TedEd-02

The Dangers of Mixing Drugs

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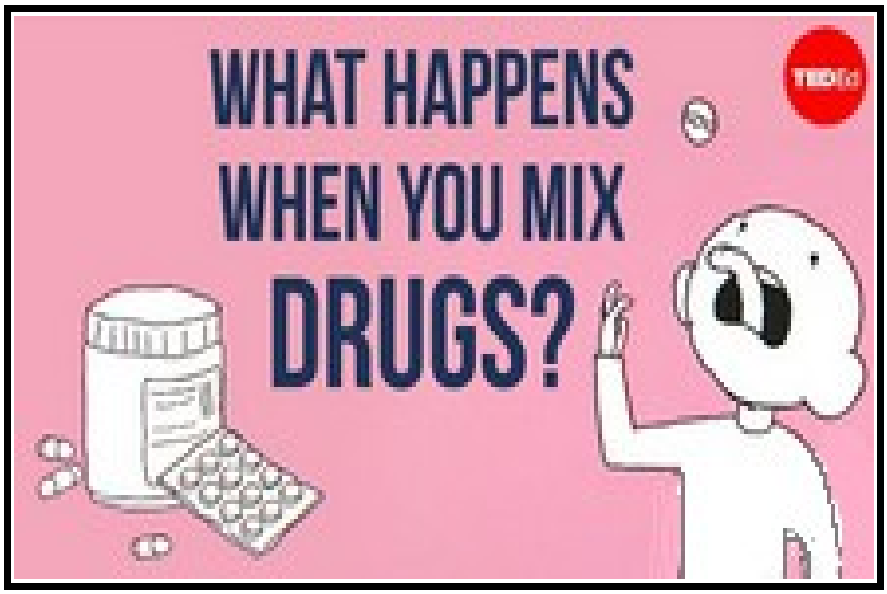

Which of these three people is doing something risky? Is it the one who takes their cholesterol medication with grapefruit juice? The one who takes Acetaminophen pain relievers for a sore ankle before going out for drinks? Or the one who's on a blood-thinning medication and takes an aspirin for a headache? Actually, all of them are. Each has inadvertently created a drug interaction that could, in extreme cases, lead to kidney failure; liver damage; or internal bleeding.

Drug interactions happen when a combination of a drug with another substance causes different effects than either would individually. Foods, herbal supplements, legal drugs, and illicit substances can all cause drug interactions. Most drug interactions fall into two categories. Some take place when two substances' effects influence each other directly. In other cases, one substance effects how the body processes another, like how it is absorbed, metabolized, or transported around the body. Blood thinners and aspirin, for example, have similar effects that become dangerous when combined. Both prevent blood clots from forming — blood thinners by preventing the formation of

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the clotting factors that hold clots together, and aspirin by preventing blood cells from clumping into groups that become clots. Individually, these effects are usually safe, but taken together, they can prevent blood clotting to a dangerous extent, possibly causing internal bleeding. While blood thinners and aspirin are generally harmless when taken individually, interactions where one substance exacerbates the effects of another can also take place between drugs that are independently harmful. Cocaine and heroin are each dangerous, and those dangers compound when the two drugs are combined — even though their behavioral effects may feel like they cancel each other out. Cocaine is a stimulant, and many of its effects, like increased heart rate, cause the body to need more oxygen. But heroin, a depressant, slows breathing — reducing the body's oxygen supply just when it needs more. This combination strains the organs and can cause respiratory failure and death.

The interaction between grapefruit juice and certain medications in class of cholesterol-lowering drugs called statins, has to do with drug metabolism. The liver produces enzymes, molecules that facilitate the breakdown of substances that enter the body. Enzymes can both activate drugs, by breaking them down into their therapeutic ingredients from more complex molecules and deactivate them, by breaking harmful compounds down into harmless metabolites. There are many, many different enzymes, each of which has a binding site that fits a specific molecule. Grapefruit binds to the same enzyme as statins making less of that enzyme available to break down statins. So combining the two means that a greater concentration of the drug stays in the bloodstream for a longer period of time, potentially causing kidney failure. Alcohol can also alter the function of the enzyme that breaks down Acetaminophen, the active ingredient in pain relievers like Tylenol and paracetamol. When someone takes Acetaminophen, some of it is converted into a toxic substance. At the recommended dose, there isn't usually enough of this toxic byproduct to cause harm. But heavy drinking can alter enzyme activity so more of that byproduct is produced. Potentially causing

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liver damage even with what's usually a safe dose of acetaminophen.

Meanwhile, the herbal remedy Saint John's Wort increases the liver's production of a particular enzyme. That means the drugs this enzyme is responsible for breaking down get metabolized faster — sometimes too fast, before they can have their therapeutic effects. In spite of the dizzying number of possible interactions, most of the dangerous interactions with commonly used drugs are well known. And new developments in science are helping us keep better track of drug interactions than ever. Some researchers are developing AI programs that can predict the side effects of drug interactions before they occur, using information about the landscape of protein interactions within your body. For the new drugs that are being developed all the time, supercomputers are being used to find potential interactions while those drugs are still in development.