3

Food and water hygiene for the traveller

Travellers' diarrhoea (TD) is contracted by consuming contaminated food or water. The risk depends on a variety of factors, as outlined in Chapter 2. Contrary to popular belief, food poses a much greater hazard to the traveller than water. The reason for this is that contamination of water by an organism is prone to a dilution effect, so that insufficient organisms are swallowed by an individual at any one time to cause an infection. Some organisms, such as *Shigella* or *Cryptosporidium*, need only be present in small numbers to cause problems, but such infections are comparatively rare in travellers. Occasionally, if a sewage system breaks down, there is a risk of cholera epidemics.

In the case of food contamination, there is an opportunity for organisms to multiply quite rapidly, resulting in large enough numbers being present on a single piece of food to cause an infection if ingested.

This chapter will examine the measures that can be taken by travellers to minimise the risk of contracting a diarrhoeal illness as a result of ingesting contaminated food and water. It is also worth remembering that not all problems are caused by infective organisms and toxins produced by fish and plants can cause serious problems.

Food hygiene

While food hygiene practices are heavily promoted to the travelling public, there is no particular need to miss out on experiencing the local cuisine. It is not necessarily the type of food that poses a danger, but how well it has been prepared and stored. This section considers practical aspects of helping the traveller choose the safest types of foods.

It would logically be expected that travellers who follow the standard advice regarding food hygiene would experience fewer incidences of diarrhoea. However, apart from avoiding very-high-risk foods, e.g. steak tartare or raw oysters,[1] following hygiene advice has not been

demonstrated to reduce the risk of TD in most formal studies.[2,3] In one study, despite pre-departure advice, 34% still suffered from TD.[4]

One study of expatriates and tourists in Nepal[5] could find no association between eating high-risk foods and diarrhoea. The best way of avoiding problems appeared to be preparing food at home, rather than eating in restaurants. However, the study did identify some association with foods that had been prepared earlier in the day and left to stand at room temperature.

Bhopal[6] gives a graphic description of a couple on a 'round-the-world' trip who went to the most extraordinary lengths to avoid risky food and yet both developed severe dysenteric disease: 'One developed life-threatening giardiasis, two episodes of diarrhoea and loose stools that persisted for 30 months on returning to Britain.'

It may be tempting to conclude that following dietary advice strictly is unnecessary. However, following the recommendations on food hygiene is supported by a number of compelling arguments:

- It is likely that failure to avoid TD is more due to an inability of travellers to follow food hygiene advice, rather than the advice being ineffective. Only a few per cent of travellers in one study were willing to comply with advice given.[7]
- The trials examining this issue to date have been rather small and therefore not of sufficient power to link incidence to a particular dietary habit.
- Those who do not follow any of the advice given may still be at greater risk of contracting parasites or *Shigella* infections, which give a more serious diarrhoea and to which resistance is not developed. This is supported by studies which indicate that such travellers tend to have multiple episodes, and a more severe TD.[8]

General principles of food hygiene

There is a universally accepted saying to help travellers avoid the riskiest situations: 'peel it, boil it or forget it'. This underlies the principle that cooked, piping-hot food is considered to be the safest. A few other general points should be understood:

- When possible, it is better to prepare food personally, rather than eating in restaurants and hotels. The quality of the restaurant seems to make little difference to the chance of contracting TD.[9] Eating products from street vendors is best avoided unless served hot, e.g. straight from a wok. It may even be the case that staying and eating in five-star accommodation poses a greater risk than lower-quality hotels. The reason for this observation is that the better presentation of food in such restaurants

involves greater handling in its preparation and therefore a greater chance of contamination.

- Dry foods are safer as organisms require a moist environment in which to grow. The key message is that bacterial contamination of moist foods, left out in a warm climate, will very rapidly produce a large number of organisms, likely to cause a gastrointestinal infection if consumed.
- Infection can potentially be picked up from contaminated plates or cutlery. Some travellers will carry their own knives, forks and drinking mugs. As an extreme measure, some also use alcohol wipes for swabbing down suspect utensils.
- It is also important to maintain good personal hygiene. If backpacking or living in rough conditions, it is easy to let standards drop. Travellers may need reminding of the importance of clean hands and fingernails when eating or preparing food.
- Even if pre-travel advice does not reduce the incidence of TD, it may help individuals in their understanding of the condition. This was illustrated by a recent study, where those offered such advice tended to be less likely to seek medical help regarding TD.[10]
- Local foods are often safer than attempts by restaurants to produce more westernised foods in a style of cooking with which they are unfamiliar.

Particular types of food

Table 3.1 indicates the types of foods and their relative safety for the traveller. These are now discussed individually.

Salads

These come quite high on the list of high-risk foods.[11] The worst is considered to be broad-leafed vegetables such as lettuce. This is because of

Table 3.1 Choice of foods for the traveller

Usually safe	*Risky*	*Best avoided*
Freshly prepared and hot food	Food from street vendors unless fresh and hot	Poorly stored food
Peeled fruit	Unpeeled fruit and salad unless well washed in clean water	Broad-leafed salad
Canned food	Icecream	Shellfish
Dried food and freshly baked bread		Rare meat and fish Unpasteurised dairy products

the large surface area where there is a potential to harbour many organisms, so it must be adequately cleaned. Added to this is the practice of using human excrement, known as 'night soil', as a fertiliser in some developing countries. Other salad items such as tomatoes or cucumber may present a lesser risk if well prepared.

If undertaken personally, preparation of salad or raw vegetables should always include scrubbing with clean water until all visible signs of dirt have been removed and then finally rinsing with sterilised or boiled water. Some travellers like to soak vegetables overnight in a chemical disinfectant. There is little evidence that this offers significant advantage over scrupulous cleaning, but it does no harm. Traditionally, solutions of potassium permanganate were used, but this tends to spoil the quality of the food and vegetables would need a fairly long contact time. Iodine or chlorine used for water purification (as discussed later) can also be used for soaking and manufacturers of these products give recommendations for the appropriate concentrations. It is claimed that eating the salad with a heavy vinegar or lemon dressing might lessen the risk as the organisms survive less well at a low pH.[12]

Fruit and vegetables

The golden rule is that, if fruit and vegetables are not cooked, opt for those that must first be peeled. Therefore, in terms of fruit, bananas and oranges would be ideal, but grapes would be far more risky. Also, any cooked vegetables that have been allowed to stand for some hours could represent a hazard.

Buffets and sauces

These are quite common sources of TD and food poisoning. In the case of open buffets, flies settle on food and can deposit organisms, which in a warm environment multiply very rapidly. Cold sauces that have been left to stand are also a potential breeding ground for microorganisms.

Breads, rice and pasta

Bread, being a dry food, is relatively safe. Rice and pasta, once cooked, should be consumed immediately. Rice in particular may harbour a bacterium called *Bacillus cereus* that produces a toxin, causing severe diarrhoea.

Fish and shellfish

On the list of foods best avoided, fish and shellfish come quite high. Shellfish in particular can present hazards due to their feeding method of filtering large quantities of water for plankton. This results in a high chance of contamination if such fish are exposed to sewage outlets in the shallow waters where they grow. Fish generally require careful storage. Poisoning by specific toxins can be a problem, for instance, ciguatera poisoning is caused by ciguatoxin-producing (neuro- and cardiotoxin) dinoflagellate plankton, which enter the fish food chain.

Meat and poultry

These are not intrinsically any more of a hazard than vegetable dishes, provided that they are well prepared and not reheated or incorrectly stored. When eating out, these conditions may not always be known so they may represent a potential source of infection. Where possible, freshly and thoroughly cooked meat products should be chosen. It may also be wise to avoid more elaborate dishes that have required a lot of handling during preparation.

Dairy

The major problem with dairy products is the potential that they have been made from unpasteurised milk, presenting a risk of brucellosis. Provided milk has been boiled, it can be considered safe. Therefore, Indian chai, which is a widely available brew of tea and milk boiled together in a large vat, presents little danger. Goat's cheese is a particularly notorious cause of problems.

Water hygiene

In many respects it is easier to arrange a source of clean drinking water than to follow strictly the recommendations given concerning food hygiene. In addition, many people in westernised countries now regularly use bottled water as a main source of fluid intake, a practice that can usually be followed when travelling.

The use of bottled water does still carry a risk because in some developing countries there is a trade in 'counterfeit' bottled water that has simply been filled from a tap. Even sealed bottles can be no guarantee of safety. Partly for this reason, it is often recommended to choose

carbonated water if available, as this is less likely to be counterfeit. Also, it is claimed that the relative acidity of carbonated water makes it a less hospitable environment for bacteria.[12] Some concern has been expressed over the increased use of bottled water by travellers to developing countries, in that it presents an environmental hazard. It has been observed that discarded bottles cannot be either recycled or properly disposed of due to lack of resources for waste disposal in poorer countries. Thus the litter generated by tourists in some popular tourist destinations has become a problem.

It is generally recommended that ice in drinks be avoided. The biggest danger is ice that has been chipped from large blocks; in some parts of the world these are delivered to restaurants, sometimes being left out in a street and stored in unhygienic conditions. A problem has been reported in cruise ships which take on board water in foreign ports, which is then used to produce ice before being properly chlorinated.[13] A myth that should be dispelled is that alcohol will sterilise fruit juice or water to which it has been added – the quantity required would not be achieved in an alcoholic beverage.[14]

There will be circumstances where the traveller needs to sterilise a supply of water and this will be discussed in some detail. Essentially, parasites tend to be harder to kill than bacteria. *Giardia* cysts are often considered to be the hardest of all to remove. *Giardia* is most likely to be encountered by trekkers using surface waters, e.g. streams and lakes, as a source of drinking water.

There are three methods by which the traveller can prepare clean drinking water: boiling, chemical disinfection and filtration.

Boiling

Boiling should always be recommended as the method of choice for sterilising water. At higher altitudes, water must be boiled for longer than at sea level because of the lower boiling point. To allow for this variable, it is a good idea to boil water for a full 5 minutes at any altitude. Boiled and cooled water tends to have a flat taste due to loss of oxygen content. Cooling with the pan covered and drinking the water cold can improve the taste.[15]

Boiling will kill all organisms and is the most reliable method against *Cryptosporidium*. The main drawback for the traveller is arranging the facilities to boil sufficient quantities. Heating elements are available that can be used to boil water in a suitable cup or mug.

Chemicals

Water purification tablets are often supplied through pharmacies and camping shops and it is important that travellers know how to use them properly. The halogens, chlorine and iodine, are the most commonly used; the only other widely available product is katadyn silver. Their effectiveness will depend on four variables:

1. concentration of chemical used
2. contact time
3. water temperature
4. water quality (e.g. pH, presence of organic matter)

If the water is clear of particulate matter and at an ambient temperature, it can be left for a shorter time before being safe to drink. However, if the water is heavily contaminated then a higher concentration of halogen should be used. Recommendations on manufacturers' labels should be followed carefully. The concentration of halogen is usually calculated to allow sterilisation in less than half an hour.

In the UK, chlorination has long been used for the preparation of clean water by trekkers and travellers, whereas in the USA iodine appears to be more popular. There is a long-running debate concerning the choice between chlorine- and iodine-based products. Some of these issues will now be addressed.

Spectrum of activity

Both chlorine and iodine have a wide spectrum of activity and are effective against bacteria, viruses and parasites. For iodine, a concentration of around 8 mg/L is quoted[15] as desirable for removal of organisms within less than half an hour. This concentration is required for inactivation of *Giardia* cysts, but for bacterial or viral contamination a concentration of 0.5 mg/L would be sufficient. For chlorine, 8 mg/L is also effective,[16] with the most popular branded product (Puritabs) producing 10 mg/L.

The debate over activity concerns the effectiveness of the two halogens against *Giardia* cysts, which are particularly likely to present a problem to trekkers using surface waters in the wild. Chlorine can inactivate *Giardia* cysts,[17] but a study comparing different chlorine- and iodine-based products found that chlorine removed a lower percentage of cysts than the iodine products over any of the chosen contact times.[18] Interestingly, even the iodine-based products were shown not to remove more than 90% of the cysts unless left for 24 hours.

Stability at high pH

In laboratory studies, chlorine, but not iodine, tends to lose activity at high pH due to the formation of less active hypochlorite ions,[19] requiring an increase in concentration or contact time above pH 7. The relative importance of this effect when higher concentrations of chlorine are used in the field has not been well studied.

Water temperature

Both halogens are less active at lower temperatures[15–17] and an increase in contact time and/or concentration is required, particularly to remove *Giardia* cysts.

Presence of organic matter

Activity of both halogens can be reduced by the presence of organic matter. If the water appears cloudy, it should always be pre-filtered. This can be achieved by passing it through a piece of cloth or muslin. Alternatively, a special canvas bag known as a Millbank bag (Fig. 3.1) can be used to produce large quantities of clear water. These bags are particularly popular with trekkers. If pre-filtering is not possible then a greater concentration of halogen could be used.

Chlorine is claimed to be more sensitive than iodine to such inactivation, particular in the presence of ammonia ions and amino acids, where chloramines tend to be formed.[15,19]

Side-effect profile and contraindications

There are few problems associated with chlorination, and an obvious advantage over iodine, for which certain precautions must be observed:

- An excessive iodine intake could lead to effects on the thyroid. Goitre formation has been reported where iodinated water has been used exclusively for some months. The most recent of such reports occurred among peace corps workers whose purifier was yielding water with a concentration of iodine at 10 mg/L.[20] The goitre does resolve quite rapidly once iodine consumption is reduced.[21] Furthermore, there are no reports of a clinical hyperthyroidism through this practice. It is unlikely that most travellers would use iodinated water exclusively for any length of time, but most products do carry a warning stating that they should not be used continuously for more than a few weeks.

Figure 3.1 Millbank bag for filtering water prior to chemical disinfection. Courtesy of Nomad.

- Because of the theoretical effects on the thyroid, iodination is best avoided in pregnancy and in young children.
- Those people with an allergy to iodine should obviously avoid this method of purification.

Taste

Both halogens impart a taste to the water that some find unacceptable. With the higher concentrations of iodine recommended for *Giardia*, the resultant water is particularly unpalatable. Ascorbic acid is the most convenient neutraliser, removing both the taste and brown coloration of iodinated water. Dispersible ascorbic acid tablets are available for this purpose, but a pinch of ascorbic acid powder would work equally well.

Travellers should be aware that, if a neutraliser is added to the water, then the iodine will be inactivated. Even a small amount of ascorbic acid left in a flask used to sterilise water will reduce the activity of the iodine. Therefore travellers should be advised to add such neutralisers to the final drinking container, e.g. a cup, just before consumption.

The taste of chlorine and iodine can be removed by sodium thiosulphate, although no commercial tablets are available for this purpose. Hydrogen peroxide could be used, but most travellers do not wish to carry bottles of hydrogen peroxide. The taste of chlorine is worse at extremes of pH.

Storage

Once prepared, the presence of chlorine in water may be better at discouraging growth of contaminating organisms than iodine. In either case, it is usually best to consume treated water within 24 hours of preparation.

Conclusion – iodine versus chlorine (Table 3.2)

For most travellers a chlorine-based product would be the most suitable and easily obtainable. Some trekkers and more adventurous travellers

Table 3.2 Comparison of iodine and chlorine as water purification for travellers

	Iodine	*Chlorine*
Spectrum of activity	Bacteria, viruses and parasites (except *Cryptosporidium*) Possibly more effective than chlorine against *Giardia* cysts	As for iodine
pH	Stable at high pH	Not as active at high pH
Temperature	Less active at low temperature	Less active at low temperature
Presence of organic matter	Less active but more tolerant than chlorine	Less active
Toxicity	Some contraindications; not for continuous use	No special contraindications; can be used continuously

may wish to use iodine because of the theoretical advantages in certain situations, as outlined. If the water is cold (below about 10°C) it would be wise to let it stand for double the time recommended by manufacturers. Where the treatment time is not made explicit and *Giardia* is suspected, water should ideally be left overnight.

Chlorine-based preparations

Sodium dichloroisocyanurate (Puritabs) These are one of the UK market leaders and are sold through most pharmacies. They are available in different-strength tablets to treat either 1 or 25 L of water. If used according to the directions on the packaging, they should be effective against *Giardia*, although to date no studies directly investigating their use against this organism have been performed. If the water is heavily contaminated, two tablets should be used. For soaking vegetables, it is recommended to add a total of three tablets to the required quantity of water. A contact time of just 10 minutes is advised. To treat double the quantity of water with the same number of tablets, the time can be increased to 30 minutes.

Household bleach This can be used provided it is free of additives or disinfectants. Ordinary laundry bleach usually contains 4–6% of available chlorine and one or two drops could be added to a litre of water. This method is probably best reserved for emergency situations where no other products are available. It is also probably not desirable to travel with bottles of bleach as continuous shaking could result in loss of chlorine activity.

Iodine-based preparations

Tincture of Iodine (Alcoholic Iodine Solution BP) This is the most readily available and cost-effective iodine-based preparation for water purification, containing 2% available iodine. Iodide ions from potassium iodide in the solution are also present; these have no antibacterial activity but double the total iodine concentration.

Directions for using tincture of iodine are somewhat of an anomaly. *Martindale*[22] recommends using five drops per litre, increasing to 12 drops if *Giardia* is suspected. However, the volume per drop would tend to vary to some extent, depending on the type of pipette used. I estimate that one drop of tincture from a standard glass dropper

bottle is just 0.02 ml. This would mean that five drops would result in 2 mg/L, more than adequate for removing bacteria and viruses. However, the recommended 12 drops would yield just 5 mg/L, which falls at the lower range of the concentration required for inactivation of *Giardia* cysts. A full 30 minutes or longer (*Martindale* advises 1 hour) at ambient temperatures should be allowed when using tincture of iodine at this dosage if *Giardia* is suspected.

The obvious disadvantage with iodine tincture would be the mess involved with any breakage as it is stored in a glass bottle. The tincture should not be dispensed in plastic bottles because of leaching of iodine. The BP formulation of iodine tincture, which is formulated with ethanol, should always be used. There have been anecdotal reports of other iodine tinctures containing industrial methylated spirits. Povidone-iodine or other forms of aqueous iodine should not be used for water purification. There are a number of commercial pre-packed iodine tinctures in dropper bottles labelled with full instructions and warnings for use.

Tetraglycine hydroperiodide tablet These are quite widely available in the UK (e.g. Potable Aqua). Each tablet yields 4 mg of available iodine. They are more convenient than the tincture and will give a more reliable dose. However, they do have some disadvantages:

- The tablets can take a long time to dissolve, particularly in cold water.
- They rapidly lose potency once the bottle has been opened.
- They are more expensive than the tincture.

Potable Aqua is also sold in packs containing both tetraglycine hydroperiodide tablets and ascorbic acid tablets for neutralisation of iodine, as mentioned earlier.

Iodine crystals Most cost-effective of all, and occasionally employed by the more intrepid trekkers, is the system known as the Kahn–Visscher method.[19]

About 5 g of crystals of iodine is stored in a clear glass 30 ml jar with a paper-lined Bakelite cap. This is filled with water to form a saturated solution; the resulting concentration of iodine will vary to some extent with water temperature. The supernatant liquid is then carefully poured off, taking care not to draw off any crystals.

This solution is then used to disinfect water by adding 15 ml to each litre of water. The crystals can therefore generate very large quantities of water, between 250 and 500 L, at little cost.

The procedure is somewhat fiddly, although the system is available in a special cup sold for the purpose (Polar Pur), which gives clear directions on the volume to be added at different temperatures. There is also the risk of inadvertently consuming iodine crystals.

Katadyn silver (Micropure)

The main advantage of katadyn silver tablets (Micropure) is that they impart no taste to water. In addition, water can be stored, once treated, for many months.

There are no particular contraindications to their use. The main drawback is that these tablets are only effective against bacteria and should not be used to treat water where parasites may be a problem. A further disadvantage is that, following addition of the tablets to water, it must be left for 2 hours before drinking. Little published data are available on the effectiveness of katadyn silver.

Pumps and devices

There are a plethora of water purification devices that are marketed as suitable for use by travellers, although there are potential drawbacks with most types. There are two modes by which these devices are able to purify water: by simple filtration or chemically via iodine bound to a resin. Many systems use a combination of both methods.

If a simple filtration method is used, usually with a ceramic filter, the smallest pore size available is around 0.3 μm, which would be too large for removal of viruses (e.g. hepatitis A is 0.03 μm). Therefore, most practical systems that can remove all organisms employ a two-stage device: a filter to remove larger organisms and an iodine-bound resin for viruses. Some also have a third carbon filter to remove chemical contamination and any excess iodine.

The filtering systems that are designed to remove smaller organisms do require a great deal of pumping. Such filters may rapidly become clogged unless water that is free of debris is used. Some devices allow cleaning of the filter system and replacement cartridges to be used. A potential problem is that users may be unaware that the chemical is exhausted, so some purifiers are designed to pass no further water when this stage is reached.

It should be noted that iodine resin could release a high concentration of free iodine, so systems that incorporate a carbon filter are useful.

Those recommending such devices should also note the following points:

- Although it is often stated how many litres a particular system can purify, this may be much reduced if the water is very dirty.
- Be aware of the rate at which water can be produced by the purification system. Some take a great deal of pumping for little reward.
- Although manufacturers may state which organisms are removed, they may not mention the organisms against which the device is not effective.
- For water contaminated by industrial effluent, a device with a carbon filter is required.
- Water produced by purifiers should be used within 24 hours.

Table 3.3 summarises the range of devices currently available in the UK.[23] None is ideal and the price can vary from around £20 for the small-capacity devices up to £250 for the larger katadyn purifiers. The main advantage in their use is that water is available for drinking immediately after it has passed through the system, rather than waiting for a chemical to work or boiled water to cool. They will also impart no taste to the water. Travellers may therefore find them more convenient if the expense and luggage space can be justified. Considering each in Table 3.3:

- The Travelwell is a well-tested range, the PWP version is more compact and robust than the MWP. These work by allowing water to pass by

Table 3.3 Water purification devices

Type of purifer	*Maximum amount of water purified (litres)*	*Type of device*
Pocket Travelwell	25	Filter and iodine resin
Trekker Travelwell (MWP and PWP)	100	
Survival straw	20–40	Filter and iodine resin
Zero B	500	Crystal iodine
First Need		Filters
Microlite	100	
Original	400	
Pure cup	500	Filter and iodine resin
Katadyn		Ceramic filter and silver
Mini filter	7000	
Pocket filter	10 000+	
Piston filter pump	10 000+	

gravity through various filters, thus requiring no pumping to produce drinking water. Two pre-filters remove organic matter, debris and chemical contamination. The water then passes over a resin iodine filter that releases free iodine at 4 ppm. The Travelwell personal purifier has the disadvantage of a somewhat lower yield of water per fill and has a greater tendency to clog up if too much organic matter is allowed to enter the system. On the plus side, it incorporates a final-stage carbon filter that removes any free iodine, improving taste. The MWP model is based on the same principle as the PWP but water must be hand-pumped to pass it through the system so that 200 ml of water can be obtained per minute, unlike the PWP which relies on gravity. Smallest of all is the Pocket Travelwell, which also needs a pump action and is designed for emergency use.

- The travel straw is a small straw containing a pre-filter to remove solid matter, iodine and activated carbon to remove the taste. Water is sucked up directly through the straw and will block off once the iodine is exhausted. It has a very limited capacity and should be seen as a survival aid for trekkers.
- The Zero B is a somewhat fragile gravity filter that uses a crystal iodine filter, but appears not to have an efficient pre-filter for removing debris and other contaminants. It is therefore probably best reserved for treating tap water.
- One of the first purifying devices available to travellers used ceramic filters, which, although very delicate, can be removed and cleaned so that theoretically they will last indefinitely. These ceramic filters are used in the Katadyn range and these are also impregnated with silver to reduce bacterial contamination of the filter. Water must be hand-pumped and a range of sizes are available, from small pocket filters to larger, heavier models suitable for preparing water for small groups of people. A major drawback is that the device cannot be relied upon to remove all viruses.
- The First Need range does not employ any iodine resins, but relies on hand-pumping water through a special purifying cartridge. After being pumped through a 10 μm pre-filter, water then passes through a special matrix that can retain microorganisms, chemical contaminants and any other small particles. Pumping can be quite hard work: the flow rate falls as the filter reaches the end of its life, when it can be replaced. The filter unit is somewhat delicate and easily damaged.

Food and water hygiene in groups and expeditions

There is an even greater imperative for good food and water hygiene amongst those travelling in groups or expeditions as the chance for transmission of diarrhoeal infection can be great. It is common practice

amongst such groups for members to design a rota where each will take it in turn to prepare the day's meal. The problem here is that, while individuals may well observe good hygiene in food preparation for small numbers of family or friends, they are not used to preparing food for larger numbers of people, typically in an overland group of 10–20 people. In addition food may be prepared without the availability of running water or adequate sanitation. The following simple rules should be observed.[24]

- Do not let anyone suffering from a diarrhoeal illness be involved in any preparation of food. It is a good idea if just one person is in overall charge of catering to oversee the rota and ensure that good standards of hygiene are maintained.
- Fingernails should be cut and hands scrubbed clean before food preparation. Ideally, separate clean aprons or other outer garments should be available in the food preparation area. Clean, dry utensils should be used and all surfaces should be thoroughly cleaned before food preparation using a suitable chlorine-based disinfectant.
- It may be wise not to include certain foods, such as shellfish, on the menu. Any raw meat should be stored and prepared separately from other types of food.
- Hair should be tied back and any wounds covered with a dressing or plaster.
- Food should be eaten hot and not left out for buffet-style meals (see notes above). If no refrigeration is available then any left-over food most be thoroughly reheated or discarded.

Summary

- Fresh foods: those that are peeled or cooked are the safest.
- Avoid high-risk foods like shellfish.
- Boiling water is the best method of sterilisation.
- Chemicals are useful for preparing safe drinking water but have their limitations.
- Chlorine-based tablets are widely available and will be appropriate for most travellers.
- More intrepid travellers and those planning to use surface waters as a drinking water source should use an iodine-based product.

Frequently asked questions

Is it worth soaking vegetables in solutions of chlorine or potassium permanganate?
Scrubbing the vegetables in soapy water and then rinsing in freshly prepared sterilised water should be the first line of defence. Whether soaking offers any additional protection has not been studied. The contact time for effective treatment may ruin certain vegetables such as lettuce.

Are vegetables safer than meat?
It is true that certain parasitic infections such as tapeworms (Chapter 5) will only be contracted by eating meat. Also food poisoning such as from *Salmonella* may be more likely from undercooked and reheated meat or shellfish. On the other hand, vegetables are a common source of diarrhoea in travellers, particularly in the case of salads. Meat that is freshly and simply prepared, served hot and cooked through can be assumed to be safe.

Is it worth buying a filter device for producing clean water?
On purely economic grounds, for most trips they offer no advantages over chemical methods. In terms of convenience the two big advantages over chemicals are not having to wait while the water boils and leaving no taste in the water. For those using surface waters the devices do not require pre-filtered water. However, the various types on the market all have drawbacks in terms of efficiency, reliability and convenience of use, as discussed in the text.

Is it best to use chlorine- or iodine-based chemicals for water purification?
As discussed in the text, my conclusion is that chlorine is the most convenient method for sterilising tap water, but iodine may have advantages for surface waters. Iodine should not be recommended if this is the sole means of obtaining clean water for a period much greater than a few weeks.

References

1. Mattila L. Clinical features and duration of travellers' diarrhoea in relation to its aetiology. *Clin Infect Dis* 1994; 19: 28–34.
2. Cartwright R Y. Travellers' diarrhoea. *Br Med Bull* 1992; 49: 348–362.
3. Pitzinger B, Steffen R, Tschopp A. Incidence and clinical features of travellers' diarrhoea in infants and children. *Paediatr Infect Dis J* 1991; 10: 719–723.
4. Shlim D R, Hoge C W, Rajah R *et al.* Persistent high risk of diarrhoea among foreigners in Nepal during the first two years of residence. *Clin Infect Dis* 1999; 29: 613–616.

5. Hoge C W, Shlim D R, Echeverria P *et al.* Epidemiology of diarrhoea among expatriate residents living in a highly endemic environment. *JAMA* 1996; 275: 533–538.
6. Bhopal R. Travellers' diarrhoea: difficult to avoid. *BMJ* 1993; 307: 322–323.
7. Steffen R. Epidemiologic studies of travellers' diarrhoea, severe gastrointestinal infections and cholera. *Rev Infect Dis* 1986; 8: S122–S130.
8. Ryder R W, Oquist C A, Greenberg H *et al.* Travellers' diarrhoea in Panamanian tourists in Mexico. *J Infect Dis* 1981; 144: 442–448.
9. Kollaritsch H. Travellers' diarrhoea among Austrian tourists in warm climate countries. *Eur J Epidemiol* 1989; 5: 74–81.
10. McIntosh I B, Reed J M, Power K G. Travellers' diarrhoea and the effect of pre-travel health advice in general practice. *Br J Gen Pract* 1997; 47: 71–75.
11. Merson M H, Morris G K, Sack D A *et al.* Travellers' diarrhoea in Mexico: a prospective study of physicians and family members attending a congress. *N Engl J Med* 1976; 294: 1299–1305.
12. Garelick H. Safe water. In: Dawood R, ed. *Travellers' Health: How to Stay Healthy Abroad,* 3rd edn. Oxford: Oxford University Press, 2002: 71–78.
13. Daniels N A, Neimann J, Karpati A *et al.* Traveler's diahrroea at sea: three outbreaks of waterborne enterotoxigenic *Escherichia coli* on cruise ships. *J Infect Dis* 2000; 181: 1491–1495.
14. Dickens D L, DuPont H L, Johnson P C. Survival of bacterial enteropathogens in the ice of popular drinks. *JAMA* 1985; 10: 953–957.
15. Wilkerson J A, ed. *Medicine for Mountaineers,* 3rd edn. Seattle: The Mountaineers, 1985.
16. Jarroll E L, Bingham A K, Meyer E A. *Giardia* destruction: effectiveness of six small quantity water disinfection methods. *Am J Trop Med Hyg* 1980; 29: 8–11.
17. Jarroll E L, Bingham A K, Meyer E. Effect of chlorine on *Giardia lamblia* cyst viability. *Appl Environ Microbiol* 1981; 41: 483–487.
18. Ongerth J E, Johnson R L, MacDonalds S C *et al.* Backcountry water treatment to prevent giardiasis. *Am J Public Health* 1989; 79: 1633–1637.
19. Kahn F H, Visscher B R. Water disinfection in the wilderness. *West J Med* 1975; 122: 450–453.
20. Kahn L K, Li R, Gootnick D. Peace corps thyroid investigation group. *Lancet* 1998; 352: 1519.
21. Lemar H J, Georitis W J, McDermott M T. Thyroid adaptation to chronic tetraglycine hydroperiodide water purification tablet use. *J Clin Endocrinol Metab* 1995; 80: 220–223.
22. *Martindale: The complete drug reference*, 32nd edn. London: Pharmaceutical Press, 1999: 1494.
23. Goodyer P, Goodyer L. Water purification. In: Warrell D, Anderson S, eds. *Expedition Medicine*. London: Profile Books, 1998: 73–78.
24. Bennet Jones H. Base camp hygiene and health. In: Warrell D, Anderson S, eds. *Expedition Medicine*. London: Profile Books, 1998: 63–72.