What is the best portable method of purifying water to prevent infectious disease?

**Evidence-based answer**

There isn’t a single best method, but there are 5 that adequately purify water according to Environmental Protection Agency (EPA) standards. These include: 1) boiling for 1 minute if below 2000 m (6562 feet) and 3 minutes if above, 2) chlorine dioxide tablets, 3) MIOX purifier, 4) ultraviolet light (SteriPEN), and 5) portable filtration with a absolute pore size <1 micrometer combined with halagation or charcoal filtration (strength of recommendation [SOR]: C, based on expert opinion and microbiological testing). Halagation alone (ie, chlorine and iodine) is not effective against Cryptosporidium (SOR: C, based on microbiological testing).

**Clinical commentary**

Why boil water when there are so many other options? These days, “boil it, peel it, or forget it” only goes so far with the unencumbered traveler. Experience tells me that most hear “Boil it” and instantly go right to “Forget it!” Fortunately, there is an excellent resource to assist patients in choosing a personally acceptable portable water purification system. It’s called the Water Purification Database at usachppm.apgea.army.mil/WPD/CompareDevices.aspx.

This outstanding database was developed by an impartial third-party for the US Army and gives clear, well-organized guidance on over 60 purifiers. For each purifier, the guide covers efficacy against primary pathogens, purification mechanism, links to manufacturers, and an advantages/disadvantages breakdown (such as weight, cost, and ease of use). Add this site to your Internet “favorites” folder.

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**Evidence summary**

With the rise in international travel and adventure sports, individuals are at increased risk of acquiring infections by drinking water from impure water sources. Common waterborne infections that back-country and international travelers may contract include bacterial diarrhea, viruses, protozoa (such as *Giardia* and *Cryptosporidium*), and parasites (such as schistosoma). The risk of infection varies based on travel location.

To prevent illness, travelers may seek medical guidance regarding safe water practice. In one study, 36% of travelers sought advice from a physician prior to international travel. Prevent-
ing waterborne infections should be a component of traveler education, in addition to other standard advice, such as mosquito avoidance and immunizations.3 (For more on travel safety, see these Clinical Inquiries: “When should travelers begin malaria prophylaxis?” in the November 2007 Journal of Family Practice, pages 950–952, and “What is the most effective and safe malaria prophylaxis during pregnancy?” on page 51 of this issue.)

**Which devices meet EPA standards?**
The EPA has established a “minimal microbiological hazard” allowed for a

<table>
<thead>
<tr>
<th>METHOD</th>
<th>EFFECTIVENESS</th>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boiling with cooling*</td>
<td>Kills viruses, bacteria, protozoa, and parasites</td>
<td>Simple, universally accepted, no special equipment required</td>
<td>Time-consuming, may require large amounts of fuel</td>
</tr>
<tr>
<td>Chlorine dioxide*</td>
<td>Kills bacteria, viruses, protozoa, and parasites</td>
<td>Same as chlorine/iodine treatment but also treats Cryptosporidium, good palatability</td>
<td>Must wait up to 4 hours to treat Cryptosporidium, costs more than iodine/chlorine ($13 for 30 tabs)</td>
</tr>
<tr>
<td>Chlorine/iodine</td>
<td>Kills bacteria, viruses, protozoa (not Cryptosporidium), and parasites</td>
<td>Inexpensive, easy, lightweight, treats large quantities</td>
<td>Does not kill Cryptosporidium, poor taste, must wait for water to be treated; contraindicated in pregnancy, thyroid disease; not recommended beyond few weeks of use</td>
</tr>
<tr>
<td>Filtration†</td>
<td>Removes parasites, Giardia, Cryptosporidium, and bacteria</td>
<td>Able to use water immediately, removes sediment, many have combination of activated carbon, chemical disinfectant, or both</td>
<td>Can potentially be expensive, filters may clog easily, heavy, not effective against small particle viruses, therefore should supplement with chlorine or iodine</td>
</tr>
<tr>
<td>MIOX Purifier*</td>
<td>Kills bacteria, viruses, protozoa, and parasites</td>
<td>Light (8 oz), sturdy, treats large quantities; requires camera batteries and salt</td>
<td>Cost $130, must wait for 4 hours and treat with higher strength to treat Cryptosporidium; requires 30 minutes to treat viruses, bacteria, and Giardia</td>
</tr>
<tr>
<td>UV light (SteriPEN)‡</td>
<td>Kills bacteria, viruses, protozoa, parasites in clear water</td>
<td>Light (8 oz), quick (treats 16 oz of water in 1 minute)</td>
<td>Cost $100, does not work in turbid conditions</td>
</tr>
</tbody>
</table>

* Meets EPA standards.
† Some filtration systems meet EPA standards. See chppm-www.apgea.army.mil/WPD/CompareDevices.aspx for testing results of individual filters. 
‡ Meets EPA standards in clear water.
portable water purification system to be considered safe. Water purifiers must reduce bacteria by 99.9999%, viruses by 99.99%, and protozoa (such as *Cryptosporidium parvum*) by 99.9% to receive an EPA certification number.4

There are no head-to-head trials comparing the effectiveness of different methods of purification to prevent infectious disease. The majority of the evidence is based on data provided by manufacturers to the EPA, with some independent studies and expert opinion (TABLE).

Expert opinion recommends bringing water to a rapid boil for at least 3 minutes and letting it cool as an effective means of water purification.5 Chlorine dioxide tablets, the MIOX purifier, and UV light (SteriPEN) have all met EPA standards for lower pathogen counts under ideal conditions. Halogenation does not reduce *Cryptosporidium* below the microbiological hazard of 99.9%, but it is generally accepted to effectively treat viruses, bacteria, and other protozoa after filtering through a cloth to remove large particles.6

Filtration with an absolute pore size of <0.1 micrometer (10 times smaller than the EPA standard) has been generally accepted as effective against protozoa and bacteria, but it is not effective against viruses because of their small size.7 When combined with either halogenation or charcoal filters, filtration can be effective against all pathogens.8

**Recommendations from others**
The US Army Center for Health Promotion and Preventive Medicine (USACHPPM) published a report in 2006 on the efficacy of commercial off-the-shelf individual water purifiers.8 Using National Sanitation Foundation Protocol P248 and applying it to “real-world” emergency military operational conditions, USACHPPM found that no device scored high on every attribute, and that overall scores for most devices were in the moderate range. The top score for any device was 79 (out of 100).8

The overall top 3 scoring products were: 1) the SweetWater Purifier from Mountain Safety Research; 2) the Micropur MP 1 tablets from Katadyn North America, Inc; and 3) the First Need Deluxe water purifier from General Ecology, Inc. ■

**Acknowledgments**
The opinions and assertions contained herein are the private views of the authors and not to be construed as official, or as reflecting the views of the US Air Force Medical Service or the US Air Force at large.

**References**