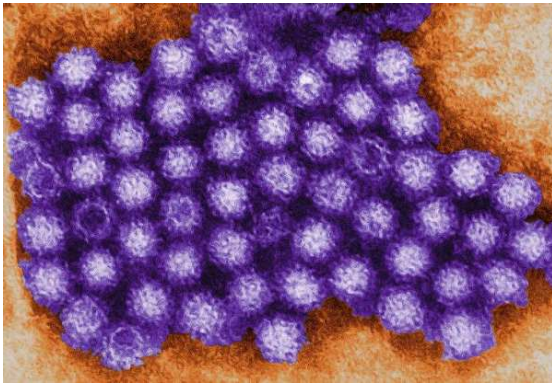


# SCIENTIFIC AMERICAN™

## Misery-Inducing Norovirus Can Survive for Months – Perhaps Years – In Drinking Water

By [Jennifer Frazer](#) | January 17, 2012



Purple packages of pain: false colored (no, they're not purple in real life) transmission electron micrograph of human norovirus. CDC/Charles D. Humphrey. CDC Public Health Image Library ID 10708, [click for link](#).

If there is a central circle of hell, I now know what's there: endless glasses of water spiked with norovirus that you must drink for eternity. Yet incredibly, some persons of Achilles-class bravery/stupidity actually signed up for this punishment of their own free will, and did so in the name of science. Brave souls, I salute you.

Because what these people helped discover is nothing short of spine-tingling: **norovirus can survive at least 61 days in well water**. Considering it takes **only the number of virus particles that you can count on two hands** to make you wish for death for about 24-48 hours, this is *not* good news. However, there is some good news, too, in the world of norovirus defense. More on that in a minute.

OK, so many of you are no doubt wondering: What the heck is norovirus?

### **A Pain in the Gut**

Norovirus is Norwalk Virus, named for the Ohio town which in 1968 was home to the virus's first identified outbreak and which no doubt do not include this information in its Chamber of Commerce literature. Often called "stomach flu" or "24-hour flu", this awful malady has no relation to influenza virus, but has gained a reputation no less sinister in recent years. It is the agent responsible for innumerable cruise-ship "gastroenteritis"

outbreaks and outbreaks at camps, state fairs, nursing homes, schools, and yes, even NBA locker rooms.

Anyone who's experienced it can tell you it's a bit like having **all of your intestines' pain receptors activated at once, with uncontrollable nausea and/or diarrhea added as a special bonus**. When I was in high school, every so often I'd experience twelve hours of intense pain along with nausea so powerful that I'd feel the urge to hurl even when nothing was left. This was followed by 12 hours of utter exhaustion. Then, I'd feel pretty much normal again and go right back to school, no doubt perpetuating the cycle since victims shed virus for several days after they recover. I'm pretty sure that it was norovirus.

I've never given birth, but if I ever do, it will be interesting to make the comparison. So far, the only other thing that's come close to the pain of norovirus infection is an unfortunate incident in which I was told that some people didn't need anaesthesia during their flexible sigmoidoscopy (aka colonoscopy lite) and I chose this option in a misguided money-saving move. Once they blew the air into my colon (I know, I know, TMI), it was like someone had flipped all the norovirus pain switches again. Needless to say, the next 5 minutes were among the longest of my life.

This virus is **responsible for about nine out of 10 "stomach flu" cases in the U.S.**, and is **probably responsible for about 50% of the cases of what people call "food poisoning"**. It takes **fewer than 10 virus particles to make you sick**, and the virus can be spread by sick people handling your food or water, or shaking your hand, or by you touching surfaces they've touched, or even by (I know, ewwww) aerosolization of their bodily fluids when they flush the toilet after a visit to the necessary room.

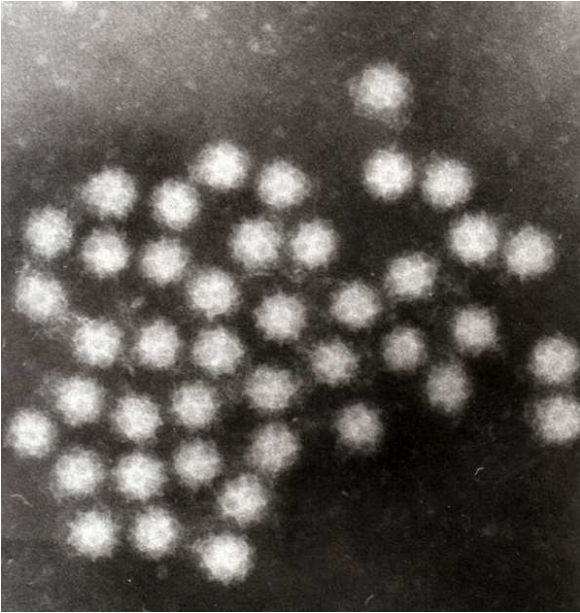
At one Boy Scout Jamboree in the Netherlands, scientists calculated each sick person infected 14 others before anything was done. After strict hygiene was imposed, each sick person infected a mere *two* others, which, the scientists soberly noted, was still not few enough to contain such an outbreak. In the NBA outbreak mentioned above, the CDC concluded there were at least two occasions on which norovirus was likely to have been transmitted to a new victim *during a game*.

## **A Simple Formula for Suffering**

Let's back up a bit and look at what viruses are in general, so you can understand what noroviruses in particular actually are. **Viruses are little packages of DNA or DNA's henchman RNA wrapped in a protein and/or fatty lipid coat**. The protein coat, if it exists, is referred to as a "capsid", and **individual virus particles are "virions"**. When present, lipid coats are more or less like our own cell membranes, and are often stolen from them by the virus.

Noroviruses are in the family Caliciviridae, whose members seem to specialize in making hits on terrestrial vertebrates — everything from frogs on up. Another calicivirus — Rabbit Hemorrhagic Disease Virus — has been used for bio-control in Australia and New Zealand, while other viruses in the family — like the beautiful hexagonal icosohedral

Sapovirus, below, cause other forms of gastroenteritis in people. Norovirus has a more or less amorphous spherical capsid. You can see this in the photo at the top, where a few viruses that happen to have been sliced in half during the preparation for microscopy reveal the cross section of the virus.



The ghostly, graceful icosahedrons of Sapporo Virus, also called Sapovirus, in the Calicivirus family. Creative Commons GrahamColm. Click image for source and license.

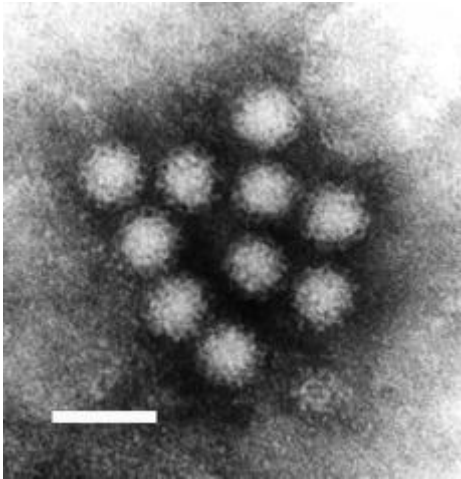
“Calicivirus”, which I *so* hope is pronounced “ka-leaky-virus” — not unlike the titular greeting in this totally unrelated but awesome ditty — name comes from **calyx, which means a cup or goblet**. The botanists in the room will recognize the term as the same one that refers collectively to the sepals of a flower, the sometimes, but not always, cup-shaped green leaves at the base of a flower. Some species apparently have a cup-shaped depression on their capsid surfaces.

**Caliciviruses contain one single piece of single-stranded RNA in a protein capsid with no lipid envelope. Norovirus is the same, and its RNA encodes a mere two proteins, both used in making the capsid.** It is utterly amazing to me that something so inconsequentially small and simple could cause such profound misery from such an efficient little package. If someone calculated a misery per base pair per person infected index, I think norovirus would be right at the top, considering **Ebola virus clocks in at just under 19,000 RNA base pairs and might cause a few hundred cases a year at most (thank god), while norovirus contains a mere 7,500 but infects 21 million, hospitalizes 70,000 and kills more than 500 people in the U.S. alone every year. In developing countries, the virus kills about 200,000 children under age five annually.** Not Cool, norovirus, Not Cool.

Unfortunately, norovirus also has a **high mutation rate even by RNA-virus standards.** The **further bad news here is that having no fatty-lipid membrane means that the virus isn't**

killed very well by alcohol or detergents (which break down fats), though bleach and old-fashioned handwashing supposedly work well (Oh, old-fashioned handwashing, is there anything you *can't* do?). This is not good news for those that rely on alcohol-based hand sanitizers and wipes (something to think about next time you blithely swipe an alcohol-based wipe across the handle of your grocery cart or rub your hands with hand sanitizer). Obviously, this is one insidious virus.

Which brings us to the findings of two new studies.



Norovirus. Bar=50 nm. F.P. Williams, U.S. EPA

### ***Viral Survivor***

Scientists wondered how long well water — from which about half the U.S. population draws its water — would support noroviruses. The viruses could and have gotten into such water through leaking septic tanks or sewer lines, and in fact, when I was a reporter in Wyoming, I covered just such a case at a remote kids' camp. The results of this study were jaw-dropping. The scientists spiked water from an Atlanta well with a known quantity of the virus. Then they had (the sado-masochistic?) volunteers drink this water on day one, 4, 14, 21, 27, and 61. Volunteers were sickened by the water on each of these days, including day 61.

They didn't have enough money to subject the poor people to "testing" longer than that. *But* they did store and test the water for viral RNA contained in intact capsids up to 1,266 days later. That's nearly 3 1/2 years after spiking the water. There was no change in RNA levels over a year later, and only a small reduction after 3 1/2. That is one tenacious virus.

Since most ground and well water in the U.S. isn't treated prior to drinking, the scientists suggested we might want to start doing that.

In lieu of that (this country *is* home to a hatred of government regulation neatly encapsulated in New Hampshire's motto "Live Free or Die"), scientists are working on

another approach: a vaccine. This is also important, as I've already mentioned, because a lot of people pick up the virus in other places, and seniors with weakened immune systems in long-term care facilities are particularly vulnerable.

As covered in *Science* late last year (original New England Journal of Medicine paper [here](#)), scientists have discovered that when one of the two viral proteins is produced by cultured cells, they spontaneously assemble (as they do in nature) into “virus-like particles” that contain no viral RNA payload and are thus non-infectious. But they *look* like norovirus from the outside ([check out the photo in the \*Science\* article](#)), and apparently look enough like it to our immune system that they can generate a partially-effective response.

Symptoms of norovirus infection appeared in just over two out of three of people exposed to both the virus and a placebo vaccine, but in only one in three of people given the real vaccine. Their symptoms were also less intense and took longer to develop. Well, it ain't perfect, but it's a good start. Porcelain-god worshipers everywhere will no doubt greet the news with the greatest relief.



**About the Author:** Jennifer Frazer is a [AAAS Science Journalism Award-winning](#) science writer who lives in Colorado. She has degrees in biology, plant pathology/mycology, and science writing, and has spent many happy hours studying life *in situ*.