Hand disinfectant with activity against all viruses

Across the hospitals worldwide the same procedure can be seen to take place: the doctor or the nurse applies disinfectant (sanitizer) on their hand before examining the patient. In doing so, she or he inactivates bacteria, yeasts and many viruses on their hands. Many, but not all: some viruses are so resistant that they will survive the disinfection and continue to present a danger of infection.

The resistance of viruses can be explained by their structure. Viruses can be divided in two categories: enveloped (surrounded by a lipid membrane) and non-enveloped. Since the lipid membrane is easily disrupted by various disinfectants, enveloped viruses are generally easy to inactivate on hands or surfaces. Not so the non-enveloped viruses. These viruses are composed of genetic material (DNA or RNA) tightly packed with proteins into a dense particle. Disinfectants have hard time disrupting such compact structure and many non-enveloped viruses are highly resistant. Applying a common hand disinfectant, a 70% ethanol solution, for one minute will have no effect on non-enveloped poliovirus.

Polioviurs, Adenovirus and Polyomavirus. (The figure is based on images purchased on shutterstock.com)

The goal of this study was to identify skin-compatible additives that can enhance the activity of the 70% ethanol solution to such an extent that it could destroy all viruses, enveloped as well as non-enveloped.

The lookout for substances that may advance the antiviral activity of ethanol was largely trial and error. We got hints from the reports from 1930s and 40s that urea in very high concentration can disassemble the poliovirus particles. It turned out that the addition urea to ethanol had an enhancing effect; however urea alone was yet potent enough. It took more trial and error till the second component was identified: citric acid.

And indeed, a combination of ethanol, urea and citric acid had a strong inactivation effect on poliovirus: The addition 1% urea and 1.5% citric acid to the common 70% alcohol solution was enough to make it inactivate poliovirus in 1 minute.

But can a disinfectant that destroys poliovirus also be considered active against all other non-enveloped viruses? It is unfortunately not possible to answer this question by simply testing them all. Many viruses are outright too dangerous to experiment with and for many other the conditions for propagation in the laboratory for disinfectant testing are not yet known. Instead, a set of model viruses is defined that are believed to be the toughest to inactivate and the disinfectant that inactivates them all can be considered active against all viruses. Different countries have different sets of model viruses and test conditions, but the toughest criteria are set by the German Robert Koch Institute (RKI) for prevention of viral diseases. To pass their test, a disinfectant must kill not only poliovirus, but also polyomavirus, adenovirus and norovirus in the presence of protein load that mimics the presence of dirt on hands.

It turned out, that the 1% urea and 1.5% citric acid in ethanol did not sufficiently inactivate adenovirus and polyomavirus in RKI test, but after systematic examination we found a combination that did: 70% ethanol with 2% urea and 2% citric acid. Further tests confirmed that this formula can also inactivate norovirus, all enveloped viruses and in addition inactivate adenovirus, vaccinia virus and norovirus on surfaces.

Doctors and nurses thus have a new tool to protect them against viruses. With novel viral diseases emerging regularly, some attributed to hitherto unknown viruses, this is good news. Since urea and citric acid are naturally present in the human skin, the new disinfectant is also expected to be highly skin compatible, which is good since medical personnel disinfect their hands tens to hundred times per day.

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Publication

Development and virucidal activity of a novel alcohol-based hand disinfectant supplemented with urea and citric acid.
Ionidis G, Hübscher J, Jack T, Becker B, Bischoff B, Todt D, Hodasa V, Brill FH, Steinmann E, Steinmann J.
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