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The science of soap – here's how it kills the coronavirus

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Alcohol-based disinfectants are also effective, but soap is a highly efficient way of killing the virus when it's on your skin

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'Soap dissolves the fat membrane of the virus – and the virus falls apart like a house of cards and dies.' Photograph: Flashpop/Getty Images

Viruses can be active outside the body for hours, even days. Disinfectants, liquids, wipes, gels and creams containing alcohol are all useful at getting rid of them – but they are not quite as good as normal soap.

When I shared the information above using Twitter, it went viral. I think I have

worked out why. Health authorities have been giving us two messages: once you have the virus there are no drugs that can kill it or help you get rid of it. But also, wash your hands to stop the virus spreading. This seems odd. You can't, even for a million dollars, get a drug for the coronavirus - but your grandmother's bar of soap kills the virus.

So why does soap work so well on the Sars-CoV-2, the coronavirus and indeed most viruses? The short story: because the virus is a self-assembled nanoparticle in which the weakest link is the lipid (fatty) bilayer. Soap dissolves the fat membrane and the virus falls apart like a house of cards and dies - or rather, we should say it becomes inactive as viruses aren't really alive.

The slightly longer story is that most viruses consist of three key building blocks: ribonucleic acid (RNA), proteins and lipids. A virus-infected cell makes lots of these building blocks, which then spontaneously self-assemble to form the virus. Critically, there are no strong covalent bonds holding these units together, which means you do not necessarily need harsh chemicals to split those units apart. When an infected cell dies, all these new viruses escape and go on to infect other cells. Some end up also in the airways of lungs.

When you cough, or especially when you sneeze, tiny droplets from the airways can fly up to 10 metres. The larger ones are thought to be the main coronavirus carriers and they can go at least two metres.

These tiny droplets end on surfaces and often dry out quickly. But the viruses remain active. Human skin is an ideal surface for a virus. It is "organic" and the proteins and fatty acids in the dead cells on the surface interact with the virus.

When you touch, say, a steel surface with a virus particle on it, it will stick to your skin and hence get transferred on to your hands. If you then touch your face, especially your eyes, nostrils or mouth, you can get infected. And it turns out that most people touch their face once every two to five minutes.

Washing the virus off with water alone might work. But water is not good at competing with the strong, glue-like interactions between the skin and the virus. Water isn't enough.

Soapy water is totally different. Soap contains fat-like substances known as amphiphiles, some of which are structurally very similar to the lipids in the virus membrane. The soap molecules "compete" with the lipids in the virus membrane. This is more or less how soap also removes normal dirt from the skin.

The soap not only loosens the "glue" between the virus and the skin but also the Velcro-like interactions that hold the proteins, lipids and RNA in the virus together.

Alcohol-based products, which pretty much includes all "disinfectant" products, contain a high-percentage alcohol solution (typically 60-80% ethanol) and kill viruses in a similar fashion. But soap is better because you only need a fairly small amount of soapy water, which, with rubbing, covers your entire hand easily. Whereas you need to literally soak the virus in ethanol for a brief moment, and wipes or rubbing a gel on the hands does not

guarantee that you soak every corner of the skin on your hands effectively enough.

So, soap is the best, but do please use alcohol-based sanitiser when soap is not handy or practical.

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