Commonly Used Antibiotics in the Outpatient Setting

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Purpose: This course will provide an overview of the antibiotics most commonly ordered by primary care providers for common conditions in the outpatient setting.

Objectives:

- List three major problems associated with the use of antibiotics
- Discuss common allergic reactions to antibiotics
- List three health conditions that are treated with each class of antibiotic discussed
- List three side effects associated with each class of antibiotic discussed
- Discuss the nurse’s role in the administration of oral antibiotics

The course will look at 6 major classes of commonly used oral antibiotics, some miscellaneous antibiotics and topical antibiotics that health care providers prescribe in the outpatient setting. One injection medication that is commonly used in the primary care office will be discussed.

Many people go to the doctor with false perceptions of the ideal antibiotic to treat their infection. One common example is the use of the Z-Pak. The Z-Pak is a formulation of the commonly used antibiotic azithromycin. It is a very good antibiotic, but it gets over used.

The reason that this medication is overused is because it is a once a day antibiotic for five days (some infections can be treated with a three or even one day course). This is convenient for people and is often requested. While the Z-Pak is commonly a good choice to treat many infections, it is not always the ideal choice. There is currently a lot of resistance to this antibiotic, due to its overuse.
The use of antibiotics is a major part of the primary care doctor’s practice as many visits are due to an infectious process. It is often a knee jerk reaction for primary care health care providers to prescribe antibiotics for any infectious illness, but many infections do not need antibiotics.

Common problems that drive patients to the doctor include sore throat, cough, earache, nasal congestion, sinus infection, upper respiratory tract infection and bronchitis. These conditions make up a large percentage of visits to primary care health care providers and most do not require the use of antibiotics, though they are often prescribed.

Problems with Antibiotic

Antibiotics do not work against viruses, fungus or parasites. They are not helpful for the common cold, and many other illnesses that are caused by viruses. Even though most people understand this, many people feel the need to get an antibiotic when they are sick irrespective of whether bacteria or a virus causes the infection.

The next section will discuss some common problems with antibiotics. The topics covered will include: antibiotic resistance, allergy, medical errors, side effects, complications and drug interactions.

Antibiotic resistance

The overuse and misuse of antibiotics have greatly contributed to antibiotic resistance. Widespread use of antibiotics has allowed infectious organisms to adapt and learn how to withstand assault from future attacks of antibiotics.

Resistance is not a new phenomenon; it was noticed shortly after penicillin was developed in the 1940’s. Many organisms have developed some degree of resistance to antibiotics. Some examples include some pneumonias, sexually transmitted diseases and skin infections.
A common antibiotic resistant bacterium is *Methicillin-resistant Staphylococcus aureus* (MRSA). In the past, MRSA was only seen in the hospital, but over recent years it has been found in the community.

When common antibiotics are unable to fight infection because of antibiotic resistance more powerful antibiotics will be needed to combat disease. These more powerful antibiotics are often associated with more severe side effects. If antibiotic resistance continues to progress, then the more powerful antibiotics become resistant, and a time may come when no antibiotic is available to fight certain bacterial infections.

Illness will be more costly, in both time and money, as antibiotic resistance increases. In the future, infections once handled in the community may require the increased use of hospitalization for intravenous therapy.

**Allergy to Antibiotic**

Allergy to antibiotics is a common problem. Patients can be allergic to any medication, but some medications are more likely to cause an allergy. To highlight allergy to antibiotics, two common medications that cause allergy will be discussed: penicillin and sulfa drugs.

Allergy to penicillin is common, but serious reactions to penicillin are not. About 90% of people who report an allergy to penicillin are either not allergic or the allergy diminished or went always over time. Only twenty percent of people are allergic to penicillin ten years after their allergic reaction if they have not taken the antibiotic over that time (1).

Another common allergy is sulfa. Common antibiotics that have sulfa in them are Bactrim, Septra and Pediazole. About 3% of the population has an allergy to sulfa antibiotics (2).
Some individuals are more commonly affected with sulfa allergy such as those with diseases of the immune system such as HIV or AIDS.

Common sulfa reactions include:

- Rash
- Stevens-Johnson syndrome
- Photosensitivity
- Hives
- Hepatotoxicity
- Renal toxicity
- Anaphylaxis
- Bronchospasm
- Hemolysis

Those who are allergic to sulfa antibiotics are often allergic to many other drugs. Other than the drugs already listed the following drugs may also cause problems in those that are allergic to sulfa:

- Sulfasalazine
- Sulfacetamide eye drops
- Silver sulfadiazine cream
- Some diuretics – hydrochlorothiazide
- Sulfonylureas (glyburide, glipizide)
- Celecoxib (Celebrex)
- Sumatriptan (Imitrex)
**Adverse drug reactions**

Drugs cause people to get sick, especially the older population. Adverse drug reactions occur many times every day. It is estimated that 1.5 million people are admitted to the hospital and 100,000 deaths occur every year because of adverse drug reactions (3). Adverse drug reactions include: medication errors, side effects, drug interaction or complications from the drug.

**Medication Errors**

There are many causes of medication errors and they vary by health care setting. In the outpatient setting a common error is the pharmacist filling the wrong prescription due to inability to read the physician’s handwriting. Patients not understanding the instructions to take the medicine are another common cause of error. Improved communication between the doctor and pharmacist can reduce errors in the outpatient setting.

Patients should be taught to communicate appropriately with their doctor. Patients should be encouraged to take notes on any new drug prescribed by the doctor. Patients who take good notes on what the doctor prescribed, will be able to question the pharmacy if any inconsistency is noted.

In the hospital, errors often result from lack of attention rather than lack of knowledge. The nursing staff is often overworked and makes errors in administering medicine. Another common cause of hospital errors is not getting an accurate history from the patient. The doctor performing the initial work-up on the patient may not get an accurate list of the medications the patient takes. This results in the patient not getting
medications that are needed.

**Side Effects**

Not all adverse drug reactions are a result of error. Medicines are dangerous substances and great care must be taken when they are prescribed. All medicines have side effects and many side effects are known and considered normal. Some medicines have more side effects than others. Some side effects get better when the patient gets used to the drug while others persist indefinitely. Some side effects are easy to spot such as diarrhea and others are more subtle, such as fatigue.

Side effects vary by drug and can range from a mild inconvenience to life threatening. Common side effects include: fatigue, diarrhea, constipation, nausea, vomiting, decreased appetite, memory impairment and kidney dysfunction. Life threatening side effects include: arrhythmia or pulmonary fibrosis.

Reporting the side effects is an important aspect to drug therapy. Some side effects are expected and if present will not change the course of treatment. Other side effects may be life threatening or so severe that the risk of therapy is not worth the benefit of treatment.

Patients should be encouraged to talk over any new drug with their doctor. Encourage the patient to ask the questions listed in Table 2 when they are prescribed a new drug.
Table 1: Questions patients should know about newly prescribed antibiotics

<table>
<thead>
<tr>
<th>Question</th>
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<tbody>
<tr>
<td>• What is this medicine for?</td>
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<tr>
<td>• Does my age affect the dose needed to treat me properly?</td>
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<tr>
<td>• Are there any restrictions with this drug? For example, could this</td>
</tr>
<tr>
<td>make me drowsy so I should not drive after taking the drug?</td>
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<tr>
<td>• How will it help me? How will I know if it is working?</td>
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<tr>
<td>• When should I take the medicine? In the morning, at night etc.</td>
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<tr>
<td>• Should I take the medicine with food or on an empty stomach?</td>
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<tr>
<td>• What are the common side effects with this medicine? Are the</td>
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<tr>
<td>benefits of this drug worth the side effects and drug interactions?</td>
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<tr>
<td>• Could I benefit from taking yogurt or a pill to maintain the good</td>
</tr>
<tr>
<td>bacteria in my body while on this antibiotic?</td>
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<tr>
<td>• Are there any necessary follow-ups either by exam or laboratory</td>
</tr>
<tr>
<td>evaluation for monitoring this medicine?</td>
</tr>
<tr>
<td>• How much does it cost? Are there any cheaper alternatives to this</td>
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<tr>
<td>medicine? Is there a generic version that has equal effectiveness?</td>
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<tr>
<td>• Can this medicine interact with any of my other medicines?</td>
</tr>
<tr>
<td>• How long has this medicine been on the market?</td>
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<tr>
<td>• Are there any severe risks with this medicine?</td>
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<tr>
<td>• What should I do if I miss a dose of the medicine?</td>
</tr>
<tr>
<td>• Can I drink alcohol while on this medicine?</td>
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Drug Interactions

Drug interactions are negative effects resulting from the mixing of two or more medications. Drugs have variable effects on other drugs - they can intensify or blunt the desired effect of another medication.

For example, patients on warfarin (Coumadin) need to have tight control of the blood level requiring frequent laboratory evaluation to assure the drug is therapeutic. The addition of an antibiotic has the potential to increase or decrease the amount of drug in the blood, placing the patient at elevated risk for bleeding complications if levels become too high or risk of clots if levels are too low. Individual variation is common with drug interactions. Certain medications will interact more in one individual than another individual with variation being explained by individual body chemistry.

Medical science lacks extensive research on drug interactions, especially when patients are on more than two or three drugs. The addition of medication to any patient has the potential for negative outcomes. The interaction between the other drugs, disease states and the individual’s body chemistry is variable.

Complications

Complications are adverse events from drugs that cannot be classified as a side effect, interaction or error. A bacterial infection causing severe diarrhea secondary to antibiotic therapy, called Clostridium difficile (also known as C. diff.), is one common complication. Clostridium difficile is a bacterium that invades the gastrointestinal tract causing severe diarrhea.
What is the nurse’s role?

Antibiotics must be used correctly if we want to reserve the future efficacy of antibiotics. Here are some key points that nurses must understand and pass along to their patients to promote the proper use of antibiotics.

- Understand when antibiotics should be used. Antibiotics treat most bacterial infections, but not viral infections, such as colds, acute bronchitis or influenza. Some common bacterial illnesses, such as mild ear infections or sinus infections, do not benefit much from antibiotics.
- Teach patients to not insist on antibiotics from their doctor, especially for viral illnesses. Teach patients how to relieve the symptoms of viral illness — a saline nasal spray to clear a stuffy nose, for instance, or a mixture of warm water, lemon and honey to temporarily soothe a sore throat.
- Teach patients to take antibiotics exactly as prescribed in regards to times a day and for how long.
- Encourage patients to not stop antibiotics early, this only kills the most vulnerable bacteria and allows the stronger ones to survive contributing to antibiotic resistance.
- Prevent infection. Participate in frequent hand washing and use universal precautions.

Antibiotic resistance is everybody’s problem. Almost all bacteria have some resistance to antibiotics. Individuals who do not use antibiotics correctly contribute to the problem. Proper use of antibiotics not only affects the health of the individual, but the health of the community at large.
Penicillin

Penicillin – which was derived from fungus - was first discovered in 1928, but not produced for use until the early 1940's. While it was the second major class of antibiotic available it was very important because it was able to combat many illness that were not previously treatable including: syphilis, pneumonia, staphylococcus infections and tuberculosis.

While the drug was initially hard to produce in large quantities, a technique was developed using a moldy cantaloupe that allowed scientists to be able to mass-produce the antibiotic by 1944.

Interestingly, resistance to penicillin was noticed only three years after it was introduced as a medicine to fight infection and resistance remains a major problem today.

Penicillin consists of 4 generations. Each generation has a little bit different coverage. This section will look at the three most common penicillin antibiotics prescribed in the outpatient setting: Penicillin V potassium, amoxicillin and amoxicillin-clavulanate.

Penicillin is bactericidal which means that it kills bacteria, and it does this by attacking the bacteria’s cell wall. Unfortunately, many bacteria are now resistant to penicillin, as some bacteria produces an enzyme – called penicillinase - that prevents the antibiotic from breaking down the cell wall.
Consequently, some derivatives of penicillin have been developed that have another substance – clavulanate - meant to combat this resistance. Amoxicillin-clavulanate (Augmentin) is one example of this and is often used in infections that do not respond to other penicillins.

Penicillin treats a wide range of conditions. Penicillin V potassium has the most narrow spectrum of action, followed by amoxicillin and amoxicillin-clavulanate can cover the widest range of infections.

**Table 1: Practical use of penicillin antibiotics**

<table>
<thead>
<tr>
<th>Drug</th>
<th>Common uses</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penicillin V Potassium</td>
<td>Group A beta hemolytic streptococcus</td>
<td>Best taken one hour before or 2 hours after meals. Most common side effects are diarrhea, vomiting, nausea and rash.</td>
</tr>
<tr>
<td>Amoxicillin</td>
<td>Bacterial sinus infections, acute otitis media, group A beta hemolytic streptococcus and Helicobacter pylori.</td>
<td>Can be taken with or without food. Most common side effects are nausea, vomiting, rash and diarrhea.</td>
</tr>
<tr>
<td>Amoxicillin-Clavulanate (Augmentin)</td>
<td>Bacterial sinus infections, pneumonia, acute otitis media, other respiratory infections and cellulitis.</td>
<td>Should be taken with food, as it is more likely to cause stomach upset and diarrhea.</td>
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</tbody>
</table>
Common side effects

Penicillin is the most likely antibiotic to cause a severe allergic reaction, but an allergic reaction is not as common as generally believed. Many people who report an allergy to penicillin are not actually allergic - either because the allergy went away or lessened over time. It is estimated that 10% of the population reports an allergy to penicillin, but the actual number may be much smaller as penicillin allergy is often over diagnosed (3).

The most common side effects include:

- Rash
- Nausea
- Diarrhea
- Hives
- Candida infection (oral and vaginal candidiasis)

Less common side effects include:

- Fever
- Seizure
- Anaphylaxis
- Severe diarrhea from *Clostridium difficile*

Most side effects of penicillin are mild. Immediate medical attention must be obtained if there is any difficulty breathing, edema of the respiratory tract, hives or anaphylaxis.
Many of those allergic to penicillin are also allergic to cephalosporins, but some evidence suggests that there is no or little cross reactivity to later generation cephalosporins. In face of a respiratory tract infection antibiotics that are generally considered safe in those with a non-severe (or non Type I) allergic reaction include: cefuroxime axetil, cefdinir and cefpodoxime (3).

Those who have a mild allergic reaction, such as a rash, may be tried on other antibiotics in a similar class (Cephalosporins) and watched closely. If there is a serious allergic reaction to penicillin – such as anaphylaxis or hives – then the use of cephalosporins is not recommended.

**The individual drugs**

The main first generation penicillin is Penicillin V potassium. While it can treat a wide range of infections, it is the drug of choice in strep throat. The oral suspension of this drug has a bitter taste and therefore amoxicillin suspension is often substituted in children for strep throat.

The main second generation penicillin in oral form is dicloxacillin. This drug is not commonly used in medicine today except it is used to treat some cases of cellulitis.

The third-generation penicillin group is the most popular generation used in the outpatient setting. The two major oral antibiotics in this class are amoxicillin and amoxicillin-clavulanate (Augmentin).

Amoxicillin is used as a first-line treatment for sinus infections, acute otitis media, strep throat (especially in young children because the suspension tastes much better
than penicillin). Amoxicillin adds some gram-negative coverage to the good gram-positive coverage of the first and second-generation penicillin group.

Amoxicillin-clavulanate (Augmentin) is commonly used in the treatment of many respiratory infections. It is associated with similar side effects, but the side effects are more prevalent. Side effects are mainly gastrointestinal. Common side effects include: diarrhea and upset stomach. This drug should be taken with food to lessen the risk of side effects.

Amoxicillin-clavulanate is often used as a second-line drug for those with many of the same illnesses that amoxicillin covers. This means that if amoxicillin does not work than on a return visit to the doctor, he/she may prescribe amoxicillin-clavulanate. It is not recommended as a first-line agent because it has a broader range of coverage and has more side effects.

Amoxicillin treats many of the same infections just as effectively. Therefore, why use a more powerful antibiotic. Overuse of powerful antibiotics has the potential to lead to resistance of those antibiotics.

The main difference between amoxicillin and amoxicillin-clavulanate is obviously the clavulanate. What is the clavulanate? It is a medication called a beta-lactamase inhibitor and it prevents some bacteria from destroying the penicillin.

Common uses of amoxicillin-clavulanate (Augmentin) include:

- Sinus infections
- Acute otitis media
- Pneumonia
• Cellulitis
• Urinary tract infections

Fourth generation penicillins treat more severe infections but are only available in the intravenous form. They are associated with more side effects including bleeding disorders and electrolyte imbalances.

Cephalosporins

The first cephalosporin was developed in 1964 from compounds isolated from a sewer on an island in the Mediterranean Sea. There are four classes of cephalosporins and there is some cross reactivity between penicillin and cephalosporins in regard to allergies, but cephalosporins do not as commonly cause severe anaphylactic reactions.

The first-generation cephalosporins have approximately a 10% cross reactivity with penicillin (5). It is a question of debate whether there is cross reactivity with second or third-generation cephalosporin (5). If the reaction is severe, such as anaphylaxis or hives, then the use of cephalosporins should not be used in the face of a penicillin allergy.

Two popular oral first generation cephalosporins include: cephalexin (Keflex) and cefadroxil (Duricef). First-generation cephalosporins treat gram-positive bacteria, but have limited activity against gram-negative bacteria.

Second or third-generation cephalosporins work well for many different bacterial infections. The second and third-generation cephalosporins have added coverage of gram-negative bacteria.
There is one fourth-generation cephalosporin that is given intravenously. It is used for urinary tract infections, pyelonephritis, pneumonia, cellulitis and some abdominal infections.

The most commonly used first generation cephalosporins treat many streptococcal and staphylococcal infections. They are commonly used for minor cellulitis and some infections of the respiratory tract. First-generation cephalosporins are not used as a first line agent for most respiratory tract infections, but can be used for strep throat (but not as a first line drug).

Second-generation cephalosporins retain gram-positive coverage but adds in some gram-negative coverage. Second-generation cephalosporins are often used to treat otitis media, sinus infections and some pneumonias.

The third-generation cephalosporins have enhanced gram-negative coverage. Third generation cephalosporins come in oral, injection and intravenous forms. A popular injection drug in this class is ceftriaxone (Rocephin), which is often used in severe infections in the outpatient setting.

**Common side effects**

While side effects are not common, some of the more common side effects include: rash, nausea and diarrhea. Less prevalent side effects include: headache, diarrhea, candida infections, dizziness, fever, vomiting and electrolyte disturbance.

Some specific points to be aware of include:

- Cefdinir (Omnicef) can turn the red stool particularly if taken with iron.
• Ceftriaxone (Rocephin) can cause pain upon injection and it is sometimes mixed with lidocaine to dull the pain.

• In liquid form, Loracarbef (Lorabid) and cefpodoxime (Vantin) taste the best.
Macrolides

The first macrolide, erythromycin, was available in the early 1950s. In the 1970’s and 80’s clarithromycin (Biaxin) and azithromycin (Zithromax) were developed that were more tolerable. Erythromycin was very difficult on the gut as it caused a lot of nausea and diarrhea.

Macrolides treat a wide range of conditions such as upper respiratory tract infections, skin infections, soft tissue infections, some pneumonias, some bacterial diarrhea infections and some sexually transmitted diseases. They are often used when there is an allergy to penicillin.

Azithromycin is used to treat acute otitis media, acute bacterial sinusitis, community acquired pneumonia, throat infections, exacerbation of chronic bronchitis, skin infections and chlamydia.

Clarithromycin is used for otitis media, acute bacterial sinusitis, community acquired pneumonia, exacerbation of chronic bronchitis, pneumonia and skin infections.

Telithromycin (Ketek) is indicated for only mild to moderate pneumonia and is not commonly used.

Common side effects

Common side effects of macrolides include: nausea, abdominal pain, diarrhea and a metallic taste in the mouth (clarithromycin). Less common side effects include: tinnitus, severe rash, deafness, hepatotoxicity and nightmares.
Clarithromycin may interact with some statins such as atorvastatin (Lipitor), simvastatin (Zocor) or lovastatin (Mevacor). The combination of macrolides with statins may increase the risk of myopathy.

Another serious side effect is cardiac arrhythmias and is more common when combined with other medications and with the use of erythromycin and clarithromycin. Azithromycin is a popular medication, particularly among those who are on multiple medications as there are fewer interactions with azithromycin.

Erythromycin is not as commonly used due to its significant gastrointestinal side effects and its risk of drug interactions. Depending on the drug chosen it is dosed between two and four times a day.

Azithromycin (Zithromax) is a very popular macrolide. It comes in multiple formulations, but is commonly given as the z-pack which is a five day course or the tri-pack which is a three day course and is dosed once a day. There is even a one-time dose of this medication for some infections. It has the fewest side effects and the fewest drug interactions in the class. It is least likely to lead to cardiac rhythm problems.

Clarithromycin (Biaxin) has similar coverage to azithromycin but is not used as often form multiple reasons including it is given for 7-14 day. It is dosed once (in the extended release form – which may be more expensive) or twice a day (in the standard form) compared to once a day dosing for 3-5 days with azithromycin.

Clarithromycin is associated with unique side effects. It is more likely to lead to interactions with cholesterol lowering drugs and lead to myopathy. It is also more likely
to lead to cardiac rhythm disturbances. It is also associated with an abnormal (metallic) taste in the mouth.

Telithromycin (Ketek) is technically not a macrolide, but it is closely related. It is not used as frequently because it is associated with liver problems. It is reserved for cases when nothing else works. It is indicated for mild to moderate pneumonia.

Quinolones

Quinolones come in four generations, but the first-generation of quinolones is almost never used. The first quinolone was developed in 1962 - nalidixic acid - and it was used to treat kidney infections.

The most popular second-generation quinolone is ciprofloxacin (Cipro). Ofloxacin and norfloxacin are other second-generation quinolones that are sometimes used. The second generation has very good gram negative coverage.

Third-generation quinolones treat a wide variety of infections. Fourth-generation quinolones are rarely used because of significant liver problems, but can cover more infections than the third-generation quinolones.

Quinolones are powerful medications and should be reserved for more serious infections. Few infections in the doctor’s office – pneumonia and urinary tract infections being the most common – use quinolones as a first-line medication.

Quinolones treat a wide range of infections. Common infections that they treat include: urinary tract infections, pneumonia, acute exacerbation of chronic bronchitis and acute bacterial sinusitis.
Second-generation quinolones, in oral form, are used most frequently for urinary tract infections and some infections that are caused by *pseudomonas*. Second generation quinolones are not commonly used for respiratory tract infections, unless *pseudomonas* is the causative agent.

The third-generation quinolones do not cover infections caused by *pseudomonas* as well but do cover pneumonia and other respiratory tract infections. The third-generation quinolones are effective for sinus infections, pneumonia and urinary tract infection (Moxifloxacin does not work for urinary tract infections).

Common third generation quinolones include: Levofloxacin (Levaquin), Gatifloxacin (Tequin) and Moxifloxacin (Avelox).

Fourth-generation quinolones cover many of the same infections as the third generation quinolones but add coverage of anaerobic bacteria.

Moxifloxacin and gatifloxacin treat acute exacerbation of chronic bronchitis, pneumonia, diabetic foot infection and bone infections. Gatifloxacin can treat urinary tract infections.

One nice feature of quinolones is that they reach equal levels in the blood when given by mouth or by IV.

Quinolones come in eye and eardrop form for the treatment of bacterial eye infections and outer ear infections.

**Common side effects**

Quinolones are well-tolerated drugs. Common side effects include: nausea, rash, photosensitivity, diarrhea, itching, taste disturbance and cartilage growth interference.
More serious side effects are uncommon, but may include: tendon rupture and cardiac arrhythmia.

Quinolones may lead to tendon rupture especially when combined with corticosteroids in those over 60 years-old and those who have had a heart, lung or kidney transplant. Even though it is rare, patients at high risk should be taught to avoid vigorous exercise after starting these medications and for about three weeks afterwards.

Torsades de points and other cases of ventricular arrhythmias are not common but have been noted with levofloxacin and sparfloxacin (6).

Other effects of quinolones include impaired glucose tolerance which may be more commonly seen with gatifloxacin. Neurological side effects can occur in those on quinolones. Seizures, confusion, dizziness and headache may be seen with the use of quinolones. Neurological side effects may be enhanced by the use of non steroidal anti-inflammatory medications [e.g., Motrin, Advil and Aleve] with the quinolone.

These drugs should be used cautiously in those with liver disease and the elderly. They should not be used in those with epilepsy, a brain tumor, QT prolongation, inflammation in the central nervous system or after a stroke.

These drugs are not approved in children, pregnancy and breast-feeding as they can affect growth and the health of the cartilage. Cartridge damage has been demonstrated in animal studies, but this class is sometimes used in humans with cystic fibrosis and cartilage damage has not been noted. Anthrax is the only approved use for quinolones in children.
Interactions

As a class, there are many considerations about what else is consumed while the patient is on quinolones. Side effects can be made worse when quinolones are combined with: caffeine, non-steroidal anti-inflammatory drugs and theophylline.

Sometimes these medications do not work. This can happen when the drug is taken with calcium, magnesium, iron or zinc. If patients take any of these substances make sure the antibiotic is taken 2 hours before ingesting these substances or 8 hours afterwards.

Calcium and magnesium are found in many foods but are often found in antacids and are in some anti-diarrhea medications. Iron is found in supplements used by those with anemia. Zinc may be found in vitamin supplements or even some homeopathic cold remedies (levels are probably too low in homeopathic cold remedies to have a significant effect).

Other drugs that may interact with quinolones include: probenecid, cimetidine, warfarin, some seizure drugs and some immunosuppressant drugs (cyclosporine).

Resistance

Resistance is becoming a larger problem with quinolones. The use of quinolones significantly increases the risk of a future infection with a bacterium that is resistant to quinolones. Resistance has been noticed to strains of *streptococcus*, *staphylococcus* and *gonorrhea*.

Quinolones are very potent medications and should be used only in those who are seriously ill. The overuse of these drugs is a major contributor to antibiotic resistance.
Ciprofloxacin (Cipro) is the most popular second-generation quinolone. It is commonly used for urinary tract infections (UTIs), prostate infections, some respiratory tract infections such as some cases of acute bacterial sinusitis. Ciprofloxacin (Cipro) has good gram-negative coverage and some gram-positive coverage. Generally, quinolones are more expensive which can limit their use, but ciprofloxacin is available in generic form and it is inexpensive. It is dosed between 250-750 mg every 12 hours.

Norfloxacin (Noroxin) is another second-generation quinolone that is used for UTIs, prostate infections and some sexually transmitted diseases. It should be taken on an empty stomach and is given 400 mg every 12 hours.

Levofloxacin (Levaquin) is a popular third-generation quinolone. It is used for pneumonia, bacterial sinus infections, acute exacerbation of chronic bronchitis, urinary tract infections, pyelonephritis, prostatitis and skin infections. It is dosed between 250 and 750 mg once a day.

Moxifloxacin (Avelox) can be used for community acquired pneumonia, acute exacerbation of chronic bronchitis, bacterial sinus infections, skin infections and abdominal infections. It is dosed 400 mg once a day and is used for 5-21 days depending on the type of infection.

Gemifloxacin (Factive) is a third-generation quinolone that is dosed 320 mg once a day. It is used for five days in bronchitis and 5 to 7 days in pneumonia.

Tetracyclines
Tetracyclines, which have been around since the late 1940’s, treat a wide range of bacterial infections. Increased bacterial resistance has been noticed with this antibiotic and they are less effective. There are three main types of tetracycline antibiotics: tetracycline, doxycycline and minocycline.

**What do they treat?**

Tetracyclines cover many types of infections, but for many of the infections they are not first line agents. Some infections that they are used for in the primary care setting include: bronchitis, community acquired pneumonia, acne, acute otitis media, bacterial sinus infections, some sexually transmitted diseases and Lyme disease.

In addition to the above disease states they cover a variety of other rare infections such as: the plague, anthrax, tularemia and Rocky Mountain spotted fever.

**Common side effects**

As a class, these drugs can discolor teeth in young children and therefore the drug should not be used in children, pregnant or breastfeeding women.

Tetracyclines should be used with caution in those with liver impairment and may worsen renal failure (more common with tetracycline). They may intensify muscle weakness in myasthenia gravis and exacerbate systemic lupus erythematosus. Common side effects include: photosensitivity, teeth discoloration, nausea, diarrhea and rash. Uncommon side effects include: joint pain, dizziness, headaches, vision changes and gum disease.
Interactions

Antacids and milk-products reduce the absorption of tetracycline. Tetracyclines may reduce the effectiveness of oral contraceptives, even more than other antibiotics, but this is a question of debate. It is recommended that if you use antibiotics (especially tetracycline) that you use a back method of contraception, unless you are trying to conceive.

Other drugs that may have an interaction with tetracycline include:

- Penicillin – Penicillin will not work well when both are combined
- Blood thinners (warfarin) – The combination of these two medications increase the risk of bleeding

The individual drugs

Tetracyclines

Tetracycline is taken between one and four times a day. It is given in the oral form only. While it can be used for many different types of infections, other drugs in this class are often chosen instead.

Doxycycline

Doxycycline is usually given 1-2 times a day. It is safe to take in those with chronic renal disease as opposed to tetracycline, which is excreted through the kidney and requires dosage adjustment. Doryx is an enteric-coated form of doxycycline and it is expensive.
Minocycline

Minocycline gets into the body tissues well. This drug has some troublesome side effects including dizziness, a permanent blue/black discoloration of the skin (that may be permanent) and tooth discoloration.

Sulfa Drugs

Sulfa drugs were the first antibacterial agent brought to market in the mid 1930's; it was around for World War II and helped save many lives during war time. It was able to treat a wide range of bacterial infections when taken orally.

Today, sulfamethoxazole – sometimes combined with trimethoprim in a product called Bactrim – is a common drug used in the management of common problems in the outpatient setting.

What do they treat?

Sulfa drugs treat many infections including:

- Urinary tract infections
- Some respiratory tract infections: acute otitis media, bacterial sinus infections
- Skin infections caused by methicillin resistant *Staphylococcus Aureus (MRSA)*
- Acne
- Some gastrointestinal infections – Salmonella
- Pneumocystis pneumonia (PCP), which is common in patients with HIV/AIDS
Common side effects

Sulfa drugs are commonly associated with side effects as well as allergic reactions. Those with HIV have a higher prevalence of adverse reactions. Common side effects include: rash, nausea, vomiting, headache, photosensitivity, dizziness and diarrhea. Less common side effects include: Stevens-Johnson Syndrome, hives, toxic epidermal necrolysis, hepatitis, blood dyscrasias, hemolysis, depression and ataxia.

Those who are on this drug for long periods of time should have their blood counts monitored to watch for any blood disorders. Kidney function should also be monitored in those who are on sulfa medications for extended periods of time.

Sulfamethoxazole-Trimethoprim (Bactrim, Septra) is used in the treatment of bladder infections. It is dosed twice a day and can be given for three days in uncomplicated infections.

The most common bacterium that causes bladder infections is *Escherichia coli* (*E. coli*). Some communities are seeing a large increase in *E. coli* resistance and therefore Sulfamethoxazole-Trimethoprim is sometimes not used in the management of bladder infections.

Risk factors for resistance to Sulfamethoxazole-Trimethoprim include: those who are currently on an antibiotic when diagnosed with a bladder infection, on Sulfamethoxazole-Trimethoprim within the last three months, those who have traveled to Mexico and recent hospitalization.

Because of this resistance to sulfa drugs, quinolones are becoming a more popular choice for the treatment of urinary tract infections.
Nitrofurantoin

Nitrofurantoin is a drug that is only useful for urinary tract infections as it covers most bacterium (including *E. Coli*) that cause urinary tract infections.

This antibiotic does not cover common bacterium that cause urinary tract infections in men and some older women. It is therefore recommended to be used only for uncomplicated urinary tract infections in young women.

It should not be used in those who have renal dysfunction, are anuric or have a G6P deficiency. It has not been studied thoroughly in pregnancy and should be used with caution in pregnant women.

The extended release form is typically dosed 100 mg taken twice a day for 7 days. The standard form is dosed four times a day in the treatment of urinary tract infections.

Nitrofurantoin (Macrodantin and Macrobid) has no significant serum level and has been used extensively in the management of urinary tract infections. It does require 7 days to treat uncomplicated urinary tract infections. This is opposed to many of the other antibiotics used in the treatment of uncomplicated urinary tract infections which require a three-day course.

Common side effects include: headache, dizziness and nausea. Long-term use may lead to pulmonary fibrosis or blood dyscrasias. Therefore, monitoring kidney and lung function is critical in those who use this drug long-term. It is used long-term in the
suppression of recurrent urinary tract infections. Other less common serious side effects include: liver disease, optic nerve damage and peripheral neuropathy.

**Metronidazole**

Metronidazole (Flagyl) - a drug that is given orally, intravenously, topically or intra vaginally - covers anaerobic bacteria. Anaerobic infections are unique infections that commonly cause problems in the gastrointestinal tract, mouth or genitourinary tract. This medication also provides some anti/protozoal activity. It is used for: bacterial vaginosis, diarrhea secondary to *Clostridium difficile* or *giardia lamblia*, pelvic inflammatory disease (with other antibiotics such as quinolones), intra-abdominal abscess, peritonitis, diabetic foot ulcer, brain abscess, acne rosacea, trichomonas vaginalis, *Helicobacter pylori*, acute gingivitis/dental abscess, lung abscess or aspiration pneumonia.

Common side effects include: metallic taste in the mouth, nausea and diarrhea.

Uncommon side effects include: fever, itching, seizure, rash, dizziness, headache, vomiting, numbness and tongue inflammation. Long-term use of metronidazole may cause: leukopenia, neuropathy and black hairy tongue.

Topical therapy is associated with skin irritation, erythema, xerosis and watery eyes.

Taking the antibiotic with alcohol is contraindicated. It can cause a severe reaction that presents with nausea, vomiting, tachycardia, flushing of the skin and shortness of breath. No alcohol should be drunk while the patient is on the antibiotic and for at least two days afterwards.
**Clindamycin**

Oral clindamycin is available as a generic and under multiple trade names, including: Cleocin and Evoclin. It is also available in topical form and combined with benzoyl peroxide in products such as Duac and BenzaClin.

It is used for infections caused by streptococci, staphylococci and pneumococci. It is not used as a first-line medication most of the time because it is associated with multiple adverse effects. It is often reserved for those with multiple antibiotic allergies. Clindamycin treats infections with anaerobic bacteria which may cause peritonitis, intra abdominal abscesses and some pelvic infections.

Common reasons it is used include:

- Acne (particularly in topical form)
- Cellulitis
- Bacterial vaginosis during early pregnancy – treatment with Clindamycin reduces risk of premature births
- Some respiratory tract infections
- Pelvic inflammatory disease
- Bone and joint infections
- Peritonitis
- Serious infections such as toxic shock often in combination with vancomycin

**Side effects**

A serious side effect is *Clostridium difficile*-associated diarrhea. While any antibiotic can lead to this infection, it is very common with clindamycin. The incidence of
*Clostridium difficile*-associated diarrhea is one of the main reasons that this drug is not used often for infections.

Other common side effects include: rash, nausea, vomiting abdominal pain and cramps and metallic taste in the mouth. Rare side effects include: hepatotoxicity, arthritis, blood dyscrasias and renal dysfunction.

**Topical Antibiotics**

This section will address three classes of antibiotics: skin applied antibiotics, antibiotics in the ear and antibiotics in the eye.

**Skin applied antibiotics**

There are three major over the counter antibiotics for the skin: Neosporin, Bacitracin and Polysporin. Over the counter topical antibiotics decrease the risk of skin infection in a minor wound, but are not used to treat established skin infections.

Neosporin is a triple antibiotic that contains neomycin, bacitracin and polymyxin. This topical medication comes in an ointment and cream form. It is the broadest of the topical antibiotics as it contains three antibiotics. Neomycin is associated with significant allergic potential as it may make the skin red and painful and it may be more harmful than helpful in many people. On the positive side, the addition of neomycin provides coverage against bacteria that are not covered by the other topical medications.
Bacitracin contains only one antibiotic – bacitracin. Bacitracin provides some protection against staphylococcal and streptococcal infections. Its coverage is not as broad as Neosporin, but is associated with less allergic potential.

Polysporin contains two antibiotics – bacitracin and polymyxin.

Bactine is an over the counter product that contains benzalkonium (antiseptic) and lidocaine (pain reliever). It is used for the prevention of bacterial infection and a reduction in discomfort associated with cuts and scrapes.

Antiseptic agents are different than antibacterial agents. Antiseptic agents reduce the growth or microorganisms. They do not target a specific agent and can work on a variety of different agents including viruses, bacteria and protozoa. There is also less chance for drug resistant bacteria to develop to antiseptics.

On the down side there is some concern that antiseptics can damage healthy cells and inhibiting wound healing. Most antiseptics have not demonstrated this negative effect in humans.

Hydrogen peroxide can be used, but is not recommended for the use of minor wounds. It is an antiseptic agent that can kill microorganisms but has the potential to harm healthy tissue. Of all antiseptics, hydrogen peroxide demonstrates the least effectiveness in the management of reducing bacterial counts.

Limited studies compare antiseptic agents to antibacterial agents in the management of minor cuts and wounds. Bacitracin or Bacitracin/Polysporin should be used in the management of minor wounds. This does not mean that Neosporin (unless you are
sensitive/allergic to it) or the use of antiseptics is inappropriate, but more research is needed before a definitive answer can be given.

Mupirocin (Bactroban) is a topical prescription antibiotic. It treats impetigo due to *staphylococcus aureus or streptococcus pyogenes* as well as eradication of nasal colonization of methicillin resistant *staphylococcus aureus*.

Individuals who are colonized with MRSA often use a nasal preparation of this antibiotic to eliminate it from their system. This is especially important before going in for elective surgery.

Retapamulin (Altabax) is a newer topical ointment used in the treatment of impetigo caused by *staphylococcus aureus and streptococcus pyogenes*. Its major side effect is application site irritation.

**Eye antibiotics**

Many options are available in the management of bacterial infections in the eye. While some prescribers are using quinolones (which have the lowest level of resistance) (see Table 2) as a first line treatment, other less expensive options are similarly effective. Moxifloxacin has a low level of resistance and good coverage against organisms responsible for conjunctivitis. Other quinolone antibiotic eye drops, such as gatifloxacin (Zymar), are dosed very frequently (one drop every two hours for 48 hours and then four times a day) and compliance becomes an issue.

Sodium sulfacetamide (Bleph-10) covers most causes of eye infections. It covers *Streptococcus pneumoniae*, group A *Streptococcus pyogenes* and *Haemophilus influenzae*.
Gentamicin (Genoptic) covers most causes of bacterial conjunctivitis such as
*Staphylococcus aureus, group A streptococci, Haemophilus influenzae, S. pneumoniae and pseudomonads.*

Quinolones (applied in the eye) can be used in children as young as one. Little gets into the blood stream and systemic effects are minimal and not a concern. There is less concern for resistance to develop with the use of later generation topical antibiotic than with oral antibiotics.

Azithromycin is a newer medication used to treat bacterial conjunctivitis. It has an improved dosing schedule, which may help improve compliance. It has been shown to be similarly efficacious to tobramycin.

Older antibiotics such as sulfacetamide based products and Gentamicin have a tendency to burn and sting.

Most antibiotics for bacterial eye infections are used for 5-7 days. See table two for a listing of antibiotics used in the treatment of bacterial eye infections.

### Table 2: Antibiotics for Bacterial Eye Infections

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Dosing</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erythromycin (Ilotycin)</td>
<td>Ointment: four times a day for 7 days</td>
<td>Does not cover all infections, some resistance</td>
</tr>
<tr>
<td>Sulfacetamide (Bleph-10)</td>
<td>Solution: 1-3 drops every 2-3 hours for 7 days</td>
<td>Stings, bacterial resistance</td>
</tr>
<tr>
<td></td>
<td>Ointment: four times a day for 7 days</td>
<td></td>
</tr>
<tr>
<td>Antibiotic</td>
<td>Formulations</td>
<td>Comments</td>
</tr>
<tr>
<td>-------------------------</td>
<td>------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>Solution: 1-2 drops four times a day for 7 days Ointment: four times a day for 7 days</td>
<td>Does not cover all infections with limited activity against gram-positive infections, tends to sting</td>
</tr>
<tr>
<td>Tobramycin (Tobrex)</td>
<td>Solution 1-2 drops four times a day for 7 days Ointment: four times a day for 7 days</td>
<td>Does not cover all infections with limited activity against gram-positive infections</td>
</tr>
<tr>
<td>Trimethoprim/polymyxin B (Polytrim)</td>
<td>Solution: four times a day for 7 days Ointment: Four times a day for 7 days</td>
<td>Slow onset of action, some resistance</td>
</tr>
<tr>
<td>Ciprofloxacin/Ofloxacin (Ciloxan/Ocuflox)</td>
<td>Solution: 1-2 drops four times a day for 7 days</td>
<td>Slow onset of action</td>
</tr>
<tr>
<td>Azithromycin (Azasite)</td>
<td>Solution: 1 drop twice a day for two days, than one drop once a day for five days</td>
<td>Newer medication</td>
</tr>
<tr>
<td>Gatifloxacin (Zymar)</td>
<td>Solution: 1 drop every 2 hours for 48 hours than four times a day for 5 days</td>
<td>Expensive</td>
</tr>
<tr>
<td>Moxifloxacin (Vigamox)</td>
<td>Solution: 1 drop three times a day for 5-7 days</td>
<td>Expensive</td>
</tr>
</tbody>
</table>

**Topical ear antibiotics**

Topical ear antibiotics are used for infections of the ear canal. The most common infection that uses topical ear antibiotics is otitis externa or swimmers ear.
For mild cases 2% acetic acid is a possible first-line choice. It may cause the ear canal to burn and irritate the skin and is therefore rarely used. The addition of a steroid to acetic acid is accomplished in the product acetic acid/propylene glycol/hydrocortisone (VoSol HC).

Hydrocortisone/polymyxin/neomycin is more commonly used in the treatment of swimmers ear. Hydrocortisone/polymyxin/neomycin should not be used if there is a tear in the ear drum as it can impair hearing. Neomycin is irritating to the skin in a number of people who use this preparation.

More expensive options include quinolone antibiotics with or without steroids. Ofloxacin is dosed 10 drops two times a day for adults and 5 drops two times a day for kids for 7 days. Ciprofloxacin/hydrocortisone (Cipro HC otic) is dosed 3 drops twice a day for those over the age of one. Ciprofloxacin/dexamethasone (Ciprodex Otic) is dosed 4 drops twice a day for those over the age of 6 months.

Ciprofloxacin/dexamethasone is indicated for patients with ear tubes and may be used if there is a tear in the ear drum.

Improvement should be noted in 2-3 days. Resolution should occur in 7-10 days. If there is no improvement noted a follow up appointment should be encouraged for a re-evaluation. Sometimes preservatives in topical medications can incite local irritation leading to an unresolved infection. Other times fungal infection is present – which do not respond to antibacterial medications.

When the ear is swollen it may not be possible to deliver drops into the lower part of the ear. In this case the use of an ear wick will allow delivery of medication into the ear
canal. The health care provider will place a small piece of cotton into the ear that will allow ear drops to penetrate into the lower ear canal.

Before putting the drops in the ear they should be warmed. The patient should lie on his or her side with the affected ear up. The drops should ideally be placed by another person and the flap of skin covering the ear canal – called the tragus – should be pushed a couple of times after the drops are inserted. The person should lie on the side for 5-10 minutes to assure adequate penetration of the medication.

<table>
<thead>
<tr>
<th>Medication</th>
<th>Dose</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bacterial infection</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acetic acid/propylene glycol/hydrocortisone (VoSol HC)</td>
<td>5 drops three to four times a day for adults and 2-3 drops 3-4 times a day for kids</td>
<td>Can be irritating to the ear</td>
</tr>
<tr>
<td>Hydrocortisone/polymyxin/neomycin</td>
<td>4 drops for adults and 3 drops for pediatric patients 3-4 times a day</td>
<td>Should not be used if there is a tear in the ear drum. Neomycin is irritating to the skin.</td>
</tr>
<tr>
<td>Ofloxacin (Floxin otic)</td>
<td>10 drops twice a day for adults and 5 drops twice a day for those between 6 months to 13-years-old for 7 days.</td>
<td>This is an antibiotic ear drop that does not have a steroid; can be used in those with ear tubes</td>
</tr>
<tr>
<td>Ciprofloxacin/hydrocortisone (Cipro HC otic)</td>
<td>3 drops twice a day for those over the age of one</td>
<td>Should not be used if there is a tear in the ear drum.</td>
</tr>
<tr>
<td>Ciprofloxacin/dexamethasone (Ciprodex Otic)</td>
<td>4 drops twice a day for those over the age of 6 months.</td>
<td>OK to use in those with ear tubes or a tear in the ear drum.</td>
</tr>
</tbody>
</table>
Summary

Antibiotics are powerful weapons in the fight against infectious disease. Unfortunately, they are overused and this overuse may eventually result increased antibiotic resistance.

Nurses need to have a basic understanding when antibiotics are needed and when they are not. Many factors need to be considered when an antibiotic is prescribed, but this chart will help the reader understand antibiotics that are appropriate in the management of common diseases.
## Antibiotic Chart

<table>
<thead>
<tr>
<th>Generic name</th>
<th>antibiotic name</th>
<th>Brand name</th>
<th>Side effects</th>
<th>Common uses in the outpatient setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penicillin</td>
<td>Penicillin V</td>
<td>Veetids</td>
<td>GI upset, nausea, vomiting, diarrhea</td>
<td>Strep throat</td>
</tr>
<tr>
<td>Penicillin Potassium</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amoxicillin</td>
<td>Trimox, Amoxil</td>
<td></td>
<td>GI upset, nausea, vomiting, diarrhea</td>
<td>Strep throat, sinus infections, bronchitis, otitis media</td>
</tr>
<tr>
<td>Amoxicillin – clavulanic acid</td>
<td>Augmentin</td>
<td></td>
<td>Diarrhea, GI upset, abdominal pain, rash, vomiting</td>
<td>Sinus infections, pneumonia, some bronchitis, cellulitis, otitis media, strep throat</td>
</tr>
<tr>
<td>Cephalosporins</td>
<td>First Generation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cephalaxin</td>
<td>Keflex</td>
<td></td>
<td>GI upset, nausea, diarrhea</td>
<td>Cellulitis, strep throat, some respiratory infections</td>
</tr>
<tr>
<td>Cefadroxil</td>
<td>Duricef</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cefaclor</td>
<td>Cefclor</td>
<td></td>
<td>GI upset, nausea, diarrhea</td>
<td>Respiratory infections, sinus infections, otitis media, cellulitis, bronchitis</td>
</tr>
<tr>
<td>Loracarbef</td>
<td>Lorabid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ceprozil</td>
<td>Cefzil</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cefuroxime</td>
<td>Ceflin</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ceftriaxone - Injection</td>
<td>Rocephin</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quinolones</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>Cipro</td>
<td></td>
<td>GI upset, headache, rash, dizziness</td>
<td>Urinary tract infections, some respiratory infections</td>
</tr>
<tr>
<td>Levofloxacin</td>
<td>Levaquin</td>
<td></td>
<td>Abdominal pain, drowsiness, nausea, vomiting, diarrhea, constipation, lightheaded</td>
<td>Urinary tract infections, sinus infections, pneumonia, some bronchitis, cellulitis</td>
</tr>
<tr>
<td>Moxifloxacin</td>
<td>Avelox</td>
<td></td>
<td>Nausea, diarrhea, headache vomiting, dizziness</td>
<td>Sinus infections, pneumonia, some bronchitis, cellulitis</td>
</tr>
<tr>
<td>Generic antibiotic name</td>
<td>Brand name</td>
<td>Side effects</td>
<td>Common uses in the outpatient setting</td>
<td></td>
</tr>
<tr>
<td>-------------------------</td>
<td>------------</td>
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<td>----------------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>Macrolides</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Erythromycin</td>
<td>Ery-tab, Eryped</td>
<td>GI upset, nausea, diarrhea</td>
<td>Strep throat, respiratory tract infections</td>
<td></td>
</tr>
<tr>
<td>Azithromycin</td>
<td>Zithromax</td>
<td>Nausea, rash, abdominal pain</td>
<td>Some pneumonias, bronchitis, otitis media, throat or tonsil infections</td>
<td></td>
</tr>
<tr>
<td>Clarithromycin</td>
<td>Biaxin</td>
<td>Nausea, abnormal taste, rash, headache, metallic taste</td>
<td>Some pneumonias, bronchitis, sinusitis, throat or tonsil infections</td>
<td></td>
</tr>
<tr>
<td><strong>Sulfa medications</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trimethoprim-sulfamethoxazole</td>
<td>Bactrim, Septra</td>
<td>Allergic reactions, rash, loss of appetite, diarrhea, nausea, itching, headache, vomiting, dizziness</td>
<td>Otitis media, urinary tract infections, chronic bronchitis with bacterial exacerbations</td>
<td></td>
</tr>
<tr>
<td><strong>Tetracycline</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tetracycline</td>
<td>Sumycin</td>
<td>Nausea, sensitivity to sun, rash, tooth discoloration</td>
<td>Some respiratory infections, acne</td>
<td></td>
</tr>
<tr>
<td>Doxycycline</td>
<td>Doryx, Monodox</td>
<td>Nausea, sensitivity to sun, rash, tooth discoloration</td>
<td>Some respiratory infections, acne</td>
<td></td>
</tr>
<tr>
<td>Minocycline</td>
<td>Minocin</td>
<td>Nausea, rash, tooth discoloration, dizziness, a permanent blue/black discoloration of the skin</td>
<td>Some respiratory infections, acne</td>
<td></td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clindamycin</td>
<td>Cleocin</td>
<td>Diarrhea, nausea, rash, jaundice, renal dysfunction</td>
<td>Infections of the respiratory tract and skin when other antibiotic are not able to be used</td>
<td></td>
</tr>
<tr>
<td>Metronidazole</td>
<td>Flagyl</td>
<td>GI upset, metallic taste, headache, seizure, reduced appetite, constipation</td>
<td>Some respiratory infections, some gastrointestinal infections</td>
<td></td>
</tr>
<tr>
<td>Nitrofurantoin</td>
<td>Macrobid</td>
<td>Nausea, dizziness, headache</td>
<td>Urinary tract infections</td>
<td></td>
</tr>
</tbody>
</table>
References


