Staphylococcal food poisoning, which usually presents clinically at 2-6 hours post exposure, is attributed to the ingestion of food containing pre-formed staphylococcal enterotoxins (SEs) which are quite resistant to acid and proteolysis. Most cases of staphylococcal intoxication resolve within 24-48 hours, although they may be serious.

*Staphylococcus aureus* is largely responsible for reported cases of food poisoning and is the target of food safety managers. The main sources of *S. aureus* in food are the people who prepare it and the equipment used in that preparation. Contamination from infected animals (such as mastitic cows) is not considered to be a problem with good husbandry practice.

As humans are the main reservoir for the organism, the primary management of food safety lies in ensuring that food is handled minimally (and appropriately) and that foods are stored under refrigeration temperatures that will prevent bacterial multiplication and enterotoxin production. Dirty equipment can also provide foci for bacterial multiplication. A milk storage tank valve was implicated as the source of contaminated skim milk in a staphylococcal outbreak in Japan that affected more than 10,000 people.

Other *Staphylococcus* species (*S. intermedius, S. hyicus, S. chromogenes* and some coagulase-negative Staphylococcus) are also capable of toxin production. *S. aureus* is a poor competitor but has the capacity to grow in the presence of high salt levels over a wide pH range. Consequently, it grows best in cooked/processed food where there are few, if any, other flora.

The amount of staphylococcal enterotoxin required to cause illness varies with individual susceptibility. Through primate feeding trials using SEA, SEB and SEC, SEA dose estimates from outbreaks range from 20-100µg from skim milk to 200µg or less in chocolate milk. Food microbiologists have traditionally worked on the assumption that the enterotoxigenic dose is less than 1µg, an amount of toxin which is usually achieved when the *S. aureus* populations exceed 100,000 per gram of food. This knowledge, coupled with the fact that contamination during food handling is almost unavoidable, mean that low level contamination in food is generally tolerated because it poses little risk. Standard 1.6.1 of the *Australian Food Standards Code* lists limits for CPS for some foods but there is no legislated requirement to test.

Detection of SEs in food have progressed over time from bioassays (monkey-feeding and kitten-intraperitoneal tests) to...
serological tests based on gel diffusion such as the Ouchterlony double diffusion plate method \(^{11}\) to the current use of commercial kits based on enzyme linked immunosorbent assay (ELISA), enzyme linked fluorescent assay (ELFA) and reverse passive latex agglutination (RPLA). These kits rely on the use of polyconal or monoclonal antibodies to the SEs, usually A-E, which are thought to account for about 95% of staphylococcal food poisoning outbreaks \(^{18}\). Care is required in the interpretation of test results as current test kits do not cover the entire range of SEs. Non-specific reactions and the possible presence of enzymes in the food can lead to false-positive or false-negative results \(^{8, 10, 19}\).

Detection of toxin genes may be useful for the characterisation of \textit{S. aureus} isolated from food, and techniques have also been described for direct detection of toxin genes from food and clinical specimens \(^{20}\). SE detection can also be achieved, at levels described for direct detection of toxin genes from food and an outbreak \(^{18}\). Care is required in the interpretation of test results to account for about 95% of staphylococcal food poisoning outbreaks \(^{18}\). Care is required in the interpretation of test results as current test kits do not cover the entire range of SEs. Non-specific reactions and the possible presence of enzymes in the food can lead to false-positive or false-negative results \(^{8, 10, 19}\).

Finding indistinguishable toxin-producing or toxin-gene carrying strains in an implicated food source (especially if present at \(\geq 10^5\) per g of food) and ill patients may also be compelling, as may finding these same strains in implicated food handlers. The place of testing for SE genes alone when testing food or investigating disease is not yet established.

There are relatively few reports of staphylococcal food poisoning in Australia. Possible reasons for this include under-reporting and limited testing of cases (symptoms are short-lived), better awareness of food safety and handling with readily available information on websites \(^{22}\) and limited food testing opportunities.

Although testing for CPS is routinely conducted in food testing laboratories, implicated food is often unavailable in cases of gastroenteritis and clinical labs do not usually test for \textit{S. aureus} or its enterotoxins in this setting. Thus, there is usually no evidence to implicate the organism as an outbreak cause.

---

### References

14. Available at: http://www.foodstandards.gov.au/_srcfiles/fsc_1_6_1_Micro_v78.doc

---

**Agnes Tan** oversees primary investigations and the quality program of the MDU. The MDU is a public health microbiology laboratory which integrates the detection and characterisation of bacteria and fungi of clinical and public health importance across all fields, including food and water.

**Prof Geoff Hogg** has qualifications in veterinary science, medicine and law. He is a Fellow of the Royal Australasian College of Physicians and a Fellow of the Royal College of Pathologists of Australasia. He has worked in the veterinary field as a Field Veterinarian (Department of Agriculture, Victoria) and as a Veterinary Pathologist (Bendigo Regional Veterinary Laboratory). He has also worked as a paediatrician and a Clinical Microbiologist (Royal Children’s Hospital, Melbourne). He is currently Director of the Microbiological Diagnostic Unit, Public Health Laboratory, at the University of Melbourne.