

Seeds of Doubt

by Bruce Goldfarb

In October 1994, Shelia P., R.N., received disturbing news after applying for a nursing position at a Baltimore hospital. She was turned down for the job — not for lack of education or experience, but because a urine drug test revealed substances that are the metabolic products of heroin.

"I almost dropped the phone," recalls the 34-year-old pediatric nurse practitioner. "I said, 'There must be some mistake. I don't use drugs.'"

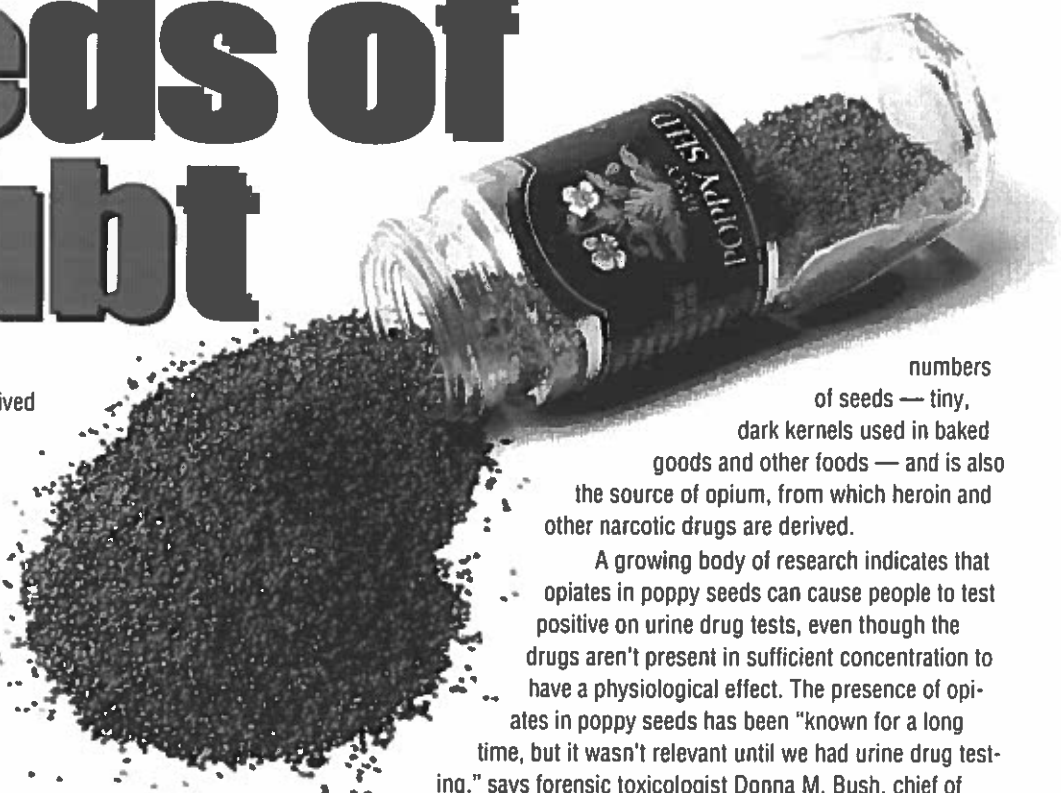
Addict. Junkie. The mere idea is abhorrent to Shelia, who denies ever using illicit drugs. Being labeled a heroin user could be personally and professionally damaging. Could this get back to the state nursing board and ruin her reputation? Would it threaten a nearly completed adoption?

Shelia did not use drugs, and yet her own physiology had somehow betrayed her. Two different chemical tests said that the products of heroin were in her urine.

Angry and confused, Shelia consulted with her husband, also a nurse, and her brother, who is a doctoral student in pharmacology. She researched in the medical library and consulted with experts in drug abuse. Ultimately, Shelia identified the likely cause of the positive drug test: a lean corned beef and cheese sandwich on a poppy seed bagel, eaten the evening before giving the urine sample.

Blooming problems

Papaver somniferum, also known as the poppy, is an impressively tall plant with large, bright flowers. The poppy flower produces large



numbers of seeds — tiny, dark kernels used in baked goods and other foods — and is also the source of opium, from which heroin and other narcotic drugs are derived.

A growing body of research indicates that opiates in poppy seeds can cause people to test positive on urine drug tests, even though the drugs aren't present in sufficient concentration to have a physiological effect. The presence of opiates in poppy seeds has been "known for a long time, but it wasn't relevant until we had urine drug testing," says forensic toxicologist Donna M. Bush, chief of drug testing at the federal Substance Abuse and Mental Health Services Administration.

Aside from its culinary contribution, the poppy is prized as a source of illegal drugs. When scored with a knife, the bulb of the poppy flower exudes a thick, milky substance. The liquid turns into a tan, sticky material that is dried and powdered. This material, now called opium, contains several alkaloid compounds used as legal and illegal drugs, including morphine, codeine, and heroin.

Opiates are related to substances known as endorphins that naturally occur in the body. These drugs have been recognized for their pain-killing effects since the mid-19th century. When consumed, usually by injection or inhalation, opiates produce a feeling of euphoria and drowsiness. They are also highly addictive, forcing users to take increasingly larger doses to achieve the desired result.

Heroin is one of a limited number of drugs that cross the "blood-brain barrier" into the central nervous system. Morphine and heroin have similar chemical structures, except that heroin has two acetyl groups (Figure 1, page 6); the chemical name of heroin is diacetylmorphine.

"Heroin is very similar, but subtly different from morphine," explains Bush. "Morphine is much more water-soluble than heroin, which has the same ring backbone with two acetyl groups hooked on. Heroin is very fat-soluble, acts more centrally on the brain, and has a quicker onset."

As heroin is metabolized in the body, its products become more hydrophilic and less soluble in fat. These are eventually excreted by the body in the urine, which is mostly water. Enzymes in the bloodstream clip off one acetyl group, creating a fairly short-lived molecule called 6-monoacetylmorphine. When the other acetyl group is removed, the end product is morphine.



TABLE 1 Variation of opiates in poppy seeds by source.

Seed variety	Morphine (µg of compound per g of seeds)	Codeine (µg of compound per g of seeds)
Commercial, US	2	0.6
USDA, blue	19	4.5
Australian	106	3.8
Canned poppy seed filling	18	2.4

The drug-free workplace

In September of 1986, then-President Ronald Reagan signed an executive order — later ratified into law by Congress — declaring that as the nation's largest employer, the federal government would initiate a program of urine drug screening to eliminate drug use by employees.

The issue of drug use in the workplace was brought to a head on January 4, 1987, when a New York-bound Amtrak passenger train derailed, killing 16 people and injuring dozens of others. It was the deadliest mishap in Amtrak history. Public sentiment turned to outrage when it was learned that two members of the Amtrak crew were under the influence of marijuana at the time of the derailment. They allegedly smoked marijuana minutes before the disaster.

Drug use on the job not only contributes to accidents — and countless needless deaths and injuries — but also causes economic losses as well. Bush says that people who use drugs are less productive, tend to miss more work, and have higher health care costs than those who don't.

Random testing of employees and testing of job applicants were initiated for federal employees and the industries regulated by the Department of Transportation (such as aviation, railroads, trucking, etc.). Additionally, many private sector companies followed the government's lead and established workplace drug testing programs for their employees.

The standard drug test panel established by the Department of Health and Human Services looks for five commonly used substances:

- Tetrahydrocannabinol (THC), the active ingredient in marijuana;
- Cocaine;
- Phencyclidine (PCP), also known as "angel dust";
- Amphetamine and methamphetamine, or "speed";
- Opiates.

As a fluid in equilibrium with the brain, blood is the definitive source of samples to determine the presence of drugs. But drawing blood from large numbers of people would be expensive and intrusive, so urine samples are used instead.

An advantage of testing urine is that it provides a "longer window of exposure to illicit substances," says Bush. Some substances exist for only minutes in the bloodstream, but they

can be detected in urine for days or weeks as they are metabolized and excreted by the body.

"We don't need to know whether somebody is under the influence at that moment," Bush says. "We want to know whether they use illicit drugs."

Two analytical methods are used for drug testing. The first is the immunoassay, in which a purified sample of urine is exposed to antibodies for specific illicit substances. If the assay indicates the presence of drugs, the sample is considered "presumptive positive" and subjected to a second analysis by gas chromatography-mass spectrometry (GC-MS), which is more precise. GC-MS traces a "molecular fingerprint" of illicit substances in a sample. "There is your proof," says Bush.

But the

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PHOTOS: MIKE CIESIELSKI

Opiate metabolism

Heroin, codeine, and morphine are the three most prominent opiates derived from the flowering poppy plant, *Papaver somniferum*. All three can induce euphoria and can be addictive. Heroin, the most potent, is an illicit drug; the others have medical uses and can be prescribed by doctors. In the body, both heroin and codeine are changed, in two steps, into morphine.

Poppy seeds contain codeine and morphine; after eating food containing poppy seeds, a person's urine may test positive for these opiates.

process does not end there. The results are given to a medical review officer, a physician who evaluates the person and determines why the substances are present in the urine. For example, a person may have taken prescribed medication that caused the test to give a false-positive result.

This three-step process — immunoassay, GC-MS, and medical review — is the "gold standard" for urine drug screening programs, Bush says. "This has withstood every court challenge in the country," she adds. "But there is a lot of testing out there that is not the gold standard."

Although the test can identify opiates in the urine, it is sometimes impossible to determine whether a person ate a poppy seed bagel or injected heroin.

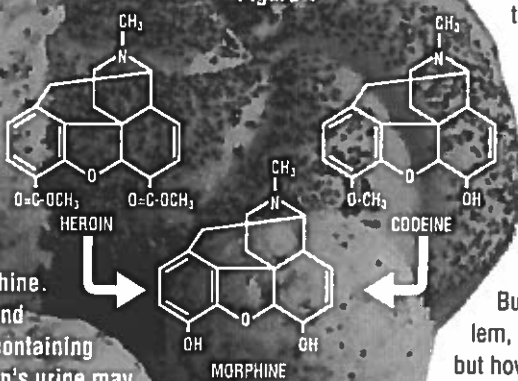
"It's not a perfect system, even with a medical review officer," Bush says. "It is possible [for poppy seeds] to dose the eater with enough opiate to be detectable in the urine, but not have a physiological effect. On the other hand, when faced with a drug test, some people will claim that they ate seven roast beef sandwiches or a pound of poppy seed streusel."

Bush says that the dose of opiate a person can receive is related to how much is contained in the poppy seeds and how much a person consumes. The opiate content of poppy seeds varies greatly depending on where the plant is grown. Commercially cultivated poppy plants grown in the United States have only traces of the drugs, whereas Australian poppies have relatively high levels (see Table 1, page 4).

It is not unusual for a portion of German-style poppy seed cake or some Asian curry dishes to contain 25 grams, or nearly an ounce, of seeds. Hamantaschen, a triangular Jewish pastry eaten during the Purim holiday, can contain an ounce or more of poppy seed filling. But few people routinely consume poppy seeds in that quantity. Most often, poppy seeds are sprinkled on bagels or hard rolls.

Scientific tests have been done with rolls, breads, cakes, muffins, and other poppy seed products. Studies show that consumption of as little as 2 to 3 grams of poppy seeds can cause a positive drug test. One or two bagels or muffins can do it.

Figure 1



"It is clear that ingestion of products containing even relatively small quantities of poppy seeds ... can lead to presumptive positive opiate urinalysis results," according to Carl M. Selavka, former head of the forensic toxicology drug testing laboratory at Tripler Army Medical Center in Hawaii.

Science and policy

As a laboratory result, a poppy seed-induced positive drug test is not considered to be inaccurate. "This is not an analytical false positive," Bush says. "Those chemicals are there." The problem, says Bush, is not the science behind drug testing, but how the technology is used and interpreted. Knowing a result is a question of science. Understanding what the result means is a matter of policy.

"If you don't understand the science, you can use that science to reach a wrong conclusion," she says. "The proper interpretation of any chemical or scientific result is essential for its application. This is true at DuPont with the manufacture of plastics, it's true at Kodak when they're making film, and it's true of us in urine testing."

Ultimately, Shelia did not get the hospital job. "They have a very cut-and-dried policy that is written in stone," she says. A hospital spokesperson confirms Shelia's version of the events and the fact that the hospital does not employ a person who flunks a urine drug test, no matter what the cause. "Our policy has no exceptions," the spokesperson says. However, the nurse will be allowed to reapply for employment after one year.

Shelia did land a job in a medical office, and there appears to be no further fallout from the drug test. Just before Christmas, Shelia and her husband adopted twin 18-month-old children from Russia. Her life is back on track.

But the blot of the drug test continues to haunt her. "It is hard to take emotionally," she says. "Somebody is questioning the very character of my being."

When urine tests are positive they always show more morphine than codeine. However, the ratio of morphine to codeine may help drug testers distinguish bagel lovers from drug abusers. Recent research conducted by the U.S. Army drug testing laboratory (second reference, below) indicates that, if the morphine/codeine ratio is less than 2, the opiates could not have come from eating poppy seeds but are the result of either abusing codeine or taking codeine for medical reasons.

Bruce Goldfarb is an award-winning science writer living in Baltimore, Maryland.

FOR FURTHER INFORMATION

"Poppy-seed Eaters May Flunk Morphine Test"; *Chemical and Engineering News* 1994, 72(32), 56.

Selavka, C. M. "Poppy Seed Ingestion as a Contributing Factor to Opiate-positive Urinalysis Results: The Pacific Perspective"; *Journal of Forensic Sciences* 1991, 36(3), 685.

"Under the Influence of Poppy Seeds"; *Tufts University Diet and Nutrition Letter* 1992, 10(3), 2.