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Chemical Compounds used in Medicines and their Impact on Human

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ABSTRACT

Chemicals are used to create medicines. Chemical analysis and the synthesis of novel chemicals are used to create new medications. This topic is so wide that it has spawned a new branch of chemistry known as 'Medicinal Chemistry' of 'Chemicals in Medicines'.

Medicinal chemistry is a branch of chemistry concerned with the design, analysis, development, and synthesis of drugs as medicine. Medicines are chemical compounds that help living creatures in the treatment of diseases or the relief of suffering. This discipline necessitates knowledge in synthetic organic chemistry, pharmacology, and biological sciences. Medicines include numerous compounds.

Medicines have an important role in the treatment and prevention of disease in both humans and animals. But it is because of the very nature of medicines that they may also have unintended effects on animals and microorganisms in the environment. Although the side effects on human and animal health are usually investigated in thorough safety and toxicology studies, the potential environmental impacts of the manufacture and use of medicines are less well understood and have only recently become a topic of research interest. More than 10 million women in the USA alone use oral contraceptives, which eventually find their way into the environment. A wide range of human medicines, including antibiotics, statins or cytotoxins used in cancer treatment, are produced and used, some in the range of thousands of tons per year. It is hard to obtain information on the amount of human medicines used, but recent data from Canada indicates that high-use drugs include acetominophen, acetylsalicylic acid, ibuprofen, naproxen and carbamazepine.

KEYWORDS: *medicines, chemical, toxicology, cytotoxins, side effects, drugs, environment*

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INTRODUCTION

Drugs used in medicine generally are divided into classes or groups on the basis of their uses, their chemical structures, or their mechanisms of action. These different classification systems can be confusing, since each drug may be included in multiple classes. The distinctions, however, are useful particularly for physicians and researchers. For example, when a patient experiences an adverse reaction to a drug, these classification systems allow a physician to readily identify an agent that has comparable efficacy but a different structure or mechanism of action. Likewise, knowledge of a drug's chemical structure facilitates the search for new and potentially more effective and safer medicines.[1,2]The following sections provide a general overview of some major types of drugs, grouped according to the disease or human tissues or organ systems on which they act. This is not intended as a comprehensive list, given that the number of drugs that have been developed is vast and research into them is ongoing. Additional information, however, can be found in separate articles on the different classes of drugs and on certain individual drugs themselves.

Antimicrobial drugs can be used for either prophylaxis (prevention) or treatment of disease caused by bacteria, fungi, viruses, protozoa, or helminths. These agents generally are of three types: (1) synthetic chemicals, (2) chemical substances or metabolic products made by microorganisms, and (3) chemical substances derived from plants. Antimicrobial agents often are effective against a specific microorganism or group of closely related microorganisms, and they often do not affect host (e.g., human) cells. A number of antimicrobial compounds, however, produce significant toxic effects in humans, but they are used because they have a favourable chemotherapeutic index (the amount required for a therapeutic effect is below the amount that causes a toxic effect). The phenomenon of resistance, in which infectious agents develop the ability to evade drug effects, has required an ongoing search for different agents. The increase in resistance to antimicrobial drugs has resulted from their widespread and sometimes indiscriminate use. [3,4]

Several major groups of drugs, notably anesthetics and psychiatric drugs, affect the central nervous system. These agents often are administered in order to produce changes in physical sensation, behaviour, or mental state. General anesthetics, for example, induce a temporary loss of consciousness, enabling surgeons to operate on a patient without the patient's feeling pain. Local anesthetics, on the other hand, induce a loss of sensation in just one area of the body by blocking conduction in nerves at and near the injection site.

Drugs that influence the operation of neurotransmitter systems in the brain can profoundly influence and alter the behaviour of patients with mental disorders. Psychiatric drugs that affect mood and behaviour may be classified as antianxiety [5,6]agents, antidepressants, antipsychotics, or antimanics. Cardiovascular drugs affect the function of the heart and the blood vessels. Given the relatively high prevalence of certain cardiovascular diseases, including hypertension (high blood pressure) and atherosclerosis (hardening of the arteries caused primarily by the deposition of fat on the inner walls of the arteries), these agents necessarily rank among some of the most widely used drugs in medicine. They frequently are classified according to the tissues they act on and the specific actions they produce. Thus, there are drugs that act on the heart and that are distinguished further by their ability to alter either the frequency of heartbeat, the force of contraction of the heart muscle, or the regularity of the heartbeat. There also are a number of drugs that act on the blood vessels, typically causing the vessels to constrict (to raise blood pressure) or to relax (to lower blood pressure).

Drugs may also affect the blood itself, such as by activating or inhibiting enzymes involved in the formation of clots (thrombi) within blood vessels. Thrombi form when blood vessels are damaged, such as by wounding or by the accumulation of harmful substances (e.g., fat, cholesterol, inflammatory substances) on the inner walls of vessels. Thrombi are further defined by their adherence to vessel walls, which in the case of a condition such as atherosclerosis can give rise to thrombosis,[7,8,9] in which the thrombus partially impedes the flow of blood through the vessel. When a portion of a thrombus breaks off, the circulating clot becomes known as an embolus. An embolus travels in the bloodstream and may become lodged in an artery, blocking (occluding) blood flow. This can lead to heart attack or stroke. Anticoagulants, antiplatelet drugs, and fibrinolytic drugs all affect the clotting process to some degree; these classes of drugs are distinguished by their unique mechanisms of actions.

Other drugs that act on the blood include the hypolipidemic drugs (or lipid-lowering agents) and the antianemic drugs. The former are used in the treatment hyperlipidemia (high serum levels of lipids), which frequently is associated with elevated cholesterol; examples include the widely prescribed statins (HMG-CoA reductase inhibitors). Antianemic agents increase the number of red blood cells or the amount of hemoglobin (an oxygen-carrying protein) in the blood, deficiencies that underlie anemia. Drugs may act on the digestive system either by affecting the actions of the involuntary muscle (motility) and thus altering movement or by altering the secretion of digestive juices or gastric emptying. Some examples of major groups of digestive drugs include antidiarrheal drugs, laxatives, antiemetics, emetics, proton pump inhibitors, and antacids.

Several sites in the reproductive system either are vulnerable to chemicals or can be manipulated by drugs. Within the central nervous system, sensitive sites include the hypothalamus (and adjacent areas of the brain) and the anterior lobe of the pituitary gland. Regions outside the brain that are vulnerable include the gonads (i.e., the ovaries in the female and the testes in the male), the uterus in the female, and the prostate gland in the male.[10,11]

The body has anatomic or physiological barriers that tend to protect the reproductive system. The so-called placental barrier and the blood-testis barrier impede certain chemicals, although both allow most fat-

soluble chemicals to cross. Drugs that are more water-soluble and that possess higher molecular weights tend not to cross either the placental or the blood-testis barrier. In addition, if a drug binds to a large molecule such as a blood-borne protein, it is less likely to be transported into the testes or less likely to come in contact with the fetus. If the fetus is exposed in the uterus to certain drugs, it may develop abnormalities; those toxic substances are described as teratogenic (literally, "monster-producing"). The sedative and antiemetic agent thalidomide and the anticonvulsant drug phenytoin are notorious examples of teratogens. Women frequently are advised to avoid all drugs (including nicotine) during pregnancy, unless the medicine is well-tried and essential. Drugs taken by males may be teratogenic if they damage the genetic material (chromosomes) of the spermatozoa. There appears to be little, if any, barrier to chemicals, or drugs, gaining entry to breast milk or semen.

Control of most body functions is achieved by the nervous system and the endocrine system, which constitute the two main communication systems of the body. They function in a closely coordinated way, each being dependent on the other for its proper operation. The total behaviour of the organism is integrated by a constant traffic of both neural and hormonal signals, which are received and responded to by appropriate tissues. The activities of the central nervous system and of the endocrine glands are themselves dependent on feedback control through neural and hormonal stimuli. This control is related to the toxicity of hormones when used therapeutically, because prolonged use of certain hormones or their analogs in this way may quell, sometimes irreversibly, the appropriate gland's output of endogenous hormone.[12,13]

The natural hormones belong to only a few chemical classes. Most are polypeptides; some are derivatives of amino acids (epinephrine, norepinephrine, dopamine, or thyroid hormones); and some are steroids (the sex hormones and the hormones of the adrenal cortex). Polypeptide and amino acid hormones bring about their effects by acting on cell membrane receptors that are specifically sensitive to their action. Steroid hormones penetrate the cell membrane and interact with receptors on specific binding proteins, which then act on the cell nucleus to modify protein synthesis. The techniques of recombinant DNA technology have begun to provide improved methods for obtaining large amounts of scarce human hormones in pure form.

Diuretics that act in the loop of Henle produce a rapid peak in the excretion of urine (diuresis), which then wanes as the drugs are excreted and because of the compensatory factors due to fluid loss. These diuretics clear sodium chloride (salt) from the body and interfere indirectly with the mechanisms by which water is reabsorbed from the collecting duct. Consequently, large volumes of dilute urine containing sodium, potassium, and chloride ions are formed. The loop diuretics are also called high-ceiling diuretics because they can produce an extra level of diuresis over and above the maximum produced by other classes of diuretic drugs. Examples of this class are furosemide, ethacrynic acid, and bumetanide. Loop diuretics are used in the treatment of pulmonary edema associated with congestive heart failure. The major side effect of these drugs is hypokalemia.[14,15]

Neuromuscular blocking drugs act on acetylcholine receptors and fall into two distinct groups: nondepolarizing (competitive) and depolarizing blocking agents. Competitive neuromuscular blocking drugs act as antagonists at acetylcholine receptors, reducing the effectiveness of acetylcholine in generating an end-plate potential. When the amplitude of the end-plate potential falls below a critical level, it fails to initiate an impulse in the muscle fibre, and transmission is blocked. The most important competitive blocking drug is tubocurarine, which is the active constituent of curare, a drug with a long history and one of the first drugs whose action was analyzed in physiological terms. Claude Bernard, a 19th-century French physiologist, showed that curare causes paralysis by blocking transmission between nerve and muscle, without affecting nerve conduction or muscle contraction directly. Curare is a product of plants (mainly species of Chondodendron and Strychnos) that grow primarily in South America and has been used there for centuries as an arrow poison.[16,17,18]

Discussion

Synthetic drugs, also called "designer" drugs, are created in laboratories. Some of the chemicals used to make them were originally developed to become new prescription drugs for pharmaceutical companies, but they didn't end up being used for this purpose. Rogue chemists have since taken these chemicals, modified them slightly so they're technically legal, and sold them as "research chemicals."

The rise of synthetic drugs is an epidemic that's affecting many lives, especially young people. This is why it's important to know:

Different types of synthetic drugs that are out there

Dangers these drugs pose to our loved ones

Treatments available for addicts

Here are the most well-known synthetic drugs available today:

Spice and K2
These are just two of many street names for synthetic marijuana. This drug is sold in small, silver plastic bags and looks like dried leaves. It can also be found in liquid form. Synthetic marijuana is advertised as legal and safe, but neither is true. It's a highly addictive drug.

Molly, or Ecstasy
Molly, also referred to as MDMA, is a synthetic version of Ecstasy. Like Ecstasy, it's commonly distributed at music festivals, night clubs, and dance clubs as a colored pill. Users may believe it is only Ecstasy they're taking, but the pill could actually be laced with some kind of chemical compound to make it even more potent.[19,20]

Krokodil
Krokodil, a.k.a. desomorphine, is a derivative of the opioid pain medication codeine. It's similar to heroin in both use and effects. It is highly addictive and can be made at home by mixing codeine with paint thinner, gasoline, hydrochloric acid, and iodine. Krokodil is known to be even more lethal than its cousin, heroin.

Synthetic Cocaine
Synthetic cocaine is easily accessible and still legal in most countries. It can be found online, where it's labeled as "research chemicals," "plant food," or other misleading names. It's sold under street names such as Mind Melt, Amplified, or Mint Mania.

Bath Salts
Bath Salts are synthetic stimulants. They cause hallucinations similar to the drug LSD. They're sold in small plastic or foil packages, and look a lot like the bath salts they're named after. They are also sold as capsules, or in small jars as a liquid. Street names include Arctic Blast, Blue Silk, or Monkey Dust, among many others.

Synthetic Psychedelics
Synthetic forms of the drug LSD are referred to as N-bomb or Smiles. Synthetic psychedelics are powerful hallucinogens. There are many variations of them, but the most potent is "25I." N-bomb is sold in liquid or powdered form, and can also be injected, inhaled, or even used as a suppository. A tiny amount of this drug can last for 12 hours or longer.[21]

Synthetic Opioids
Synthetic versions of fentanyl and ketamine are widely available. They're usually injected, but ketamine can also be smoked or sniffed. These drugs have unpredictable and more severe side effects than the opioids they're derived from. Ketamine is typically called Vitamin K on the street.

The effects of synthetic drugs are deadly, and sometimes even violent. The high comes on fast and strong. It's important to know the signs someone has taken designer drugs so you can take action immediately if you notice these symptoms in a friend or loved one.

Here are common symptoms of someone who has taken synthetic drugs:

Paranoia

Extreme anxiety

Hallucinations

Seizures

Aggression

Suicidal or homicidal behavior

Chest pain or heart attack

Delusions Less severe effects include:

Sweating

Restlessness

Inability to speak

Euphoria

Results and Conclusions
Synthetic drug use is hard on relationships, friendships, and family. Deception and other out-of-character behaviors can cause loved ones to feel worried, confused, and scared. As is the case with many other types of substance abuse, use of synthetic drugs can cause permanent damage to your family and relationships.[22,23]

In addition, synthetic drug use can have a negative social and economic impact. Users may resort to stealing money from their friends and family or selling items from their homes to get the money needed to continue to buy drugs. Furthermore, synthetic drug use can lead to financial and career instability, such as poor performance at work, penalizations at work, or termination. Synthetic drugs may be thought of as being safer than other illicit

drugs, but the opposite may actually be true. In truth, these drugs are often toxic, as NIDA reported 19 deaths from the synthetic hallucinogen called "N-bomb" between March 2012 and August 2013 alone. Synthetic drugs may be especially dangerous when combined with other drugs or alcohol, as the potential interactions between substances may not be fully understood and may have unintended negative consequences.[24,25]

Synthetic drugs may appeal mostly to young adults and are commonly bought online. These compounds are manufactured in clandestine laboratories and often imported from other countries, like China, where the chemicals may not be regulated. In the United States, the DEA and FDA continue to try and stay ahead of the synthetic drug trade; however, drug manufacturers are able to change the chemical makeup of these drugs just enough to keep them from being controlled or regulated by authorities. As one synthetic compound is recognized and controlled or banned, several more rise to take its place.

These research chemicals are risky and as little as one dose may prove fatal. Regular abuse of synthetic drugs can lead to dependence and addiction just as other illicit drugs can. Addiction is a treatable disease. Comprehensive substance abuse treatment can lead to full recovery.[25]

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