of commonly used medications can aid the audiologist in understanding certain limitations of audiologic testing. For example, certain medications will render videonystagmography (VNG) results invalid, and other medications may cause a temporary threshold shift, which would affect comprehensive audiological evaluation (CAE) results.

In order for the audiologist to fulfil standard A9, which requires the understanding of the implications of biopsychosocial factors in the experience of and adjustment to auditory disorders and other chronic health conditions, knowledge of common medications may be useful (Clinical Certification in Audiology and Speech-Language Pathology of the American Speech-Language-Hearing Association, 2018). Patient prescription drug use can have an effect on the biopsychosocial factors which are involved in adjustment to auditory disorders and other hearing conditions. In addition, knowledge of the conditions which common medications are used to treat can be indicative to the audiologist of a patient's chronic health conditions.

Standard B1 outlines the responsibility of the audiologist to educate the public on prevention, potential causes, effects and treatment of auditory and vestibular disorders (Clinical Certification in Audiology and Speech-Language Pathology of the American Speech-Language-Hearing Association, 2018). Basic knowledge of prescription medications and their effects on the auditory and vestibular systems is necessary for the audiologist to be able to educate properly in these areas. Many common medications can cause dizziness, hearing loss, tinnitus and other effects, and it is the role of the audiologist to promote awareness of these side effects.

Standard B3 requires the audiologist to participate in programs which are designed to reduce the effects of noise exposure and toxic agents (Clinical Certification in Audiology and Speech-Language Pathology of the American Speech-Language-Hearing Association, 2018). In order to participate in such programs, the audiologist must have knowledge of ototoxic medications and their uses. It is important for the audiologist to be able to advocate for the proper course of treatment for a patient who is being treated with a drug that is toxic to the vestibular or auditory system.

Standard C1 states that the audiologist must have skills in evaluating information from referral sources with the goal of enhancing patient care (Clinical Certification in Audiology and Speech-Language Pathology of the American Speech-Language-Hearing Association, 2018). In order to do this properly, the audiologist should be able to identify medications highlighted by referral sources and use the information to facilitate the plan of diagnosis and treatment of the patient. If the referring provider presents information about the patient which includes their present medications, the audiologist should be able to use this information to guide their decision making throughout their appointments with that patient.

As outlined in standard C2, the audiologist should have knowledge and skills in obtaining a case history of their patient (Clinical Certification in Audiology and Speech-Language Pathology of the American Speech-Language-Hearing Association, 2018). It is important that a clinical intake for audiology includes a question regarding current medication use. It is even more important that the audiologist knows how to interpret the information given by the patient in response to this question. Use of medication by a patient can have an effect on audiological testing, test results and ability to participate in certain treatment plans. In addition, the results of the audiological evaluation performed by the audiologist, in context with the medications

prescribed, can inform the referring physician and can be used to modify the treatment plan as well as the medications prescribed to the patient.

Standard D1 states that the audiologist must use the narrative presented by the patient to inform their counseling techniques and goals (Clinical Certification in Audiology and Speech-Language Pathology of the American Speech-Language-Hearing Association, 2018). The patient narrative may include medication history, which can inform patient-centered counseling and treatment goals. An example of this would be an audiologist who adapts a patient's hearing aid style after hearing in their patient narrative that the patient is on medication which produces tremors as a side effect. If a clinical setting has an intake form which asks for patient medical conditions and medication usage, the audiologist should be able to use this information to guide, but not determine, their clinical techniques.

According to standard D2, the audiologist must provide counseling as needed based on patient and clinical population needs (Clinical Certification in Audiology and Speech-Language Pathology of the American Speech-Language-Hearing Association, 2018). The knowledge of common medications would inform the audiologist how to counsel individuals based on clinical need. For example, an audiologist might see that a patient is taking medication that is used to treat Attention Deficit Hyperactivity Disorder (ADHD) and adapt their counseling strategy and treatment plan with the knowledge that the patient may have trouble with executive functioning and focusing.

Standard E2 outlines the need for the audiologist to be aware of coexisting health and medical conditions which may require interprofessional collaboration in order to properly treat all of the patient's relevant issues (Clinical Certification in Audiology and Speech-Language Pathology of the American Speech-Language-Hearing Association, 2018). It is important for

audiologists to be knowledgeable about common medications and the conditions that they are used to treat when working with other professionals. It can be assumed that most other healthcare professionals have some to vast knowledge of pharmacology, and audiologists need to be able to understand the implications of medications in order to effectively work inter-professionally with others.

Similar to Standard D2, Standard E7 requires that the audiologist develop individualized plans of care which account for a patient's abilities and related adjustment difficulties (Clinical Certification in Audiology and Speech-Language Pathology of the American Speech-Language-Hearing Association, 2018). Existing knowledge of a patient's medications and greater medical history makes it possible for the audiologist to further individualize the intervention and plan of care to suit the needs of the patient. For example, a case history which includes medications may prompt the audiologist to change aspects of a patient's hearing aid fitting, if a medication indicates that the patient may have limited ability.

Lastly, Standard E22 states that the audiologist must be prepared to explain tinnitus and its causes to patients who experience tinnitus-related anxiety (Clinical Certification in Audiology and Speech-Language Pathology of the American Speech-Language-Hearing Association, 2018). Tinnitus is a common side effect of many different commonly prescribed medications. Knowledge of what medications could potentially cause tinnitus would better equip the audiologist to counsel a tinnitus patient on possible sources of their tinnitus.

Basic Overview of Pharmacology for the Audiologist

The Audiologist is a health professional and ethical practice requires basic knowledge of commonly prescribed medications, the conditions they are used to treat, and their side effects. There are over 2,000 drugs which have side effects that could result in misdiagnosis of a hearing

or vestibular problem (DiSogra, 2019). Offerdahl and Mishra introduce the and explain common terminology in the field of pharmacology as well as some of the basic principles of the discipline (Offerdahl & Mishra, 2019). They justify their review by saying that that as a part of the healthcare team, the audiologist should be able to be able to explain audiologic manifestations of the chemicals found in drugs to other healthcare professionals (Offerdahl & Mishra, 2019). In every patient interaction, it is necessary to evaluate the patient from the pharmaceutical perspective, as to produce the best possible outcomes and minimize otologic harm (Cianfrone et. al, 2011). In addition, it is of significant importance that the audiologist prevents an ototoxic effect in a patient as often as possible (Offerdahl & Mishra, 2019).

Pharmacology is generally defined as the study of any substance that affects or interacts with any living organism through a chemical process, which typically causes an activation or inhibition of natural body processes (Katzung & Trevor, 2012). Pharmacology is closely related to toxicology, which is the branch of pharmacology with the harmful effects of chemical substances on living organisms (Katzung & Trevor, 2012). Pharmacology and toxicology must be considered together to find a balance between benefit and harm. Many chemicals that are used for their therapeutic effects on the organism also have co-occurring undesirable effects on the organism (Katzung & Trevor, 2012). Mediating the desirable and undesirable effects of medications on the body is an important part of medicine, pharmacy and research (Katzung & Trevor, 2012). In the present review, the words drug, prescription, medicine and medication will be used to refer to chemical substances which interact with living organisms.

Offerdahl and Mishra (2019) explain that pharmacology is inseparable from the study of chemistry, however, it is not necessary for an audiologist to have an extensive knowledge of chemistry to effectively use pharmacology to enhance patient interactions (Offerdahl & Mishra,

2019). Only a basic knowledge is required for the audiologist to have effective communication on the topic of pharmacology with a patient. There are two subclasses of pharmacology: pharmacokinetics and pharmacodynamics. The four steps of pharmacokinetics include absorption, distribution, metabolism and elimination (Offerdahl & Mishra, 2019).

These four steps outline the process of a medication's time and travel through the body. Absorption refers to the process by which the drug enters and is spread throughout the body, including dosage and type of drug administration (Offerdahl & Mishra, 2019). This is the first step in the process. After absorption, distribution outlines the movement of chemicals into areas outside of the blood stream. An important reference for distribution is the concentration of the drug inside the body compartment, namely, the volume of distribution (Offerdahl & Mishra, 2019). Distribution refers to all parts of the body, not just the areas where therapeutic effect is intended (Offerdahl & Mishra, 2019). This is an important concept for the audiologist, as drugs are typically distributed to the entire body, whether a therapeutic effect is intended for the area. An example of this would be an ototoxic chemotherapy drug. Its intended purpose of cancer treatment may come at the unintended cost of the health of the inner ear.

Negative side effects are produced when a drug has unintended consequences on a part of the body outside of the intended area of effect (Offerdahl & Mishra, 2019). Drug metabolism refers to the termination of drug activity, including the process of making a drug more water soluble for elimination by way of the kidneys (Offerdahl & Mishra, 2019). The final step in the process is elimination, which is the process by which the drug leaves the body through urine. In contrast to pharmacokinetics, pharmacodynamics refers to the mechanism of action that produces the therapeutic effects and the toxic effects of the chemical on the body (Offerdahl & Mishra, 2019). Pharmacodynamics is an explanation of what exactly the drug does to the body (Offerdahl

& Mishra, 2019). As per the review of a recent graduate level audiology text, there is limited information presented to audiologists at the graduate education level regarding pharmacology and the mechanism of action by which drugs are processed in the body (Stach & Ramachandran, 2021). Audiology students may benefit from a brief introduction to pharmacokinetics and pharmacodynamics as to enhance knowledge on medications and their possible effects on the body as well as effects on audiological practice.

Justification for Guide Categories

In the present study, it is proposed to present a list of the top 25 most commonly prescribed medications in the United States in 2019 in a guide listed with possible effects of these medications on audiological practice. In 2011, Cianfrone et al. (2011) created a guide to outline drug induced ototoxicity, tinnitus and vertigo with the intention of aiding physicians in the evaluation of evaluating the risks and benefits of prescription medications as related to the ear (Cianfrone et al., 2011). It is the job of the physician or medical professional, as opposed to the audiologist, to work towards a balance of effectiveness and safety when prescribing drugs to patients (Cianfrone et al., 2011). However, audiologists do still have the indirect responsibility to optimize patient care and interactions involving pharmacology (Cianfrone et al., 2011). In their article, Cianfrone et al. (2011) highlight three main adverse side effects which include: ototoxicity (general), tinnitus and vertigo (Cianfrone et al., 2011).

Ototoxicity is the toxic capacity of chemicals on the cochlea and inner ear structures (Cianfrone et al., 2011). Ototoxic damage can manifest as symptoms of hearing loss, tinnitus, vertigo, hyperacusis and deafness (Cianfrone et al., 2011). All of the above are important medical conditions of the inner ear which can be caused by drug use. These symptoms can occur together or individually, rapidly or over time, and they can be permanent or reversible (Cianfrone

et al., 2011). The guide by Cianfrone et al. (2011) uses four categories to classify drug safety. The first category is ototoxicity, generally, including hearing damage, vertigo and tinnitus (Cianfrone et al., 2011). The second category is the onset of tinnitus only with no hearing impairment, and the third category is the onset of vertigo only with no noted hearing loss (Cianfrone et al., 2011). The final category includes drugs with possible audiologic effects (Cianfrone et al., 2011). The guide created by Cianfrone et. al. (2011) is an extensive, although now outdated, categorization of many drugs and the risk of ototoxic effects on the ear including tinnitus and vertigo. In the present review, the medications are categorized by their effects on the ear, including tinnitus, general ear effects and vestibular effects, as was done in this article, however, categories were added to determine the effects of drugs on cognition, vision and other audiologically relevant side effects. These categories were added to extend the application of the guide to medications which are used more commonly but have broader effects on the body outside of direct ear effects.

While knowledge of medication side effects directly related to otologic health and function are very important for clinical audiology practice, there are additional factors which can influence testing and treatment of patients by an audiologist. Additional information included in this review are treatment uses (including off-label), cognitive side effects including: amnesia, confusion, memory impairment, depression, anxiety, hallucinations, irritability, impaired cognition, psychosis, hostility, suicidal ideation and mania, visual side effects including: blurred vision, photosensitivity, visual impairment, diplopia, optic neuritis, optic atrophy, amblyopia, xanthopsia and myopia and other side effects deemed relevant to audiology and audiologic testing.

Cognition, and disorders of the cognitive system can have various effects on audiological testing and diagnosis of hearing loss and balance disorders. Beck and Harvey (2021) summarize the important relationships between cognition, amplification and audition (Beck & Harvey 2021). Hearing and cognition are correlated, particularly in older adult populations. There are a few hypotheses which may explain the relationship, including the common cause hypothesis, which posits that hearing loss and cognitive decline share the same cause (Beck et. al., 2020). In addition, the social effects hypothesis states that hearing loss may lead to social disengagement which may lead to accelerated cognitive decline (Beck et. al., 2020). The auditory deprivation hypothesis notes that lack of auditory input results in neuroplastic changes due to lack of cortical input. Lastly, the cognitive load hypothesis posits that hearing loss discourages typical functioning of the temporal lobe which may cause the diversion of cognitive resources from memory to auditory processing (Beck et. al., 2020). If any of the latter three hypotheses are true, it is relevant for audiologists to know any cognitive side effects resulting from prescription medication use.

There are many factors that contribute to a patient's ability to complete audiological testing, treatment and rehabilitation. Saunders (2015) notes that many non-auditory factors influence hearing aid outcomes such as cognition, memory, dexterity, tactile sensitivity, health literacy and vision (Saunders, 2015). This is particularly relevant to older adult patients as they are more likely to experience those factors, and subsequent difficulty with hearing aid uptake. Saunders conducted a study among older veterans to determine the effects of non-auditory factors on hearing aid outcomes (Saunders, 2015). The audiologist can use information regarding patient medication use to direct their counseling sessions and to promote patient-centered care.

The results of the study beget suggestions to the audiologist for best hearing aid practice for patients with these issues. The suggestions by Saunders (2015) include the following: 1) Take home materials can help patients with memory issues. 2) Counseling information should be given with the literacy level and targeted to the needs of the patient. 3) Place an emphasis on the need for strong lighting while working with hearing aids. 4) Counsel patients on the importance of patience when handling their hearing aids, especially if they have poor tactile sensitivity or manual dexterity (Saunders, 2015). Many medications cause cognitive, visual and other side effects which may have an effect on a patient's ability to have an audiological test and/or ability to follow through on audiologist's recommendations, particularly regarding use of amplification. In addition, the audiologist will benefit from knowing the conditions that a patient's medication is used to treat. For example, if a patient only shares their medication list, but does not disclose specific medical conditions, the audiologists can make educated assumptions. If a patient is taking multiple medications used to treat Parkinson's disease, the audiologist may decide to choose a hearing aid for the patient that is easier to manipulate, due to the potential issues with manual dexterity that are associated with the disease.

Aims of the Present Study

ASHA standards require a basic knowledge of pharmacology in order for an audiologist to practice at the level of clinical competence (Clinical Certification in Audiology and Speech-Language Pathology of the American Speech-Language-Hearing Association, 2018). Presently, Audiology Doctorate programs provide little education regarding medication effects on the practice of audiology, outside of descriptions of ototoxicity and medical treatment of hearing loss (Stach & Ramachandran, 2021). Audiologists and audiology students would benefit from further knowledge on prescription drugs and the main and side effects of those drugs as it relates to

patient care in audiology. The guide presented in the current research is based off a previous study by Cianfrone et. al. (2011). This guide of the top 25 most commonly prescribed medications in the United States in 2019 is presented with the goal that it can be used to enhance audiological practice and patient centered care in clinical settings.

METHODS

For this review, the list of the top 25 most commonly prescribed drugs in the United States in 2019 was drawn from the ClinCalc Drugstats review and assembled into an excel chart which is referred to as the guide (Kane, 2020). This is the provided link to the database:

<https://clincalc.com/DrugStats/Top200Drugs.aspx> . The first column of the guide lists the rank of prescription according to the ClinCalc review (Kane, 2020). The 25 most commonly prescribed medications in the United States as per ClinCalc are listed in column two (Kane, 2020).

Additionally, the estimated total number of prescriptions and estimated total number of patients taking the medication in 2019 were drawn from the ClinCalc Drugstats review and are listed in column 3 and 4 of the guide, respectively. (Kane, 2020). Column 5 lists the brand names which are used to identify the generic drug as per PDR.net (PDR Search, n.d). Column 6 includes the drug class(es) of each medication (PDR Search, n.d). Column 7 contains a brief description of each medication which is directly quoted from the PDR.net site (PDR Search, n.d). This is the provided link to the database: <https://www.pdr.net/>. The mechanism of action for each drug is directly quoted from PDR.net in column 8, included to give the reader the exact pharmacokinetic and pharmacodynamic movements within the body (PDR Search, n.d).

Column 9 lists the identified treatment uses for the listed medications and column 10 lists any known off-label uses if there are any (PDR Search, n.d). Columns 11-16 list the noted adverse reactions of each drug, the time of onset and the incidence of reaction (PDR Search, n.d). Column 11 lists vestibular side effects including: dizziness, syncope, vertigo, orthostatic hypotension and nystagmus (PDR Search, n.d). Column 12 notes whether a drug has a tinnitus adverse effect (PDR Search, n.d). Column 13 lists ear effects including hearing loss and otalgia (PDR Search, n.d). Cognitive side effects, namely amnesia, confusion, memory impairment,

depression, anxiety, hallucinations, irritability, impaired cognition, psychosis, hostility, suicidal ideation and mania are included in column 14 (PDR Search, n.d). In column 15, visual effects including blurred vision, photosensitivity, visual impairment, diplopia, optic neuritis, optic atrophy, amblyopia, xanthopsia and myopia are listed (PDR Search, n.d). Column 16 outlines additional relevant side effects that cannot be further categorized for the purposes of this review, for example: tremors, peripheral neuropathy, and fatigue (PDR Search, n.d).

The full guide is linked in the results section of this paper. After the completion of the guide, the results were further organized into smaller lists and tables to provide more specific results. They are listed in the results section and in tables 1-6.

RESULTS

The link to the full guide is provided here: [Guide to Pharmacology for Audiologists](#).

For clarity, the prescription rank as well as the generic name of the top 25 medications is listed in order of use in Table 1 using information gathered on the ClinCalc Database (Kane, 2020). The most commonly prescribed medication is Atorvastatin followed by Levothyroxine and Lisinopril (Kane, 2020).

Table 1. Top 25 Most Commonly Used Medications as per ClinCal Database by Rank.

Prescription Rank	Generic Name of Prescription
1	Atorvastatin
2	Levothyroxine
3	Lisinopril
4	Metformin
5	Metoprolol
6	Amlodipine
7	Albuterol
8	Omeprazole
9	Losartan
10	Gabapentin
11	Hydrochlorothiazide
12	Sertraline
13	Simvastatin
14	Montelukast
15	Acetaminophen/Hydrocodone
16	Pantoprazole

17	Furosemide
18	Fluticasone
19	Escitalopram
20	Fluoxetine
21	Rosuvastatin
22	Bupropion
23	Amoxicillin
24	Dextroamphetamine; Dextroamphetamine Saccharate; Amphetamine; Amphetamine Aspartate
25	Trazodone

Per PDR.net, Table 2 lists the drug generic name along with the listed treatment uses of the drug (PDR Search, n.d). It can be seen that these commonly prescribed medications are used to treat high cholesterol, high blood pressure, type 2 diabetes, asthma, GI issues and other related common, high-prevalence medical conditions (PDR Search, n.d). For example, it can be seen in the first row that Atorvastatin is a treatment for hypercholesterolemia and hypertriglyceridemia (PDR Search, n.d).

Table 2. Top 25 Most Commonly Used Medications as per ClinCal Database and Treatment Uses

Drug Generic Name(s)	Treatment Uses
Atorvastatin	Treatment of Hypercholesterolemia, hypertriglyceridemia
Levothyroxine	Treatment of Hypothyroidism of most etiologies in adult and pediatric patients
Lisinopril	Treatment of Hypertension, congestive heart failure, post-myocardial infarction, diabetic nephropathy

Metformin	Treatment of Type 2 Diabetes in adult and pediatric patients 10 years and older; prediabetes; adjunct treatment of patients with hyperinsulinemia secondary to polycystic ovary syndrome;
Metoprolol	Treatment of angina pectoris, hypertension, heart failure, evolving acute myocardial infarction
Amlodipine	Treatment of Hypertension, coronary artery disease, angina
Albuterol	Relief of acute bronchospasm and episodic wheezing in patients with asthma or exercise-induced bronchospasm; used as reliever-therapy for COPD in adults
Omeprazole	Treatment of Dyspepsia, pyrosis (heartburn), non-erosive gastroesophageal reflux disease (GERD), erosive esophagitis, short-term treatment of active benign gastric ulcer, short-term treatment of active duodenal ulcer, long-term treatment of gastric hypersecretory conditions, also used in antimicrobial combination regimens for H. pylori eradication; also available over the counter for heartburn
Losartan	Treatment of Hypertension, diabetic nephropathy, proteinuria, stroke prophylaxis in hypertensive patients with left ventricular hypertrophy (LVH)
Gabapentin	Treatment of Restless legs syndrome, postherpetic and other neuralgias, and adjunctively for partial seizures
Hydrochlorothiazide	Treatment of Edema, hypertension
Sertraline	Indicated for depression, OCD, panic disorder, PTSD, social anxiety disorder, and PMDD in adults; used for OCD in children 6 years and older
Simvastatin	Treatment of hypercholesterolemia, including hyperlipidemia, hyperlipoproteinemia, or hypertriglyceridemia, as an adjunct to dietary control; and for reduction in cardiovascular mortality, including myocardial infarction prophylaxis and stroke prophylaxis
Montelukast	Asthma maintenance treatment, exercise-induced bronchospasm prophylaxis, treatment of allergic rhinitis, seasonal allergic rhinitis
Acetaminophen/Hydrocodone	Treatment of moderate pain to moderately severe pain
Pantoprazole	Treatment of erosive esophagitis (erosive GERD), treatment of pathological hypersecretion associated with Zollinger-Ellison syndrome or other hypersecretory syndromes

Furosemide	Treatment of peripheral edema or edema associated with heart failure, chronic lung disease (CLD), or nephrotic syndrome; adjunctive treatment of edema in patients with acute or chronic renal failure, treatment of hypertension
Fluticasone	Treatment of pruritus and topical inflammation associated with moderate to severe corticosteroid-responsive dermatoses, including the treatment of alopecia areata, discoid lupus erythematosus, generalized exfoliative dermatitis, cutaneous lichen planus, lichen simplex chronicus, lichen striatus, nodular prurigo, pompholyx (dyshidrosis), pemphigus, polymorphous light eruption, psoriasis, seborrheic dermatitis, severe contact dermatitis, severe Rhus dermatitis (due to plants like poison ivy), and xerosis
Escitalopram	Treatment of major depression, generalized anxiety disorder (GAD)
Fluoxetine	Treatment of major depression, depressive episodes associated with bipolar I disorder, obsessive-compulsive disorder (OCD), panic disorder with or without agoraphobia, bulimia nervosa, premenstrual dysphoric disorder (PMDD)
Rosuvastatin	Treatment of hypercholesterolemia, including hyperlipidemia, hyperlipoproteinemia, or hypertriglyceridemia, as an adjunct to dietary control, reduction of elevated total cholesterol, LDL-cholesterol, apolipoprotein B, and triglyceride concentrations, and to increase HDL-cholesterol in patients with primary hypercholesterolemia, primary prevention of cardiovascular disease including myocardial infarction prophylaxis and stroke prophylaxis,
Bupropion	Treatment of major depression, prevention of seasonal major depressive disorder episodes associated with seasonal affective disorder (SAD), use as an adjunct to psychosocial interventions in the management of tobacco cessation (smoking cessation)
Amoxicillin	Treatment of upper respiratory tract infections, treatment of tonsillitis and/or pharyngitis (rheumatic fever prophylaxis) secondary to Streptococcus pyogenes, treatment of sinusitis, treatment of acute otitis media, treatment of skin and skin structure infections, severe infections or infections caused by less susceptible organisms, treatment of lower respiratory tract infections (LRTIs), including community-acquired pneumonia (CAP), treatment of urinary tract infection (UTI) including cystitis

Dextroamphetamine; Dextroamphetamine Saccharate; Amphetamine; Amphetamine Aspartate	Treatment of attention-deficit hyperactivity disorder (ADHD), treatment of narcolepsy
Trazodone	Treatment of major depression

Table 3 lists the drug classifications which were identified in this review and their definitions as directly quoted from Drugs.com (Drugs.com, n.d.). Drug classifications are identified for each medication in column 6 of the guide. In table 3, it can be seen that there are 22 drug classifications which are defined in the second column. For example, statins are HMG-CoA reductase inhibitors. The results in the second column are directly quoted from Drugs.com (Drugs.com, n.d.)

Table 3. Relevant Medication Classes and Purpose per Drugs.com

Drug Classification	Definition
Statin (HMG-CoA Reductase Inhibitor)	Statins (also called HMG-CoA reductase inhibitors) block an enzyme called HMG-CoA reductase (3-hydroxy-3-methylglutaryl coenzyme A reductase) that is involved in the synthesis of mevalonate, a naturally occurring substance that is then used by the body to make sterols, including cholesterol. By inhibiting this enzyme, cholesterol and LDL-cholesterol production is decreased.
Thyroid Agent	Thyroid drugs (thyroid hormones) are used to supplement low thyroid levels in people with hypothyroidism.
Angiotensin Converting Enzyme Inhibitor	Angiotensin-converting enzyme (ACE) inhibitors are medications that help relax the veins and arteries to lower blood pressure. ACE inhibitors prevent an enzyme in the body from producing angiotensin II, a substance that narrows blood vessels. This narrowing can cause high blood pressure and forces the heart to work harder. Angiotensin II also releases hormones that raise blood pressure.

Biguanide Antidiabetic	Antidiabetic agents refer to all the distinct types of medicine involved in the treatment of diabetes. All these agents aim to reduce blood sugar levels to an acceptable range (called achieving normoglycemia) and relieve symptoms of diabetes such as thirst, excessive urination, and ketoacidosis (a serious complication of diabetes that occurs when the body cannot use glucose as a fuel source).
Anti-arrhythmic, Class II	Group II antiarrhythmics: Beta-blockers. These work by blocking sympathetic nervous system stimulation to the heart, thereby reducing the transmission of impulses within the heart's conduction system.
Selective Beta-Blocker (with calcium channel blocker)	Beta adrenergic blocking agents prevent stimulation of the beta-adrenergic receptors at the nerve endings of the sympathetic nervous system and therefore decrease the activity of the heart. They block sympathetic stimulation of the heart and reduce systolic pressure, heart rate, cardiac contractility and output, so decrease myocardial oxygen demand and increase exercise tolerance.
cardiovascular agent	Cardiovascular agents are medicines that are used to treat medical conditions associated with the heart or the circulatory system (blood vessels), such as arrhythmias, blood clots, coronary artery disease, high or low blood pressure, high cholesterol, heart failure, and stroke
Respiratory Short-Acting Beta-2 Agonist (SEBA)	Respiratory agent is a term used to describe a wide variety of medicines used to relieve, treat, or prevent respiratory diseases such as asthma, chronic bronchitis, chronic obstructive pulmonary disease (COPD), or pneumonia
Proton Pump Inhibitor/PPI	PPIs reduce the production of acid by the stomach. They work by irreversibly blocking an enzyme called H ⁺ /K ⁺ ATPase which controls acid production. This enzyme is also known as the proton pump and is found in the parietal cells of the stomach wall.
Angiotensin-II Receptor Blocker/ARB	Angiotensin receptor blockers (also called ARBs or angiotensin II inhibitors) are medicines that dilate (widen) blood vessels and are used in the treatment of conditions such as high blood pressure(hypertension), heart failure, or kidney disease in people with diabetes.
Anticonvulsant	Anticonvulsants (antiepileptics or AEDs) helps to normalize the way nerve impulses travel along the nerve cells which helps prevent or treat seizures. When the brain is working normally the nerve cells talk to each other using controlled electrical signals from one nerve cell to another. This tells the body to do everything it needs or wants to do.

Thiazide Diuretics	Thiazide diuretics are a type of diuretic (a drug that increases urine flow). They act directly on the kidneys and promote diuresis (urine flow) by inhibiting the sodium/chloride cotransporter located in the distal convoluted tubule of a nephron (the functional unit of a kidney).
Selective Serotonin Reuptake Inhibitor Antidepressant , SSRI	SSRI stands for Selective Serotonin Reuptake Inhibitor. SSRI antidepressants are a type of antidepressant that work by increasing levels of serotonin within the brain.
Systemic Leukotriene Antagonists	Leukotriene modifiers may be used for the treatment of certain conditions that are associated with an allergic response.
Opioid Agonist	Opioid receptors are distributed in the central nervous system and the digestive tract. Peripheral acting agonist and antagonist are not able to penetrate the blood brain barrier so only affect the peripheral opioid receptors.
non-salicylate analgesic	Analgesics are medicines that are used to relieve pain. They are also known as painkillers or pain relievers. Technically, the term analgesic refers to a medication that provides relief from pain without putting you to sleep or making you lose consciousness.
Loop Diuretic	Diuretics are medicines that increase urine flow (cause diuresis). Loop diuretics are a powerful type of diuretic that work by inhibiting the sodium-potassium-chloride (Na ⁺ /K ⁺ /2Cl) co-transporter in the thick ascending loop of Henle (hence the name loop diuretic), which is in the kidneys. This reduces or abolishes sodium, chloride, and potassium reabsorption, leading to increased loss of sodium, chloride, and potassium into the nephron (the functional unit of a kidney)
Corticosteroid	Inhaled corticosteroids are medicines containing corticosteroids such as beclomethasone, budesonide, ciclesonide, flunisolide, fluticasone, or mometasone in a preparation designed to be inhaled through the mouth. Inhaled corticosteroids act directly in the lungs to inhibit the inflammatory process that causes asthma. Inhaled corticosteroids help to prevent asthma attacks and improve lung function.
Antismoking Agent	Smoking cessation agents are medicines used to assist in quitting smoking.

miscellaneous Antidepressant	Antidepressants are drugs that treat depression and improve the symptoms. All types of antidepressant drugs may take more than two weeks to show any benefits, although their pharmacological effects are produced immediately. Miscellaneous antidepressants include all antidepressants not classified elsewhere.
Penicillinase-Sensitive Penicillin Antibiotic	Penicillinase resistant penicillins are antibiotics, which are not inactivated by the penicillinase enzyme. Some bacteria produce the enzyme penicillinase that destroys the beta-lactam ring of the antibiotic, making the penicillin ineffective. Penicillinase resistant penicillins are used to treat resistant strains of staphylococci and other infections.
Amphetamine	Amphetamine is a central nervous system stimulant that affects chemicals in the brain and nerves that contribute to hyperactivity and impulse control.

Table 4 includes each drug classification in this review and the drugs included which are classified under each group. It can be seen that the amphetamine class includes:

Dextroamphetamine; Dextroamphetamine Saccharate; Amphetamine; Amphetamine Aspartate, while the Angiotensin Converting Enzyme Inhibitor class includes Lisinopril (PDR Search, n.d).

Table 4. Top 25 Most Commonly Used Medications as per ClinCal Database - by Drug Classification

Drug Classification	Medications
Amphetamine	Dextroamphetamine; Dextroamphetamine Saccharate; Amphetamine; Amphetamine Aspartate
Angiotensin Converting Enzyme Inhibitor	Lisinopril
Angiotensin-II Receptor Blocker/ARB	Losartan
Anti-arrhythmic, Class II	Metoprolol
Anticonvulsant	Gabapentin

Antismoking Agent	Bupropion
Biguanide Antidiabetic	Metformin
cardiovascular agent	Amlodipine
Corticosteroid	Fluticasone
Loop Diuretic	Furosemide
miscellaneous Antidepressant	Bupropion, Trazodone
Non-salicylate analgesic	Acetaminophen/Hydrocodone
Opioid Agonist	Acetaminophen/Hydrocodone
Penicillinase-Sensitive Penicillin Antibiotic	Amoxicillin
Proton Pump Inhibitor/PPI	Omeprazole, Pantoprazole
Respiratory Short-Acting Beta-2 Agonist (SEBA)	Albuterol
Selective Beta-Blocker (with calcium channel blocker)	Metoprolol
Selective Serotonin Reuptake Inhibitor Antidepressant, SSRI	Sertraline, Escitalopram, Fluoxetine
Statin (HMG-CoA Reductase Inhibitor)	Atorvastatin, Simvastatin, Rosuvastatin
Systemic Leukotriene Antagonists	Montelukast
Thiazide Diuretics	Hydrochlorothiazide
Thyroid Agent	Levothyroxine

Table 5 lists the drugs that have a tinnitus effect, a vestibular effect, a hearing loss effect and an otalgia effect. It can be seen that Atorvastatin, Lisinopril, Metoprolol, Amlodipine, Albuterol, Omeprazole, Losartan, Sertraline, Pantoprazole, Furosemide, Escitalopram, Fluoxetine, Bupropion and Trazodone all have a tinnitus side effect.

Table 5. List of Medications with Tinnitus Side Effect, Dizziness/Vertigo Side Effect, Hearing Loss Side Effect, and Otalgia Side Effect

Tinnitus Side Effect	Vertigo/Dizziness Side Effect	Hearing Loss Side Effect	Otalgia Side Effect
Atorvastatin Lisinopril Metoprolol Amlodipine Albuterol Omeprazole Losartan Sertraline Pantoprazole Furosemide Escitalopram Fluoxetine Bupropion Trazodone	Atorvastatin Lisinopril Metformin Metoprolol Amlodipine Albuterol Omeprazole Losartan Gabapentin Hydrochlorothiazide Sertraline Simvastatin Montelukast Acetaminophen/Hydr ocodone Pantoprazole Furosemide Fluticasone Escitalopram Fluoxetine Rosuvastatin Bupropion Amoxicillin Dextroamphetamine; Dextroamphetamine Saccharate; Amphetamine; Amphetamine Aspartate Trazodone	Acetaminophen/Hydr ocodone Furosemide Fluoxetine Bupropion Trazodone	Fluticasone Fluoxetine

Table 6 lists the drugs that have each cognitive side effect. The cognitive side effects included in this table are amnesia, confusion, memory impairment, depression, anxiety, hallucinations, irritability, impaired cognition, psychosis, hostility, suicidal ideation and mania. It can be seen in this table that Atorvastatin, Metoprolol, Gabapentin, Simvastatin, Escitalopram, Rosuvastatin and Bupropion all have an amnesia side effect.

Table 6. List of Medications by Type of Cognitive Side Effect

Amnesia Side Effect	Atorvastatin Metoprolol Gabapentin Simvastatin Escitalopram Rosuvastatin Bupropion
Confusion Side Effect	Atorvastatin Lisinopril Metoprolol Omeprazole Losartan Gabapentin Sertraline Simvastatin Montelukast Acetaminophen/Hydrocodone Pantoprazole Escitalopram Fluoxetine Rosuvastatin Bupropion Amoxicillin Dextroamphetamine; Dextroamphetamine Saccharate; Amphetamine; Amphetamine Aspartate Trazodone
Memory Impairment Side Effect	Atorvastatin Losartan Gabapentin Simvastatin Montelukast Fluoxetine Rosuvastatin Bupropion

Depression Side Effect	<p>Atorvastatin Lisinopril Metoprolol Amlodipine Omeprazole Losartan Gabapentin Sertraline Simvastatin Montelukast Pantoprazole Fluticasone Escitalopram Fluoxetine Rosuvastatin Bupropion Dextroamphetamine; Dextroamphetamine Saccharate; Amphetamine; Amphetamine Aspartate</p>
Anxiety Side Effect	<p>Levothyroxine Metoprolol Albuterol Omeprazole Losartan Sertraline Montelukast Acetaminophen/Hydrocodone Fluticasone Escitalopram Fluoxetine Bupropion Amoxicillin Dextroamphetamine; Dextroamphetamine Saccharate; Amphetamine; Amphetamine Aspartate Trazodone Amlodipine</p>
Hallucinations Side Effect	<p>Lisinopril Metoprolol Omeprazole Acetaminophen/Hydrocodone Pantoprazole</p>
Irritability Side Effect	<p>Albuterol Montelukast Escitalopram</p>
Impaired Cognition Side Effect	<p>Gabapentin Acetaminophen/Hydrocodone Trazodone</p>

Psychosis Side Effect	Sertraline Fluoxetine Bupropion Dextroamphetamine; Dextroamphetamine Saccharate; Amphetamine; Amphetamine Aspartate Trazodone
Hostility Side Effect	Montelukast Escitalopram
Suicidal Ideation Side Effect	Escitalopram Bupropion
Mania Side Effect	Fluoxetine Bupropion Dextroamphetamine; Dextroamphetamine Saccharate; Amphetamine; Amphetamine Aspartate

DISCUSSION

The results of this review reveal that commonly prescribed medications can have many adverse reactions which affect the auditory system, audiological testing and treatment of audiological conditions. It is important for audiology professionals to be aware of common medications which are taken by patients and be able to use that information to inform patient-centered care in the clinic. The guide presented is to be of use for audiologists, audiology students and related professionals as a desktop guide for quick and easy use in a clinical setting. Future directions for this research may include the extension of the guide in this format to include more common medications. In addition to this, the guide could be updated to include the latest information in the future. Ideally, this guide could be used as the beginning of a searchable database, which is frequently updated to include common medications and their potential to affect audiological testing, results and treatment.

DISSEMINATION

This chart is to be presented in fulfillment of the Doctor of Audiology capstone project at the CUNY Graduate Center. A digital copy will be provided to all faculty and student attendees of presentation and can henceforth be used at student clinical sites.

REFERENCES

- American Speech-Language-Hearing Association. (n.d.). *Audiologists*. Job Description and Career Information. Retrieved October 9, 2021, from <https://www.asha.org/students/audiologists/>.
- American Speech-Language-Hearing Association. (n.d.). The Profession of Audiology. Retrieved March 9, 2022, from <https://www.asha.org/students/audiology/>
- L Beck, D., Bant, S., & A Clarke, N. (2020). Hearing loss and Cognition: A Discussion for Audiologists and Hearing Healthcare Professionals. *Journal of Otolaryngology-ENT Research*, 12(3), 72–78. <https://doi.org/10.15406/joentr.2020.12.00459>
- Beck, D. L., & Harvey, M. (2021). Issues in Cognition, Audiology, and Amplification. *Hearing Review*, 28(1), 28-33.
- Cianfrone, G., Pentangelo, D., Cianfrone, F., Mazzei, F., Turchetta, R., Orlando, M. P., & Altissimi, G. (2011). Pharmacological drugs inducing ototoxicity, vestibular symptoms and tinnitus: a reasoned and updated guide. *Eur Rev Med Pharmacol Sci*, 15(6), 601-36.
- Clinical Certification in Audiology and Speech-Language Pathology of the American Speech-Language-Hearing Association. (2018). *2020 Standards for the Certificate of Clinical Competence in Audiology*. Retrieved from www.asha.org/certification/2020-Audiology-Certification-Standards/

DiSogra, R. M. (2019, May). The impact of pharmaceutical side effects on audiological and vestibular measurements. In *Seminars in Hearing* (Vol. 40, No. 02, pp. 097-103). Thieme Medical Publishers.

Drugs.com. (n.d.). *Prescription drug information, Interactions & Side effects*. Drugs.com. Retrieved February 7, 2022, from <https://www.drugs.com/>

Kane, S. P. (2020). *The Top 200 Drugs of 2019*. CLINICAL DrugStats database. Retrieved February 7, 2022, from <https://clincalc.com/DrugStats/>

Katzung, B. G., & Trevor, A. J. (Eds.). (2012). *Basic & clinical pharmacology*.

Offerdahl, T., & Mishra, V. (2019). Pharmacology for the audiologist. *Seminars in Hearing*, 40(02), 087–096. <https://doi.org/10.1055/s-0039-1684038>

PDR Search. PDR.Net. (n.d.). Retrieved February 7, 2022, from <https://www.pdr.net/>

Saunders, G. (2015). Hearing aid outcomes and the influence of non-auditory factors. *Hearing Review*, 22(9), 19.

Stach, B. A., & Ramachandran, V. (2021). *Clinical audiology: An introduction*. Plural Publishing.