Infected food handlers

Occupational aspects of management

A national guideline

Royal College of Physicians

Setting higher medical standards

NHS Plus

Infected food handlers

Occupational aspects of management

A national guideline

2008

Royal College of Physicians
Setting higher medical standards

NHS Plus

Acknowledgements

We are grateful to Dr John Ballard, OH @Work, for his assistance in drafting the guideline, and to Goutam Adak, Health Protection Agency, Paul Williams, Canterbury City Council, Susan Smith and Dr Arek Hassey, East Kent Hospitals NHS Trust, for their advice during the preparation of the guideline.

We would also like to thank Susan Paterson, Research Librarian, NHS Plus, for her assistance with literature searches, and Helen Banks, Department of Health, for her administrative support.

NHS Plus

The NHS Plus Project aims to improve the quality and delivery of occupational health services to NHS staff and in turn increase the availability of NHS Plus services to small and medium employers. In addition to commissioning the Occupational Health Clinical Effectiveness Unit to produce evidence-based guidelines and conduct national audits, the Project has work strands to improve the delivery of services, provide an improved trading model and improve the strategic leadership of occupational health services in the NHS.

The Royal College of Physicians

The Royal College of Physicians plays a leading role in the delivery of high-quality patient care by setting standards of medical practice and promoting clinical excellence. We provide physicians in the United Kingdom and overseas with education, training and support throughout their careers. As an independent body representing over 20,000 Fellows and Members worldwide, we advise and work with government, the public, patients and other professions to improve health and healthcare.

Occupational Health Clinical Effectiveness Unit

The Occupational Health Clinical Effectiveness Unit at the Royal College of Physicians aims to measure and raise standards, and to reduce variability, of occupational healthcare through the development of evidence-based guidelines and conduct of national clinical audits.

Faculty of Occupational Medicine

Our aim is for healthy working lives through:

- elimination of preventable injury and illness caused or aggravated by work
- maximising people's opportunities to benefit from healthy and rewarding work while not putting themselves or others at unreasonable risk
- access for everyone to advice from a competent occupational physician as part of comprehensive occupational health and safety services.

Citation for this document

NHS Plus, Royal College of Physicians, Faculty of Occupational Medicine. *Infected food handlers: occupational aspects of management. A national guideline*. London: RCP, 2008.

Copyright

ISBN 978-1-86016-335-7

Review date: 2013

Royal College of Physicians of London
11 St Andrews Place, London NW1 4LE

www.rcplondon.ac.uk

Registered Charity No 210508

Cover design: WLG Design

Typeset by Dan-Set Graphics, Telford, Shropshire

Printed by The Lavenham Press Ltd, Sudbury, Suffolk

Contents

Guideline Development Group

Guideline leader

Annette Woods, Research Associate, Kent Institute of Medicine and Health Science, University of Kent

Director of evidence-based guideline project, NHS Plus

Dr Ira Madan, Consultant and Senior Lecturer in Occupational Medicine, Guys and St Thomas' NHS Foundation Trust and King's College London

External assessors

Professor Sarah O'Brien, School of Translational Medicine, Hope Hospital, Salford Royal NHS Foundation Trust

Professor Hugh Pennington, Emeritus Professor of Bacteriology, University of Aberdeen

Guideline Development Group Members

Dr Syed Ahmed, Specialist Registrar, Occupational Health, East Kent Hospitals NHS Trust

Professor Tar-Ching Aw, Chair, Department of Community Medicine, United Arab Emirates University

Ms Dawn Clifford, Occupational Health Manager, Houses of Parliament

Dr Melody Greenwood, Consultant Microbiologist, Health Protection Agency, London

Dr Clive Harker, Chief Occupational Physician, United Biscuits

Dr Sarah Holton, Specialist Registrar, Occupational Health, Guys and St Thomas' NHS Foundation Trust

Mrs Sarah L Jones, Food Safety Consultant, Department of Primary Care and Public Health, Cardiff University

Ms Jenny Morris, Principal Policy Officer, Chartered Institute of Environmental Health

Mr Paul Winter, Catering Manager, Bethlem Royal Hospital, South London and Maudsley NHS Foundation Trust, Kent

Mr Kevin Woodfine, Head of General Food Hygiene Branch, Food Standards Agency, UK

Conflicts of interest: none declared.

Executive summary

Food handlers are defined as employees who fall into the following categories as classified by the Department of Health in *Food handlers: fitness to work*:[1]

- people employed directly in the production and preparation of foodstuffs, including those in the manufacturing, catering and retail industries
- people undertaking maintenance or repairing equipment in food-handling areas, whether permanent staff or workers on contract, and visitors to food-handling areas.

This review summarises the current evidence and is intended to assist occupational health professionals, managers and other interested parties who are responsible for providing advice on the management of infected food handlers and the prevention of transmission of infection.

Three key questions were used as the basis for the systematic review:

1 What have been the organisms responsible for outbreaks of food poisoning by infected food handlers in the past 10 years within the UK?
2 What are the best methods for identifying food handlers who may be infected?
3 What are the best methods of preventing food handlers who may be infected from spreading disease?

Key findings and recommendations

- Norovirus, *Salmonella enteritidis* and *Salmonella typhimurium* are responsible for the majority of the outbreaks of food poisoning.
- Some food handlers continue to work with symptoms such as diarrhoea or vomiting and pose a significant infection risk via the food.
- Infected food handlers may be asymptomatic and be unaware of the increased risk of passing infection to others via the food they handle.
- No methods were reported for identifying asymptomatic food handlers who are infected with relevant micro-organisms.
- Hand washing by food handlers is an effective method for preventing the spread of infection from food handlers to food.
- A standardised hand-washing procedure should be included in all induction programmes for food handlers.
- Hand washing with soap and water should be the method of choice for food handlers and they should dry their hands using paper towels or a hot air dryer.

1 Introduction

The aim of this guideline is to provide evidence-based advice on the occupational management of potentially infected food handlers. The guideline will assist occupational health (OH) professionals, managers and other interested parties in determining fitness for work of food handlers, and covers issues about returning to work as well as providing the scientific evidence underpinning fitness for work criteria. Where evidence does not exist, or is insufficiently robust, recommendations for further research are made.

Definitions and epidemiology

Food-borne disease is an infectious illness contracted through the consumption of food or drink contaminated with pathogenic bacteria, toxins, viruses, prions or parasites. Typically, it is an acute gastrointestinal infection resulting in symptoms which may include:

- diarrhoea (with or without blood)
- constipation
- abdominal cramps or pain
- nausea
- vomiting
- fever
- general malaise
- headache
- fatigue.

The most important infections attributed to transmission from infected food handlers are norovirus, *Salmonella enteritidis* and *Salmonella typhimurium*, which together account for the largest numbers of outbreaks and individual infections. The most common routes of transmission are faecal–oral, and via aerosol formation from vomit. Food handlers can be symptomatic or asymptomatic carriers of food-borne infections – both the transmission of norovirus and *Salmonella enteritidis* have been attributed to asymptomatic food handlers.[2]

Other definitions

A *case* of food-borne disease can be defined as any person who contracts a food-borne infection.[3]

Most infections are *sporadic*, occurring in single or scattered cases.

Food handlers include those individuals employed directly in the production and preparation of foodstuffs, including the manufacturing, processing, catering, and hospitality and retail industries. However, the definition can also encompass workers undertaking maintenance work or repairing equipment in food-handling areas, and visitors to food-handling areas.

Food handling involves all aspects of treatment and storage of food from receipt of raw materials to the delivery of the prepared product.

Infected food handlers are those individuals who carry infection either with or without symptoms. Food handlers have transmitted both enteric and non-enteric infections via the food that they handled.

Scale of food-borne disease and the importance of occupational health management

In industrialised countries infected food handlers are an important source of food-borne disease. Ingestion of infected food can result in mild to severe illness, hospitalisation or even death.

The magnitude of the problem is unknown, as cases of food-borne disease tend only to be reported where there are large outbreaks or where the consequences are so severe that individuals seek medical attention. Diseases with short incubation periods are more likely to be detected and attributed to infected food than those with longer incubation periods where the individual may not associate their illness with ingestion of infected food.

Many food handlers who go off sick with a food-borne disease appear to make their own decision about returning to work and do not consult their GP or an occupational health professional. This is suggested by a number of reports of food handlers continuing to work while suffering with diarrhoea, vomiting or pyrexia.[14,32,44,48,62,63,68,69,83,88]

Most food handlers do not have access to occupational health advice and because relevant illness is generally short lived, they will usually self-certify as fit or unfit for work.

Scale of infection

The Food Standards Agency (FSA) and Health Protection Agency (HPA) estimate that in England and Wales in 2005 food-borne diseases cost the economy just under £1.4 billion, with 765,000 cases recorded.[6] According to the HPA, only 1 in 130 cases of food-borne disease are reported. Estimates suggest that infected food handlers cause between 4% and 33% of food-borne disease outbreaks in the UK.[5–7]

- *Cost to employers.* Employers incur losses from workers absent from work with food-borne infections through loss of work output, provision of cover for absent staff, and through the impact on productivity. However, businesses in the food production and related service sectors risk even greater economic losses in the event of an outbreak or incident. These losses may result from product recall, investigation, enforcement, liability and loss of reputation. Employers in the food processing, production and supply industries incur additional costs in prevention and compliance measures, including health screening of food handlers, training, education and record keeping.
- *Cost to individuals.* People who become infected with a food-borne disease can suffer anything from mild illness to serious infection, and occasionally death. Financial costs may include loss of salary and, for those employed in food handling, potential loss of employment.

Given the scale of food-borne infection and the consequences of an outbreak, ensuring food handlers' fitness for work is a risk-management priority.

Legal aspects of food safety

The 1995 Regulations have been revoked and no longer apply.[8]

New food hygiene legislation came into force in the UK on 1 January 2006, in compliance with the European Food Hygiene Regulation 852/2004.[9] It requires all food businesses to be registered

with a designated competent authority, such as the local environmental health service, and to put in place food safety management procedures based on the hazard analysis and critical control point (HACCP) principles (see page 6). Regulation 852/2004 was implemented in England by the Food Hygiene (England) Regulations 2006, which came into force on 1 January 2006.[10] Similar legislation was implemented in Wales, Scotland and Northern Ireland.[11–13] Among other provisions, these regulations provide the enforcement agencies with powers of entry to premises and for the procurement and analysis of samples. The authority can also serve hygiene improvement and prohibition orders on businesses that fail to comply with the regulations.

Exclusion from work

Consensus-based recommendations for the exclusion of infected food handlers from work following gastrointestinal infections advise that the individual should be excluded for a further 48 hours following the cessation of diarrhoea.[1] More stringent guidance applies to infection with *Salmonella typhi*, verotoxigenic *Escherichia coli* (VTEC) O157 and hepatitis A.[15] Some authors have raised concerns that the period of absence is not long enough, especially in the case of norovirus.[47,54] Earlier estimates of viral excretion observed by electron microscopy have been superseded by more sensitive polymerase chain reaction (PCR) assays, which allow detection of viral antigen after the cessation of symptoms. What is not clear, however, is whether or not the virus is still infectious at this stage,[16,17] and as yet there is insufficient evidence to support a change to the above consensus-based recommendations.

2 Investigation and prevention of disease outbreaks

Investigating the role of the infected food handler in disease outbreaks

The time lag between infected food consumption and the onset of disease symptoms can hamper the identification of the source of infection, including any involvement of an infected food handler. Diseases with long incubation periods, such as hepatitis A, are particularly hard to investigate because of the difficulty in establishing exactly what was eaten and when, especially if the person who has contracted the disease is unable to remember potentially relevant information. Stool samples taken from food handlers can be important in the investigation process, but the presence of the causative organism does not automatically imply that the food handler is the source of an outbreak, since they too may have contracted the pathogen from the infected food.

The role of occupational health in pre-employment screening of food handlers

Some food handlers will be employed in organisations with access to occupational health services. Occupational health will be able to advise on procedures to determine fitness to work in the following situations:

- assessment of any health condition likely to affect safety of food
- assessment of any health condition likely to be exacerbated by work as a food handler
- assessment of suitability of return to work after illness or holiday.

The most common tool used for assessing fitness for work is a health questionnaire, many of which are based on guidance drawn up by the Department of Health in 1995,[8] though some organisations produce their own bespoke versions. In some establishments, job applicants may be required to undergo physical examination by a doctor or nurse, and may be subjected to further investigations including microbial analysis of stool samples.[19] Despite available guidance, there is considerable variation in pre-employment screening practice, particularly as applied by employment agencies. The type of the employment contract – temporary or permanent – is also cited as a source of variation in the nature of the pre-employment screening.

A survey of occupational physicians in the Food Industry Medical Association in 1999–2000 showed a strong consensus that all applicants for food handling jobs should complete a pre-employment health questionnaire.[19] There was also consensus that these should include questions on typhoid or paratyphoid fever, skin problems, ear problems and recurring bowel problems, but less agreement on conditions that did not relate to microbiological risk, such as asthma, diabetes and mental health disorders. The authors of the study recommended a simple, three-item questionnaire that focuses on recent microbiological risk, with limited questions on previous medical history and medication. The authors suggest that applicants should be asked to indicate if, in the previous two weeks, they have suffered from either diarrhoea or vomiting, a skin infection, or infection of the eyes, ears or gums, or had contact with anyone at home or abroad who may have had typhoid or paratyphoid fever.[19]

Methods for the prevention of transmission of infection from infected food handlers

Microbiological screening of food handlers

Routine analysis of food handlers' stool samples by public health laboratories in the UK and USA ceased by the 1960s, on the grounds that the number of positive isolates was too low to justify continued surveillance.[20]

Hand washing and personal hygiene

The current consensus is that ensuring personal hygiene, particularly hand washing, is the most effective tool in preventing the spread of food-borne infections. While awareness of the need for frequent hand washing may be high, compliance is often low.[21,22] A survey of 1,000 catering workers and managers by the FSA in 2002 reported that 39% of staff did not wash their hands after visiting the lavatory, while 53% did not wash their hands before preparing food.[23] Reasons given for low compliance included:

- skin irritation
- inaccessibility of hand-washing facilities
- reliance on gloves
- being too busy
- forgetting to follow procedures
- lack of training and supervision.

Immunisation

Vaccines are effective against infection with hepatitis A virus; a single injection plus booster will give about 10 years' protection. Immunisation may be recommended for food handlers in countries where prevalence is high,[84] but it is not currently warranted in the UK where prevalence is low.

Food safety inspections

Environmental health officers inspect restaurants and other food handling establishments in England and Wales. The frequency of their visits is adjusted according to the level of risk of food infection, with higher-risk establishments inspected more frequently than lower-risk premises. Inspections should be made when the establishment is most busy – and therefore when the risks of contamination are highest. They should include inspections of hand-washing practice.

Food safety training

Within the UK, all food handlers must be supervised and instructed and/or trained in food-hygiene matters to enable them to handle food safely. All training should follow the hazard analysis and critical control point (HACCP) system (see section below). Managers or supervisors responsible for maintaining the food safety management procedures must be trained in the application of HACCP principles. There is no legal requirement for either staff or managers to attend a formal training course or obtain a qualification, though many employers may want

their staff to do so. The employer/proprietor is responsible for ensuring that food handlers reach the required level of competence, which can be achieved either through formal courses or on-the-job training.

Hazard analysis and critical control point principles

The HACCP system is an internationally recognised approach to food safety management that focuses on identifying the critical points in the food-handling process where hazards might arise, and putting in place measures to prevent them. It also emphasises the importance of record keeping. HACCP is incorporated in the European Food Hygiene Regulation 852/2004.[9]

3 Methodology of the evidence review

A multidisciplinary Guideline Development Group (GDG) was formed in April 2005 and three key questions were developed.

Key questions

1. What organisms have been responsible for outbreaks of food poisoning by infected food handlers in the last 10 years in the UK?

Population	Infected food handlers
Organisms	Bacteria Viruses Amoeba Protozoa Fungi/yeasts
Outcomes	Infection in those consuming food products handled by an infected food handler
Study design	Observational studies Case reports

2. What are the best methods for identifying food handlers who may have an infection that could be transmitted via food to the consumer?

Population	Food handlers
Screening	Questionnaire Microbial screening of body samples Assessment by a health professional Assessment by a manager or other non-health professional
Outcomes	Detection of a relevant infection
Study design	Randomised controlled trials (RCTs), systematic reviews, cross-sectional studies, longitudinal studies and case studies

3. Which interventions are the most effective in preventing infected food handlers from transmitting infection to consumers via food?

Population	Food handlers
Interventions	Hand washing by food handlers Provision of toilet/washing facilities Exclusion from work
Outcomes	Prevention or reduction of transmission of infection
Study design	RCTs, systematic reviews, case-control studies, cross-sectional studies, longitudinal studies and case studies

Search strategy

Search strategy for questions 1 and 2

The following terms were used in the search strategy.

Food Handler [tw]
Food Safety [tw]
Food Hygiene [tw]
Catering [tw] AND sickness [tw]
Catering [tw] AND poisoning [tw]
Catering [tw] AND outbreak [tw]
Catering [tw] AND contamination [tw]
'Foodborne disease' [tw]
'Foodborne illness' [tw]
'Food health and safety' [tw]
'Food hand*' [tw] AND screen* [tw] OR assess*[tw] OR question* [tw]

Search dates for questions 1 and 2

Question 1: 01/01/1995 to 20/08/2005
Question 2: 01/01/1990 to 30/09/2005

Databases searched for all questions

Medline
PubMed
Embase
HSE line
Communicable Disease Report
Centre for Disease Control and Prevention
FoodNet
The Health Development Agency Public Health Evidence Base
Health Periodicals Database
Evidence Based Periodicals Database
Cochrane Library
CINAHL
Health Protection Agency (HPA) database

Search strategy for question 3

'Food hand*' [tw] AND 'hand washing' [tw] OR 'washing facilities' [tw] OR 'toilet facilities' [tw] OR training [tw]
Food hand*[tw] AND RCT
'Food borne disease' [tw] AND prevention OR 'hand wash*' [tw] OR 'toilet facilities' [tw]
'Food hand*' [tw] AND gloves [tw]
Food hand* [tw] AND vaccinat* [tw]
'Occupational Health' [tw] AND hand wash* [tw]

Search dates for question 3

01/01/1990 to 30/09/2005

Limitations of the literature/database searches

The limitations for question 1 were:

- English language
- human subjects
- UK studies.

The limitations for questions 2 and 3 were:

- English language
- human subjects
- studies from Europe, North America, Australia, New Zealand and Japan.

Papers from other countries were excluded as the differences in hygiene standards, prevalence of infectious diseases in the population and methods of recording food-borne disease would make the data unlikely to be applicable to the UK population.

Selection of papers for critical appraisal and grading of evidence

The literature searches were undertaken as outlined above. This yielded a total of 4,415 abstracts after de-duplication (Fig 1). The Guideline Development Group Leader (GDGL) and one member of the GDG independently reviewed all the abstracts in order to select papers that met the criteria for the key questions. A total of 137 papers were appraised for the three questions.

A bespoke appraisal form was developed for question 1 as the papers appraised used case studies rather than intervention studies. The form was based on the evaluation tool used by Rooney.[24] Twelve papers were used to pilot the draft tool. Minor modifications were made following the pilot and the final form was used to evaluate papers for question 1 (Appendix 1). The papers for questions 2 and 3 were assessed for methodological quality, using a pro forma adapted from the Critical Appraisal Skills Programme (shown in Appendix 2). The revised Scottish Intercollegiate Guideline Network (SIGN) grading system (2000) (Table 1) was used to grade each paper (see form reproduced in Appendix 3). All papers were assessed independently by two members of the GDG. The GDGL read all the papers and differences in SIGN grading between the pairs of assessors and the GDGL were resolved by discussion. The appraisers were asked to identify any follow-on papers listed in the references of the papers that they were appraising.

An algorithm produced by NICE for classifying primary study designs about effectiveness was used to ensure papers reviewed in this guideline were correctly assigned (see *Methods for development of NICE public health guidance*, NICE, 2006).[31]

Due to the paucity of information on outbreaks of food-borne disease in the published literature, the GDG approached the Health Protection Agency for information on the involvement of infected food handlers in disease outbreaks.

All members of the GDG appraising the literature were trained in critical appraisal skills.

Fig 1 Flow chart showing selection of papers

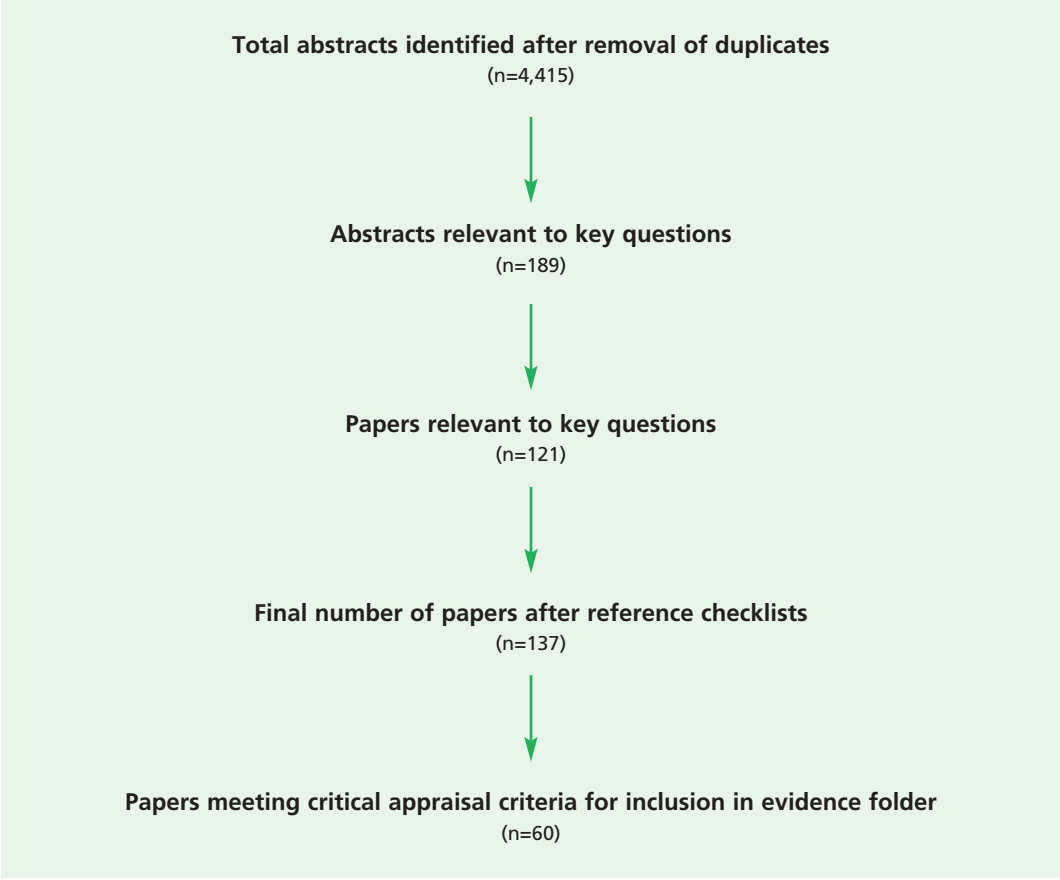

Table 1 Revised SIGN grading system

Levels of evidence	
1++	High-quality meta-analyses, systematic reviews of randomised controlled trials (RCTs) or RCTs with a very low risk of bias
1+	Well conducted meta-analyses, systematic reviews of RCTs or RCTs with a low risk of bias
1–	Meta-analyses, systematic reviews of RCTs or RCTs with a high risk of bias
2++	High-quality systematic reviews of case-control or cohort studies High-quality case-control or cohort studies with a very low risk of confounding, bias, or chance and a high probability that the relationship is causal
2+	Well conducted case-control or cohort studies with a low risk of confounding, bias, or chance and a moderate probability that the relationship is causal
2–	Case-control or cohort studies with a high risk of confounding, bias or chance and a significant risk that the relationship is not causal
3	Non-analytic studies, eg case reports, case series
4	Expert opinion

Table 2 Grades of recommendation

A	At least one meta-analysis, systematic review, or RCT rated as 1++, and directly applicable to the target population; or A systematic review of RCTs or a body of evidence consisting principally of studies rated as 1+, directly applicable to the target population, and demonstrating overall consistency of results
B	A body of evidence including studies rated as 2++, directly applicable to the target population, and demonstrating overall consistency of results; or Extrapolated evidence from studies rated as 1++ or 1+
C	A body of evidence including studies rated as 2+, directly applicable to the target population and demonstrating overall consistency of results; or Extrapolated evidence from studies rated as 2++
D	Evidence level 3 or 4; or Extrapolated evidence from studies rated as 2+

Good practice points

Good practice points (GPPs) are practical points that the GDG wished to emphasise but for which there is not, and nor is there likely to be, any research evidence. For example, some aspect of management or treatment that is regarded as such sound clinical practice that nobody is likely to question it would be classified as a GPP. These are not alternatives to evidence-based recommendations, and are only used where there is no other way of highlighting the issue.

Limitations of the evidence review

- Few outbreaks of food-borne disease attributable to infected food handlers reach publication in the scientific literature.
- The pattern of outbreaks in the published literature does not reflect the pattern of outbreaks found in the HPA database.
- There is significant under-reporting of food-borne disease outbreaks.
- Only the larger or more significant outbreaks are usually reported, which may be reflected in the organisms seen to cause outbreaks.
- Due to the inherent difficulties of investigating outbreaks, the role of the infected food handler may be underestimated.
- There are few papers on hand washing in the food handler population. The majority focus on hand washing in the healthcare industry.

4 Findings and recommendations

The findings for the identification and management of infected food handlers and the prevention of transmission of infection are divided into three sections:

(1) organisms responsible for causing infections from infected food handlers

(2) identification of infected food handlers prior to spread of infection

(3) prevention of transmission of infection from infected food handlers.

1 Micro-organisms implicated in food-borne disease from infected food handlers

All the data below, from papers and the HPA, relate to the UK.

Table 3 Micro-organisms involved in outbreaks of food poisoning from infected food handlers

Name of organism	Number of outbreaks	Number of individual cases	Range of cases per outbreak	Average number of cases per outbreak
Salmonella enteritidis	93	2,685	3–340	27
Norovirus	47	2,346	5–200	50
Salmonella typhimurium	18	494	6–126	27
Staphylococcus aureus	7	85	2–34	24
Salmonella virchow	3	109	9–70	36
VTEC O157	3	29	9–11	10
Salmonella hadar	2	80	13–67	40
Shigella sonnei	2	42	16–26	21

Source: HPA Centre for Infections 1992–2005.

Micro-organisms responsible for causing one outbreak of food poisoning from infected food handers as reported to the HPA between 1992 and 2005 include:

- *Salmonella saint paul*
- *Salmonella bovis morbificans*
- *Salmonella give*
- *Salmonella java*
- *Salmonella agama*
- *Salmonella Heidelberg*
- Campylobacter
- *Salmonella brandenberg*
- *Salmonella braenderup*
- *Escherichia coli* 0124
- *Clostridium perfringens.*

In a further 29 outbreaks no organism was identified.

Table 4 Location of outbreaks in which an infected food handler was implicated as the source

Location	Number of outbreaks
Restaurant	30
Pub/bar	26
Hotel	25
Shop retailer	24
Hall caterers	15
Private house	14
Residential institution	12
Hospital	7
Canteen	6
Armed services	4
School	4
Shop caterer	4
University/college	4
Workplace	3
Club/centre	2
Holiday camp	1
Community	1
Function caterer	1
Other	1

Source: HPA Centre for Infections 1992–2005.

Table 5 Micro-organisms involved in outbreaks caused by infected food handlers (from published papers reviewed 1995–2005)

Name of organism	Number of outbreaks	Number of individual cases	Range of cases per outbreak
Norovirus	14	4,873	48–2700
Salmonella typhimurium	4	469	24–390
Hepatitis A	4		
Group A Streptococci	2		
Shigella sonnei	2		

Micro-organisms responsible for causing one outbreak of food poisoning from infected food handers, as reported in the published papers, include:

- *Salmonella virchow*
- *Salmonella javiana*
- *Salmonella hadar*
- *Salmonella enterica* serotype typhi
- Salmonella serotype Thompson
- *Shigella flexneri*
- *Staphylococcus aureus*
- *Campylobacter jejuni*
- cryptosporidiosis
- rotavirus group A serotype G2.

Norovirus, *Salmonella enteritidis* and *Salmonella typhimurium* appear to account for the majority of identifiable infections where an infected food handler was involved.

Information on organisms that caused food-borne disease from infected food handlers

Norovirus

Summary statement from evidence-based review of papers

Norovirus was responsible for the greatest number of outbreaks attributable to food handlers in the review of the published literature. This is probably because papers on outbreaks of Salmonella are rarely submitted for publication. In the papers reviewed, 14 (35.8%) of the outbreaks were attributed to norovirus. Nine were confirmed outbreaks, four suspected and one presumptive. Nine food handlers worked while symptomatic, but four were asymptomatic; there was no information on the health status of one food handler. Raw foods or those not requiring further heating were the main vehicles of infection. These foods require more extensive handling than cooked food. In two outbreaks, sickness within the food handler's close family was recorded as a contributory factor.

Summary statement from Health Protection Agency database

Norovirus was second to *Salmonella enteritidis* in causing infections from infected food handlers in the HPA database. In 47 (21.7%) outbreaks, 15 food handlers worked while sick, one returned to work four hours after symptoms ceased, and two prepared food within 24 hours of the onset of diarrhoea and vomiting. Fourteen food handlers were asymptomatic for norovirus. In all but two of the outbreaks the food vehicle was either raw or food which had no further cooking after handling. Sandwiches, salad, buffet items, mayonnaise and cakes were the cold foods most frequently implicated, while roast turkey, Christmas pudding and soup, were the hot foods most frequently implicated.

Salmonella enteritidis

Summary statement from evidence-based review of papers

Salmonella enteritidis was not reported in the review of the published literature as an organism causing infection from infected food handlers but this is likely to be due to case reports not being submitted for publication.

Summary statement from Health Protection Agency database

Ninety-three outbreaks were attributable to *Salmonella enteritidis*, virtually double the number attributable to norovirus. Thirty-five (37.6%) food handlers worked while sick, and an

additional 21 (22.6%) were asymptomatic. A wide range of both hot and cold foods acted as vectors for the transmission of the disease. Individuals returning from a holiday abroad caused two outbreaks.

Other Salmonellas

Summary statement from evidence-based review of papers

Nine outbreaks (23%) were attributed to other members of the Salmonella species. Numbers involved in outbreaks ranged from seven to over 390, with an average of 87. A chronic carrier was identified in one outbreak. An immigrant casual worker was identified as the source in another outbreak. Raw foods or those not cooked further were the main food vehicles. In one outbreak, sickness within a food handler's close family was also recorded as a contributory factor.

Summary statement from Health Protection Agency database

Thirty-one outbreaks (14.9%) were attributable to members of the Salmonella genus other than *Salmonella enteritidis*; 18 (8.7%) were attributable to *Salmonella typhimurium*. A range of both hot and cold food acted as vectors for the transmission of the disease.

Hepatitis A

Summary statement from evidence-based review of papers

Six outbreaks (15.3%) were attributable to hepatitis A. Of these, four were confirmed outbreaks and two presumptive. Four food handlers worked whilst infective and one food handler implied that s/he was asymptomatic. In the remaining outbreak the status of the food handler was unknown. Ready meals or those not cooked further were the main food vehicles. In one outbreak the food handler had a colostomy bag and the paper indicated that poor hand-washing technique contributed to this outbreak.

Summary statement from Health Protection Agency database

There was no evidence in this information source of outbreaks of food-borne disease caused by hepatitis A in England and Wales from infected food handlers.

Shigella flexneri/sonnei

Summary statement from evidence-based review of papers

Both the cases of outbreaks caused by *Shigella sonnei* were in food handlers who also changed nappies either at home or at work.

Summary statement from Health Protection Agency database

There is no additional information from this source to add to the summary statement.

Staphylococcus aureus

Summary statement from evidence-based review of papers

Poor hygiene practices, in particular hand washing, by food handlers at mass catering events, were identified as a cause of outbreaks of *Staphylococcus aureus*. The lack of adequate hand-washing facilities at these types of events was highlighted.

Summary statement from Health Protection Agency database

Nasal carriage in a food handler was implicated in one outbreak caused by *S. aureus*.

Summary statement from the data and outbreaks reviewed for question 1

There was no evidence that food handlers with skin conditions affecting hands, arms or face, boils, styes, cut or septic fingers, or discharges from eyes, ears, gums or mouth, were associated with infecting food. This may be due to education and self-exclusion of workers with the above conditions. In none of the outbreaks were jewellery, tattoos and plasters reported as being associated with transmission of the infection.

The research reviewed did not produce any evidence as to whether the current advice that food handlers with diarrhoea and vomiting should be excluded from work until 48 hours after the cessation of symptoms is effective in preventing transmission of infection from food handlers to food.

Conclusion

From the data available the most important infections attributed to transmission from infected food handlers are norovirus, *Salmonella enteritidis* and *Salmonella typhimurium*. However, the results of the literature search show that it is hard to get a true reflection of the organisms causing infection from the published literature, and there is a discrepancy between the published literature and the HPA database.

The recommendations for question 1 are based on the factors that were associated with infected food handlers transmitting infection to food.

RECOMMENDATIONS (based on the factors that have been associated with infected food handlers transmitting infection to food)

Recommendation	Grade	Evidence
Managers must ensure that a risk assessment of the food being prepared is carried out to ensure that effective controls that accord with the statutory requirements are in place.	GPP	
Food handlers need to be aware that they are at increased risk of infection if a household member has diarrhoea or vomiting.	B	Telfer[88] Daniels[47]
Managers need to emphasise to food handlers the importance of reporting symptoms and signs of an infective illness.	B	Telfer[88] Kilgore[68] Lachlan[70] Albers[36] Eriksen[49]

Recommendation	Grade	Evidence
In the absence of evidence, it is recommended that employers continue to follow the consensus advice that food handlers with diarrhoea and vomiting should be excluded from work until 48 hours after the cessation of symptoms.	D	
Food handlers do not require hepatitis A vaccination at the current prevalence of hepatitis A in the UK.	D	Chironna[44]
Separation of food preparation from nappy changing areas would assist in preventing contamination of food with Shigella.	B	Mohle-Boetani[78] Shane[87] Guzewich[7]
Staff who both prepare food and change nappies need to pay particular attention to regular hand washing with a good technique.	B	Mohle-Boetani[78] Shane[87] Guzewich[7]

2 Identification of infected food handlers before spread of infection

Summary statement from evidence-based review of papers

Faustini *et al* reported investigation of an outbreak of food-borne disease caused by *Salmonella hadar*, where six food handlers were found to be symptomatic and stool sampling was positive for group C Salmonella, and one food handler was found to be an asymptomatic excreter of group C Salmonella.[51] In the asymptomatic case the bacteria could not have been detected by any means other than microbial analysis. In a study of nasal sampling for *Staphylococcus aureus* in flight catering staff, 39 out of 136 (29%) staff tested were shown to harbour potentially pathogenic bacteria, but were unaware of this fact and had no symptoms.[59] There was no evidence that any of the catering staff had contaminated the food.

No studies evaluated the effectiveness of questionnaires in detecting asymptomatic food handlers or those at high risk of being infected.

Conclusion

Food handlers who are infected with organisms capable of causing an outbreak of food-borne disease may be asymptomatic; however, there is insufficient literature to estimate how common this is or how frequently infected but asymptomatic food handlers cause outbreaks of food-borne infections. Therefore it is not currently possible to recommend routine microbial testing as a means of detecting asymptomatic, infected food handlers.

RECOMMENDATION

Recommendation	Grade	Evidence
Until further evidence is available, employers may wish to consider the use of a questionnaire such as that recommended by the Department of Health[2] to detect potentially infected food handlers.	D	Department of Health[1]

3 Prevention of transmission of infection from infected food handlers

Summary statements from evidence-based review of papers

Hand washing

Organic matter reduces the effectiveness of alcohol scrubs in hand cleaning. Long nails harbour more bacteria under them than short ones; however, bacteria are more effectively removed from below long nails by liquid soap and a nail brush than by alcohol scrubs. Separate toilet and hand-washing facilities increase the ability of workers to use good hand-washing techniques. Most of the papers demonstrate the effectiveness of soap and water hand washes for hand cleaning in food handlers, over other methods such as alcohol rubs.

Glove use

The use of gloves appears not to reduce the transfer of micro-organisms from hand to food. This may be due to the quality of gloves or the way in which gloves are used. Concern has been raised that gloves may also give food handlers a false sense of security resulting in a reduction in hand washing.

Training and knowledge

Knowledge of hand washing is highest in those who have either been in the industry the longest or have attended a training course. Active, participatory training demonstrated improved knowledge retention as compared to passive non-participatory training. Combinations of education and feedback improve compliance, but improvements remain only while the education and feedback programme is in place. Obligatory training for catering managers, accompanied by certification, improved inspection scores. However, knowledge is not always reflected in practice and managers need to be aware of this.

Hand drying

Hand drying is essential to decrease the spread of bacteria. Drying hands with disposable paper towels or a hot air dryer is equally effective.

RECOMMENDATIONS

Recommendation	Grade	Evidence
Finger nails of food handlers need to be short enough to be effectively cleaned.	C	Lin[74]
Use of soap and water should be the method of choice for hand washing. There is insufficient evidence to state how frequently hands should be washed.	B	Barker[40] Bidawid[41] Bidawid[42] Lin[74] Charbonneau[28]
A standardised hand-washing technique, demonstrated and explained by a competent staff member, should be used.	C	Allwood[37] Charbonneau[28]
Demonstration of this technique should be repeated on a three-monthly basis.	D	Allwood[37] GPP

Recommendation	Grade	Evidence
Standardised hand-washing procedures should be included in all induction and regular training programmes for food handlers.	C	Naikoba[79]
Hand-washing training sessions should be participatory and varied.	B	Lillquist[73] Campbell[43] Hinkin[60] Naikoba[79] Harbarth[95]
Food handlers need to thoroughly dry hands after washing either using paper towels or a hot air dryer.	B	Gustafson[57] Taylor[29] Patrick[82]
Gloves should not be used by food handlers solely for the prevention of transmission of micro-organisms from food handler to food.	C	Lynch[75]

5 Future research and audit criteria

Future research

- The effectiveness of health questionnaires for detecting infected food handlers.
- The period of exclusion from work for food handlers after cessation of diarrhoea and vomiting.

Suggested audit criteria

Audit criteria are shown in Table 6.

Table 6 Audit criteria for the management, training and facilities of food handlers

Key priority for implementation	Audit criterion
Managers need to emphasise to food handlers the importance of reporting symptoms and signs of infective illness	% of food handlers who are aware that they should report symptoms and signs of an infective illness to their employer
A standard hand-washing technique should be used and demonstrated by a competent member of staff and this training should be repeated on a 3-monthly basis	% of food handlers who have received training including a demonstration of a standard hand-washing technique % of food handlers who have the training repeated on a 3-monthly basis
Standardised hand-washing procedures should be included in all induction and regular training programmes for food handlers	% of induction and training programmes for food handlers containing instructions on standardised hand-washing procedures
Use of soap and water should be the method of choice for hand washing. Food handlers need to thoroughly dry hands after washing using either paper towels or a hot air dryer	Adequacy of provision of hand-washing facilities with soap and paper towels or hot air dryer

Appendix 1 Critical appraisal form for question 1

Author/title of paper			
Was agent isolated from sick individuals?		Are there any relevant pre-existing medical conditions in the food handler? (name)	
Was agent identified? (name)		Had food handler recently returned from abroad? If so, from where?	
Was same agent isolated from/detected in food?		Was the changing of nappies or diapers implicated in the outbreak?	
Was same agent isolated from food handler?		Size of outbreak	
Was the pattern of exposure consistent with the biological mechanisms?		Accepted for guideline (yes/no)	
Did the on-site investigation *or* epidemiological study *or* statistical evidence point to infected food handler?		Are there any other papers cited in this paper that the working group should appraise? (list first author and year)	
What food(s) were implicated? (name)			
How was the agent transmitted?		Are there any unusual circumstances in this paper that we should be aware of?	
Was food handler symptomatic or asymptomatic?			
Could the infection in the food handler be identified? If so, how?			
Could the infection in the food handler be prevented? If so, how?		Please summarise the paper in one sentence if it is to be included in the guideline.	
Did food handler report illness in close family member?			
Was an agent identified? (name)			

Scoring system

Yes/No/NA

Size of outbreak

Small = <10, medium = between 11–50, large = >50.

Criteria for confirmation of food handler being responsible for food-borne illness

Confirmation status	Criteria
Confirmed	Isolation of agent from ill individuals and food handler, and exposure that preceded infection by a period of time consistent with proposed biological mechanisms, *and* combination of on-site investigation and statistical evidence from epidemiological study
Presumptive	On-site investigation *or* epidemiological investigation determining that there has been an association between ill food handler and individuals becoming ill
Suspected	Descriptive epidemiology suggesting that the outbreak is food-handler related and excluding obvious alternative explanations *or* food hander implicated in the outbreak report/publication but no information on epidemiology or microbiology available
Unknown	Investigation determining an association between food handler and individuals becoming ill, but suspected vehicle not identified

Adapted from Rooney RM, Cramer EH, Mantha S *et al*. A review of outbreaks of foodborne disease associated with passenger ships: evidence for risk management. *Public Health Rep* 2004;119:427–34. Personal communication from Dr GK Adak, Gastrointestinal Diseases Division, PHLS Communicable Disease Surveillance Centre, 61 Colindale Avenue, London NW9 5EQ.

Appendix 2 Critical appraisal form for questions 2 and 3

Author, title: _____

Study type (tick all that apply)

Randomised controlled trial	❑
Systematic review	❑
Meta-analysis	❑
Qualitative research	❑
Literature review	❑
Case-control study	❑
Longitudinal/cohort study	❑
Other	❑

(Please describe)

Screening questions

1. Does the paper have a clearly focused aim or research question?

Yes ❑ No ❑ Can't tell ❑

Consider:
1 population studied
2 interventions delivered
3 outcomes

2. Is the chosen method appropriate?

Yes ❑ No ❑ Can't tell ❑

Consider whether:
1 the authors explain their research design
2 the chosen method addresses the research question

Is it worth continuing?

Yes ❑ No ❑

Please explain

Detailed questions

3. Has the research been conducted rigorously?

Yes ❑ No ❑ Can't tell ❑

Consider:
1 search strategy described
2 inclusions and exclusions
3 more than one researcher
4 resolving issues of bias

4. Is it clear how data has been analysed?

Yes ❑ No ❑ Can't tell ❑

Consider:
1 were study results combined
2 if so was this reasonable
3 in-depth description of the analysis process
4 all participants accounted for
5 contradictory findings explained

5. Is there a clear statement of findings?

Yes ❑ No ❑ Can't tell ❑

Consider:
1 sufficient evidence to support conclusions
2 do findings support the research question
3 precision of results
4 all important variables considered

6. How are the results presented?

Consider:
1 are the results presented numerically, i.e. p-value, OR (odds ratio)
2 are the results presented narratively

7. What is the main result?

Consider:
1 how large is the size of the result
2 how meaningful is the result
3 how would you sum up the bottom-line result in one sentence

8. Are there limitations to the research?

Yes ❑ No ❑ Can't tell ❑

Consider:
1 was the sample size large enough
2 were all important outcomes considered
3 was the intervention process adequately described
4 was there any follow-up data
5 do the authors acknowledge weaknesses

9. Can the results be applied to a UK context?

Yes ❑ No ❑ Can't tell ❑

Consider:
1 any discussion on how the findings can be used
2 findings considered in relation to current practice
3 estimation of benefits and costs

Accept for inclusion as evidence Yes ❑ No ❑ Can't tell ❑

Refer to guideline leader Yes ❑ No ❑

Guideline leader's notes

Any references to be followed up from this article?

Please attach this form to your recording sheet for appraising and grading and return to guideline leader.

Appendix 3 Recording form for appraisal and grading

Title: _____

Author: _____

Discussed (tick as appropriate)

1 Electronically ❑
2 By telephone ❑
3 Face-to-face ❑

Discussed (tick as appropriate)

1 Once only ❑
2 Twice ❑
3 Several times ❑

Appraisal *(attach completed forms)* **(tick as appropriate)**

1 Complete agreement ❑
2 Negotiated agreement
a. process? ❑
3 Referral to guidelines leader
a. outcome? ❑

Grading (tick as appropriate)

1 Complete agreement ❑
2 Negotiated agreement
a. process? ❑
3 Referral to a third party
a. outcome? ❑

CONCLUSION

Level of evidence (circle one)

1++	1+	1–	2++	2+	2–	3	4

Appendix 4 Evidence tables for included papers

Question 1

Key

Confirmed	Isolation of agent from ill individuals and food handler, and exposure that preceded infection by a period of time consistent with proposed biological mechanisms, *and* combination of on-site investigation and statistical evidence from epidemiological study
Presumptive	On-site investigation *or* epidemiological investigation determining that there has been an association between ill food handler and individuals becoming ill
Suspected	Descriptive epidemiology suggesting that the outbreak is food-handler related and excluding obvious alternative explanations *or* food hander implicated in the outbreak report/publication but no information on epidemiology or microbiology available
Reviewers' comments	Comments made by pair of appraisers during review process taken from reviewed paper

Adapted from Rooney RM, Cramer EH, Mantha S *et al.* A review of outbreaks of foodborne disease associated with passenger ships: evidence for risk management. *Public Health Rep* 2004;119:427–34. Personal communication from Dr GK Adak, Gastrointestinal Diseases Division, PHLS Communicable Disease Surveillance Centre, 61 Colindale Avenue, London NW9 5EQ.

First author	Summary	Food vehicle	Other factors	Numbers affected	Reviewers' comments
Norovirus infection from food handlers					
Albers[36]	**Confirmed status.** Norovirus outbreak in a tertiary care facility	No specific food, cafeteria service	Symptomatic, but infected staff were absent from work before outbreak began.	74	Key to control norovirus outbreaks is exclusion of food handler and swift implementation of strict infection control procedures.
Anderson[38]	**Confirmed status.** Two food handlers from one of the catering companies had elevated immunoglobulin A antibody suggesting recent infection. Asymptomatic food handlers responsible for multi-state outbreak, as employees denied history of illness.	Salads	Asymptomatic	Large; 333 persons from 52 car dealerships in 13 states	

continued

First author	Summary	Food vehicle	Other factors	Numbers affected	Reviewers' comments
Norovirus infection from food handlers – *continued*					
Daniels[47]	**Confirmed status.** College outbreak confirmed using reverse transcriptase (RT) polymerase chain reaction (PCR) assay. Norovirus detected in stools from food handler's sick infant, food and college students.	Ham	Employee denied having any gastrointestinal illness, but her infant had been sick with watery diarrhoea two days before she prepared food items implicated in the outbreak.	Large; 125 cases	Food handler with sick infant refused to submit stool specimen, but claimed that she wore gloves while slicing ham and serving at the deli bar.
Friedman[54]	**Confirmed status.** The illness was associated with the consumption of wedding cake supplied to the wedding parties by the same bakery.	Wedding cakes	At least two infected food handlers, one symptomatic and the other asymptomatic. Two bakery employees reported gastrointestinal illness, but extent of outbreak thought to be compounded by asymptomatic employees and person-to-person spread.	Up to 2,700 persons attending 46 weddings in a single weekend	The paper demonstrates the importance of norovirus as a food handler risk, and the importance of not returning to work until symptom free for 72 hrs, due to possibility of viral shedding after recovery.
Hirakata[61]	**Confirmed status.** Organism identified and isolated from food handlers (5/10), kitchen environment and from ill restaurant diners. Demonstrates mass spread of virus by handling of food.	Sara udon, deep-fried spring roll, boiled broccoli and lettuce	One asymptomatic food handler who felt general fatigue but no gastrointestinal symptoms	Large; 660	Insufficient hand-washing and toilet facilities available. Only one washroom shared by staff and tourists. No hand-washing sink in kitchen; staff washed hands in sink used for preparing vegetables.
Kilgore[68]	**Confirmed status.** Large outbreak of small round structured virus (SRSV) (norovirus) caused by handling of salad bar items by ill food handler	Salad	Salad chef worked for two days following onset of symptoms.	188	
Lachlan[70]	**Confirmed status.** Large SRSV outbreaks associated with symptomatic food handler in hotel	Egg sandwiches and drinks from the bar	Symptomatic – but only flu-like symptoms	Large; 92	Worked during illness

continued

First author	Summary	Food vehicle	Other factors	Numbers affected	Reviewers' comments
Norovirus infection from food handlers – *continued*					
MMWR – Alaska and Wisconsin[32]	**Confirmed status for Alaska outbreak.** Two outbreaks; the first in Alaska caused by potato salad prepared by ill food handler who used bare hands to mix salad in 12-gallon container. Wisconsin outbreak could not be linked to an infected food handler.	Potato salad	Symptomatic, and worked while ill	100	Exclusion of first evidence of symptoms plus good personal hygiene at all times are essential to avoid potential transmission of Norwalk-like viruses (NLV) through food.
Parashar[81]	**Confirmed status.** Sandwiches at company lunch, prepared by food handlers implicated as source of infection by detection of virus in stools	Sandwiches	One symptomatic, but illness had subsided four days prior to event. This food handler was asymptomatic when preparing sandwiches. Second food handler was asymptomatic, and a relative of the above.	85	Norwalk virus may be shed up to 10 days after illness or while asymptomatic. Buffet food should be served by serving staff.
Patterson[83]	**Confirmed status**. An outbreak of SRSV caused by a food handler vomiting into the vegetable preparation sink	Potato salad	Food handler vomited in sink.	55	Highlights the virulence and relative resistance to environmental disinfection. Attempts were made to disinfect the sink with a chlorine-based compound.
Telfer[88]	**Confirmed status**. A retrospective cohort study linked the outbreak to two food handlers who had been ill two days prior. Food had also been prepared in homes of sick food handlers.	Range of foods including passion fruit slices and ham sandwiches	Family member of sick food handler was also ill. Gloves were not used in food preparation. Hand-washing facilities were also inadequate.	Large; 125	

continued

First author	Summary	Food vehicle	Other factors	Numbers affected	Reviewers' comments
Norovirus infection from food handlers – *continued*					
Gotz[56]	**Presumptive status.** Infected food handlers supplying food to day care centres in Sweden were responsible for food-borne gastroenteritis outbreak.	Pumpkin seeds, salad	Possibility that the food handler who prepared the salad shed the virus pre-symptomatically.	Large; more than 195	Outbreak affected 30 centres served by one caterer. This outbreak highlights the problems associated with norovirus; primary infection can be caused by infected food handler. Secondary infection spread by person-to-person transmission.
Eriksen[49]	**Suspected status**. An infected food handler was the common source for the start of a norovirus outbreak, which continued after the infected food handlers were sent home, by person-to-person spread.	Strawberry jam, dried fruit butter	Symptomatic food handler reported sick prior to outbreak. It is not reported whether infected food handler continued to work while ill.	48	Severity of illness was increased as a result of pre-existing chronic condition and medication, steroids.
Kassa[66]	**Suspected Status**. Implication that an infected food handler may have played a role in the transmission of the virus	Tossed salad		93	
Salmonella typhi					
Cote[45]	**Confirmed status.** A food-borne outbreak of typhoid fever associated with consumption of potato salad served at a private picnic, and prepared by an asymptomatic food handler	Potato salad	Asymptomatic carrier, recently immigrated	24	Travel to and from endemic areas remains a risk.
Xercavins[91]	**Presumptive status.** A prolonged food-borne outbreak of typhoid fever originating from a casual food handler who was a chronic carrier	Cannelloni	Carrier	27	

continued

First author	Summary	Food vehicle	Other factors	Numbers affected	Reviewers' comments
Salmonella typhimuriun					
Ethelberg[50]	**Confirmed status.** Asymptomatic food handler caused large outbreak over considerable time period due to lack of identification of illness and poor personal hygiene.	Cooked pasta, salad	Asymptomatic chef who excreted the organism.	Large; up to 390	
Hundy[63]	**Confirmed status.** Symptomatic food handler continued to work while ill, which resulted in outbreak at a Korean restaurant in Australia.	Mango pudding	Two food handlers reported illness. The first, solely responsible for preparing the mango pudding, continued to work until symptoms resolved six days later. The second worked for three days while symptomatic.	28	Importance of excluding symptomatic food handlers, training and dedicated hand-washing facilities. Training needs to be culturally and language appropriate.
Other Salmonellas					
Faustini[51]	**Confirmed status.** Retrospective cohort study confirmed a biphasic outbreak of *S. hadar* associated with food at a building canteen. Evidence indicates there was an initial outbreak of *S. hadar* (which may have been due to a food handler) with subsequent food-borne and person-to-person transmission, with food-borne transmission by an infected food handler.	Spaghetti with tomato sauce, chicken, scaloppini, cold pasta salad and meat salad		448 symptomatic (61 positive for group C Salmonella, including 6 food handlers), 32 asymptomatic excreters (22 positive for group C Salmonella, including 1 food handler)	

continued

First author	Summary	Food vehicle	Other factors	Numbers affected	Reviewers' comments
Other Salmonellas – *continued*					
Maguire[76]	**Confirmed status.** Double outbreak of two strains of *Salmonella virchow*. The first linked to infected child of food handler which was responsible for five outbreaks. The second outbreak was due to food handler who developed symptoms 10 days later with a different strain.	Sandwiches	Baby ill prior to outbreak	10	
Kimura[69]	**Confirmed status.** *Salmonella* serotype Thompson; symptomatic food handler identified from stool sample. Samples from food handler and cases were indistinguishable by pulsed-field gel electrophoresis (PFGE).	Bread buns	Employee worked for four days from onset of illness until hospitalisation on fourth day. Brother of employee worked while sick at same bakery, until removed from work by health officials.	78	Bakery did not offer formal training on safe food handling practices to employees. Many employees spoke Spanish only, while the procedure manuals were available only in English. Exclusion from work of sick employees.
Lee[71]	**Presumptive outbreak.** *Salmonella javiana*; a rarely encountered organism was isolated from food handlers, patron and food in a restaurant in Massachusetts.	Chicken sandwich		66	
Yoon[93]	**Suspected status.** *Salmonella enterica* serotype typhi. Report focuses on the medical presentation of four of the cases. There is insufficient evidence within the paper to confirm that the cause was the food handler. However, the seven cases were linked epidemiologically to a local restaurant where an immigrant worker had been employed.			7	

continued

First author	Summary	Food vehicle	Other factors	Numbers affected	Reviewers' comments
Hepatitis A					
Chironna[44]	**Confirmed status.** Study confirms a point source outbreak at a delicatessen where a food handler worked while suffering from acute hepatitis A.	Sandwiches		26	Recommendation for food handlers to be vaccinated in areas where hepatitis A virus (HAV) is endemic
Honish[62]	**Confirmed status.** A food handler infected with hepatitis A worked at a grocery store in Edmonton, Alberta, handling ready-to-eat food.				Following identification of infected food handler, public health strategies were undertaken, including the administration of hepatitis A immune serum globulin (IG) to approximately 5,400 individuals.
MMWR[34]	**Confirmed status.** Outbreak caused by food handler with hepatitis A	Sandwiches	Symptomatic	32	Food handler had colostomy bag and poor hand-washing techniques.
Massoudi[77]	**Confirmed status.** Hepatitis A can be transmitted through consumption of contaminated, uncooked food and salad from an infected food handler.	Uncooked food and salad	Asymptomatic	Large; 91	Infected food handler had been diagnosed with hepatitis A. No control measures at the food handler's place of work were deemed necessary by health officials. Food handler regularly prepared high-risk food. In addition, there was a lack of hand-washing facilities, which was believed to contribute to the outbreak.
Munnoch[35]	**Presumptive status**	Coleslaw and cordial	Not known	21	Infection thought to be due to an infected food handler who refused to be tested. Other means of contamination of coleslaw and cordial were ruled out as there was no evidence.

continued

First author	Summary	Food vehicle	Other factors	Numbers affected	Reviewers' comments
Hepatitis A – *continued*					
Weltman[90]	**Presumptive status**. Matched case-control study found an association between eating sugar-glazed baked goods from a retail buyers' club and developing hepatitis. Transmission was thought to occur through inadequate hand washing and bare-hand contact with food.	Sugar-glazed Danish pastry	Symptomatic	79	Importance of avoiding bare-skin contact with food which will not be further cooked before consumption.
Shigella flexneri					
Dunn[48]	**Suspected Status.** Investigations indicated that *Shigella flexneri* was the cause of the outbreak originating from infected food handlers.	Tossed salad	At least three symptomatic salad preparers who continued to work during illness.	46	
Shigella sonnei					
Mohle-Boetani[78]	Good hand washing is key to prevention and spread of shigellosis. There is an association between outbreaks and staff that both prepare food and change nappies.	Some asymptomatic food handlers			Infection could have been prevented by hand washing, especially when multitasking. Separation of food preparation from nappy-changing duties.
Shane[87]	Identified the risk factors for secondary transmission in licensed day care centres in recurrent and prolonged multi-community outbreaks in the USA			1,642 (prolonged, multi-community outbreaks)	Proper disposal of faecally contaminated material (nappies) and hand washing may reduce the likelihood of transmission of *Shigella sonnei*. No food source identified, no exposure to food handler, poor nappy disposal

continued

First author	Summary	Food vehicle	Other factors	Numbers affected	Reviewers' comments
Staphylococcus aureus					
Jones[65]	**Confirmed status** Methicillin-resistant *Staphylococcus aureus* (MRSA) infection passed on via poor handling practices and poor personal hygiene from infected food handler	Pork barbecue and coleslaw	Asymptomatic food handler	3	Infected food handler visited elderly relative at their home two or three times a month before the outbreak. The relative had staphylococcal infection and subsequently died.
Group A Streptococci/pyogenes					
Bar-Dayan[39]	**Confirmed status.** Asymptomatic food handler responsible for outbreak of disease, the vehicle being white cheese	White cheese	Asymptomatic	197	Results suggest that food handlers with sore throats should be excluded from work. This outbreak was recognised as a food-borne outbreak because it had occurred in an institution. Concerns exist that these outbreaks are not recognised in the wider community.
Levy[72]	**Suspected status**. Tonsillopharyngitis outbreak possibly transmitted by infected food handler in an Australian prison. *S. pyogenes* isolated from throat swab and hand of one food handler	Curried egg rolls (association between eating egg and infection not statistically significant)	Symptomatic, infected hand wounds	72	This outbreak was recognised as a food-borne outbreak because it had occurred in an institution. Concerns exist that these outbreaks are not recognised in the wider community.
Campylobacter jejuni					
Olsen[80]	**Confirmed outbreak.** Infected food handler linked to outbreak in customers eating on premises. The pulsed-field gel electrophoresis patterns from food handler and eight of the lunch attendees were indistinguishable.	Gravy, pineapple, mashed potato	Symptomatic	27	Food handler continued to work despite diarrhoea.

continued

First author	Summary	Food vehicle	Other factors	Numbers affected	Reviewers' comments
Cryptosporidiosis					
Quiroz[85]	**Confirmed outbreak**. Cryptosporidiosis has potential to cause large outbreaks with food handlers as a source. Many outbreaks may go undetected if samples are untested.	Fruit and vegetables	Symptomatic with diarrhoea	92	Long incubation period; affected food handlers would need to be away from work for eight days.
Rotavirus Group A serotype G2					
Fletcher[33]	Large week-long outbreak of rotavirus Group A infection associated with eating sandwiches from a campus dining hall	Sandwiches	Two food handlers reported symptoms prior to the outbreak. One asymptomatic server. Unclear if they worked while ill.	108	

First author	Study design	Research quality (SIGN grading)	Study population	Research question	Main results
Guzewich[7]	Literature review	2++	Review of 72 articles describing 81 outbreaks of food-borne disease thought to have resulted from contamination of food by food workers	To assess the factors influencing food-borne disease attributable to food handlers	16 different pathogens were identified as the causal agents from food handlers. Hepatitis A and norovirus accounted for 60% of outbreaks. 93% of outbreaks involved food handlers who were ill just prior to or at the time of the outbreak, and the remainder were attributed to asymptomatic food handlers.

Appendix 5 Evidence tables for included papers

Question 2

First author	Study design	Research quality (SIGN grading)	Study population	Research question	Main results
Hatakka[59]	Cross-sectional study	3	153 hand samples and 136 nose samples were taken from flight catering staff between 1995 and 1997.	To assess the risk associated with flight catering employees carrying Staphylococcus	Nasal sampling for *Staphylococcus aureus* was a more effective method of detecting carriers than hand sampling. Twenty-nine per cent of flight catering staff demonstrated nasal carriage of *S. aureus*, compared to 9% when hand sampling was used. Forty-six per cent of strains isolated were enterotoxigenic, and 6% and 12% of staff, according to hand and nasal sampling, carried enterotoxigenic *S. aureus*.

Appendix 6 Evidence tables for included papers

Question 3

First author	Study design	Research quality (SIGN grading)	Study population	Research question	Main results
Hand washing					
Allwood[37]	Cross-sectional study	3	123 retail food establishments (RFE) in Minnesota allowed the collection of data from the person in charge (PIC) during routine inspections; a standardised instrument and trained sanitarians were used.	What is the effect of various factors on the ability of workers to demonstrate food code-compliant hand-washing according to the Minnesota Food Code?	Hand-washing performance is directly proportional to the number of methods used to train, the most effective being demonstration and explanation. There was a strong association between the hand-washing knowledge of the PIC and ability of food workers to demonstrate proper hand washing. Formal training and certification increases both the ability of managers and food workers to demonstrate proper hand washing, and the likelihood of finding adequate hand-washing facilities (hand sink and fingernail brush).
Barker[40]	Qualitative research	2+	Hands, kitchen food contact surfaces, telephone receiver and tap handle in a model kitchen	To determine the effectiveness of different decontamination procedures after kitchen surfaces, equipment, materials and hands had been contaminated with *Salmonella enteritidis* PT4 strain from a contaminated chicken.	The results showed that during the handling of an infected chicken carcass, the organism was spread throughout the kitchen with surfaces in direct contact being consistently highly contaminated. Hand washing in a bowl did not remove contamination; the most effective washing involved washing for two minutes with soap and water followed by rinsing.

continued

First author	Study design	Research quality (SIGN grading)	Study population	Research question	Main results
Hand washing – *continued*					
Bidawid[41]	Scientific study	2++	Eleven adults were inoculated with a known quantity of hepatitis A virus (HAV) in a demarcated area on their fingertips. Transfer of the virus to food was undertaken. The ability of agents to reduce numbers of HAV was evaluated.	What is the amount of transfer of hepatitis A from artificially contaminated hands to food (lettuce) and can topical agents interrupt that transfer?	Touching lettuce resulted in a transfer of 9.2% of the infectious virus. When fingers were treated with topical agents before touching the lettuce, the transfer rate dropped to 0.3–0.6%. Water reduced transfer to nil. The implication for a food handler is that effective hand cleansing can significantly reduce contamination.
Bidawid[42]	Cohort study	2+	Six adults participated in this study. An inoculum of known concentration of feline calicivirus was deposited on demarcated areas on the fingertips. Transfers of the virus from hands to lettuce, ham or metal disks and vice versa were undertaken, and the ability of a number of hand decontaminants to interrupt virus transfer was assessed.	What is the rate of transfer of a norovirus surrogate (feline calicivirus) from hands to selected types of food and environmental surfaces, and from infected surfaces to hands? How effective are topical agents in interrupting the above transfer of feline calicivirus?	All agents, water, soap and water and alcohol-based formulations significantly reduced the virus transfer from fingertips to food and vice versa. Soap and water were the most effective in removing virus contamination from fingertips, compared to alcohol-based rubs which were less effective.
Charbonneau[28]	Qualitative research	2+	Volunteers contaminated their hands by touching chicken/beef and their hands were sampled for bacteria using the baseline method. The efficacy of hand sanitisers was tested using the same method.	Can a method be developed for assessing the effectiveness of hand sanitisers within the food industry, using a standardised 20-second hand-washing procedure?	The majority of papers evaluating the effectiveness of hand sanitisers use healthcare workers as the target occupational group. This does not take into account the specific contamination situation faced by food handlers through the handling of food. This paper assesses a method for more accurately evaluating the efficacy of hand sanitisers within the food industry. Washing hands with mild soap and water for 20 seconds was more effective than 70% alcohol scrub, for food handlers.

continued

First author	Study design	Research quality (SIGN grading)	Study population	Research question	Main results
Hand washing – *continued*					
Gehrke[55]	Qualitative research	2+	*In vitro* inactivation tests carried out mixing one part virus with one part distilled water and eight parts alcohol for the set time period. The *in vivo* tests were carried out on adult panellists. Fingertips were contaminated on a marked area, the alcohols were applied, and water was used as a control.	How effective are different types of alcohol, both *in vitro* and *in vivo*, in inactivating feline calicivirus (FCV), a surrogate for norovirus?	*In vitro*: 1-propanol is more effective than ethanol or 2-propanol for the inactivation of FCV. *In vivo*, the fingertip experiments: with an application time of 30 seconds and with 70% and 90% solutions, 70% ethanol was the most effective. A 70% alcohol solution was more effective than 90% solution for inactivating the virus from the fingertips.
Lin[74]	Experimental study	3	Eight female volunteers with artificial nails, and 10 equal numbers of male and female volunteers without artificial nails, participated in the *Escherichia coli* study. Five female volunteers with artificial nails and five (three female and two male) volunteers with natural nails participated in the hand-washing study for the virus.	Which is the most effective hand-cleansing method to remove *E. coli* and viruses from beneath the artificial and natural nails?	Longer fingernails harbour more bacteria and viruses than shorter nails. In this study, the artificial nails were significantly longer than the natural ones. The virus and bacteria were applied to the nails in ground beef which was used as artificial faeces. The most effective method of cleaning was by washing with liquid soap and a nail brush, as the organic matter (ground beef) limited the effectiveness of the alcohol washes.
Glove use					
Lynch[75]	Cohort study	2+	Flour tortillas from 371 restaurants representing three chains in Oklahoma were requested for the study.	Does glove use minimise the presence of bacteria being transmitted by food handler to food?	46% of samples were handled by workers wearing gloves, compared with 52% with bare-hand contact. Coliform bacteria were found in 9.6% of gloved samples and 4.4% of bare-handed samples. The observed tendency of food handlers to wear gloves for protracted periods, plus complacency, may account for failure of gloves to prevent or reduce bacterial contamination.

continued

First author	Study design	Research quality (SIGN grading)	Study population	Research question	Main results
Knowledge/training					
Allwood[37]	Cross-sectional study	3	123 retail food establishments (RFE) in Minnesota allowed the collection of data from the person in charge (PIC) during routine inspections; a standardised instrument and trained sanitarians were used.	What is the effect of various factors on the ability of workers to demonstrate food code-compliant hand washing according to the Minnesota Food Code?	Hand-washing performance is directly proportional to the number of methods used to train, the most effective being demonstration and explanation. There was a strong association between the hand-washing knowledge of the PIC and ability of food workers to demonstrate proper hand washing. Formal training and certification increases both the ability of managers and food workers to demonstrate proper hand washing, and the likelihood of finding adequate hand-washing facilities (hand sink and fingernail brush).
Angelillo[22]	Qualitative research	3	411 food handlers in Italy agreed to participate in face-to-face interviews using a structured questionnaire.	Can the food handlers' knowledge, attitude and behaviour concerning food safety and food-borne disease be evaluated?	The level of knowledge was higher in those who had attended education courses, or been in practice for a long period. The food handlers had a positive attitude to food safety. However, this was not always supported by their self-reported practices.
Campbell[43]	Systematic review	2++	Systematic search of the literature revealed a total of 168 studies, 15 of which were retained for the study.	How effective have been the public health interventions based in restaurants, institutions and community settings in the area of food safety?	Inspections: at least one routine inspection per food premises per year is likely to reduce risk of food-borne illness. Food-handler training: this can improve knowledge and practices of food handlers and active training is more effective than passive. Use of risk assessments to classify food services is advisable.

continued

First author	Study design	Research quality (SIGN grading)	Study population	Research question	Main results
Knowledge/training – *continued*					
Cotterchio[46]	Cohort study	2++	Ninety-four restaurants from Boston, USA, took part in the study. Managers were divided into three groups. The first, mandatory manager attendance on a training scheme; second, managers attended voluntary training; and third, control group with no training.	To evaluate the effectiveness of a food manager training and certification programme in increasing compliance with restaurant sanitary codes	Mandatory food-manager training and certification in sanitary food-handling practices resulted in a significant improvement in inspection scores that were sustained over two years.
Hammond[58]	Intervention study	2+	Compares the data relating to food-borne outbreaks from the Food and Waterborne Disease Program, Florida, before and after the intervention of mandatory training for all food workers in 2000, as opposed to training for food managers only, prior to 2000.	Can the effectiveness of food worker training programmes be measured against food-borne disease outbreaks?	The results showed that the number of cases of food-borne disease attributed to an infected food handler fell from 1,300 in 1997–2000 (before training) to 470 in 2001–2003 (after training). However, the results did not show a reduction in either the number of outbreaks or number of cases in all areas measured following the implementation of training for all food workers. This paper highlights the difficulties of measuring the effectiveness of training.
Hinkin[60]	Literature review	2+	Literature search of electronic databases from 1988–2000, using key words 'infection control, hand decontamination, hand washing and hand compliance'	What interventions, singularly or in practice, have been shown to improve hand decontamination?	The main themes were education and feedback. The studies reviewed did not look at the use of alcohol rubs. Education, as an intervention, was often used. However, the intervention was only described in 1/7 papers. Feedback was also used but again rarely described. Combinations of education, feedback and motivation improved compliance, but the improvements fell back when intervention ceased. Findings show that education must be continuous in order to be successful.

continued

First author	Study design	Research quality (SIGN grading)	Study population	Research question	Main results
Knowledge/training – *continued*					
Lillquist[73]	RCT	1+	Sixty-six participants took part; 22 in each group. Group 1 was the control; group 2 completed the standard course; and group 3 completed the standard course with the additional component of the participatory hand-washing activity.	Does active hand-washing training increase knowledge and improve attitude towards hand washing, when compared with standard training methods, in the food-handler industry?	Active training, as compared to traditional training (lecture/video) on hand washing, improves retention of knowledge which is reflected in a positive change in attitude. The paper did not go on to examine the practice of hand washing.
Naikoba[79]	Systematic review	2+	Systematic review of 17 papers, two of which were RCTs	What can be done to increase hand washing among healthcare workers?	One-off educational interventions have a very short-term effect. Strategically placed reminders can have long-term effects. Feedback on performance works as long as the feedback is being given. Alcohol rubs may lead to a minimal increase in frequency of hand washing. Authors advocate a multifaceted approach, combining education reminders and ongoing feedback on performance.
Hand drying					
Gustafson[57]	RCT	1+	The hands of 100 adult volunteers	To evaluate the effect that four different hand-drying methods had on the removal of bacteria from washed hands.	There was no statistically significant difference between drying hands by using a cloth towel, paper towels, forced warm air or evaporation for the removing of bacteria from washed hands.
Patrick[82]	Cohort	3	Six male and female staff from the Department of Medicine, University of Auckland, New Zealand, took part in the study. The volunteers were sampled six times for each different procedure evaluated.	Does the level of moisture left on the hands following hand washing determine the transfer of bacteria to other surfaces?	Numbers of bacteria recorded on different surfaces, after being touched with wet hands, were in the order of 68,000, 31,000 and 1,900 on skin, food and utilities. This number was reduced by over 94% when hands were dried.

continued

First author	Study design	Research quality (SIGN grading)	Study population	Research question	Main results
Hand drying – *continued*					
Taylor[29]	Cohort study	2+	Fifteen volunteers took part in studies to compare the effect of different hand-drying procedures on the bacterial numbers isolated from hands.	A microbial evaluation of warm air hand driers compared to paper towels with respect to hand hygiene and the washroom environment.	A finger-rinse technique for counting micro-organisms on hands showed no significant difference in the numbers of micro-organisms recovered following the drying of hands with either a warm air dryer or paper towels. This indicated that air dryers of the type tested were a hygienic method of drying hands.
Yamamoto[92]	Cohort	2+	Fifteen female volunteers took part in the hand-drying study. Participants washed hands with non-antimicrobial soap for 15 seconds, rinsed for 15 seconds, and then shook excess water from hands.	Is paper-towel drying more effective in removing bacteria from hand than drying with warm air?	Hands should be held stationary and not rubbed when dried with warm air. UV reinforced removal of bacteria. A significant increase in numbers of colony forming units (CFU) were seen on palms and fingers of hands when hands were rubbed together while being dried with warm air. Paper towels removed bacteria from fingertips but not from palms or fingers.
Hepatitis A vaccination					
Prato[84]	Case-control study	2+	Epidemiological surveillance monitoring all hepatitis A notifications	Is hepatitis A vaccination an effective method for preventing the spread of infection from infected food handlers?	A food handler identified as the index case in a community hepatitis A outbreak. In countries where hepatitis A is endemic, this paper suggests that selective vaccination is an efficient means of prevention.
Public health interventions/ inspections					
Campbell[43]	Systematic review	2++	Systematic search of the literature revealed a total of 168 studies, 15 of which were retained for the study.	How effective have been the public health interventions based in restaurants, institutions and community settings in the area of food safety?	Inspections – at least one routine inspection per food premises per year – are likely to reduce the risk of food-borne illnesses. Food-handler training can improve knowledge and practices of food handlers and active training is more effective than passive. Use of risk assessments to classify food services is advisable.

References

1 Department of Health. *Food handlers' fitness to work; guidance for businesses, enforcement officers and health professionals.* London: DH, 1995.

2 Health Protection Agency. *Communicable disease and non-infectious environmental hazards in South East region,* 2002. Website: www.hpa.org.uk

3 Food Standards Agency Scotland/Scottish Executive Health Department. *Guidance on the investigation and control of outbreaks of foodborne disease in Scotland,* 2002, amendment 8. Aberdeen: FSAS, SEHD, 2006.

4 Adak GK, Meakins SM, Yip H, Lopman BA, O'Brien SJ. Disease risks from foods, England and Wales, 1996–2000. *Emerg Infect Dis* 2005 Mar;11(3):365–72.

5 Bonner C, Foley B, Fitzgerald M. Analysis of outbreaks of infectious intestinal disease in Ireland: 1998 and 1999. *Irish Med J* 2001;94 (5):142–4.

6 Food Standards Agency Oct 2006, Board Paper.
Webpage: www.food.gov.uk/multimedia/pdfs/pro061001.pdf

7 Guzewich J, Ross M. Evaluation of risks related to microbial contamination of ready to eat food by food preparation workers and the effectiveness of interventions to minimize those risks. White Paper, Section One. A literature review pertaining to foodborne disease. Outbreaks caused by food workers, 1975–1998. MD, USA: Food and Drug Administration, Centre for Food Safety and Applied Nutrition, September 1999. Webpage: vm.cfsan.fda.gov/-ear/rterisk.html

8 Food Safety (General Food Hygiene) Regulations 1995. SI 1995/176.
Web page: www.opsi.gov.uk/si/si1995/Uksi_19951763_en_1.htm

9 Regulation (EC) No 852/2004 of the European Parliament and of the Council of 29 April 2004 on the hygiene of foodstuffs.
Web page: www.europa.eu.int/eur-lex/pri/en/oj/dat/2004/l_139/l_13920040430en00010054.pdf

10 Food Hygiene (England) Regulations 2006. SI 2006/14.
Web page: www.opsi.gov.uk/si/si2006/20060014.htm

11 Food Hygiene (Scotland) Regulations 2006. Scottish SI 2006/3.
Web page: www.opsi.gov.uk/legislation/scotland/ssi2006/20060003.htm

12 The Food Hygiene (Wales) Regulations 2006, Wales SI 2006/31.
Web page: www.edinburgh-gazette.gov.uk/legislation/wales/wsi2006/20060031e.htm

13 The Food Hygiene (Northern Ireland) Regulations 2006, Statutory Rules of Northern Ireland 2006/3.
Web page: www.opsi.gov.uk/sr/sr2006/20060003.htm

14 Green L, Selman C, Banerjee A *et al.* Food service workers' self reported food preparation practices: an EHS Net study. *Int J Hygiene Environmental Health* 2005;208(1–2):27–35.

15 PHLS Advisory Committee on Gastrointestinal Infections. Preventing person-to-person spread following gastrointestinal infections: guidelines for public health physicians and environmental health officers. *Commun Dis Public Health* 2004;7(4):362–84.

16 White KE, Osterholm MT, Mariotti JA *et al.* A foodborne outbreak of norwalk virus: evidence for post recovery transmission. *Am J Epidemiol* 1986;124(1):120–26.

17 Graham D Y, Jiang X, Tanaka T. Norwalk virus infection of volunteers: new insights based on improved assays. *J Infect Dis* 1994;170:34–43.

18 Department of Health Expert Working Group. *Food handlers: fitness to work: guidance for food business managers.* London: DH, 1995.

19 Harker C. Pre-employment health assessments for food handlers: a survey of occupational health physicians in the food industry. *Occup Med* 2001;51(5):332–5.

20 Hall H, Hauser G. Examination of feces from food handlers for Salmonellae, Shigellae, enteropathogenic Escherichia coli and Clostridium perfringes. *Appl Microbiol* 1966;14(6):928–32.

21 Clayton D. Food handlers' beliefs and self-reported practices. *Int J Environ Health Res* 2002;12:25–39.

22 Angelillo IF, Viggiani NM, Rizzo L, Bianco A. Food handlers and foodborne diseases: knowledge, attitudes, and reported behavior in Italy. *J Food Prot* 2000 Mar; 63(3):381–5.

23 MacAuslan E. Health lies in clean hands. *Environ Health J* 2004 Jul;220–22.

24 Rooney RM, Cramer EH, Mantha S *et al.* A review of outbreaks of foodborne disease associated with passenger ships: evidence for risk management. *Public Health Reports* 2004:119:427–34.

25 Woteki CE, Kineman BD. Challenges and approaches to reducing foodborne illness. *Ann Rev Nutrition* 2003;23:315–44.

26 Fiore AE. Hepatitis A transmitted by food. *Clin Infect Dis* 2004;38(5):705–15.

27 Appleton H. Control of food-borne viruses. *Br Med Bull* 2000;56(1):172–83.

28 Charbonneau DL, Ponte JM, Kochanowski BA. A method of assessing the efficacy of hand sanitizers: use of real soil encountered in the food service industry. *J Food Prot* 2000 Apr; 63(4):495–501.

29 Taylor JH,Brown KL, Toivenen J, Holah JT 2000. A micro biological evaluation of warm air hand driers with respect to hand hygiene and the washroom environment. *J Appl Microbiol* 2000 Dec;89(6):910–19.

30 Meers PD, Yeo GA. Shedding of bacteria and skin squames after hand washing. *J Hyg (Lond)* 1978 Aug;81(1):99–105.

31 National Institute for Health and Clinical Excellence. *Methods for development of NICE public health guidelines*. London: NICE, 2006. Website: www.nice.org.uk

32 Centers for Disease Control and Prevention. Outbreaks of Norwalk-like viral gastroenteritis – Alaska and Wisconsin, 1999. *MMWR Morb Mortal Wkly Rep* 2000 Mar 17;49(10):207–11.

33 Centers for Disease Control and Prevention. Foodborne outbreak of group A rotavirus gastroenteritis among college students – District of Columbia, March–April 2000. *JAMA* 2001 Jan 24, 2001 Jan 31;285(4):405–6.

34 Centers for Disease Control and Prevention. Foodborne transmission of hepatitis A – Massachusetts, 2001. *MMWR Morb Mortal Wkly Rep* 2003 Jun 20;52(24):565–7.

35 Munnoch SA, Ashbolt RH, Coleman DJ *et al.* A multi-jurisdictional outbreak of Hepatitis A related to a youth camp – implications for catering operations and mass gatherings. *Commun Dis Intell* 2004;28: 521–27.

36 Albers MK. An unwanted visitor. *Canadian Nurse* Nov 2004;100(9):21–6.

37 Allwood PB, Jenkins T, Paulus C, Johnson L, Hedberg CW. Hand washing compliance among retail food establishment workers in Minnesota. *J Food Prot* 2004 Dec;67(12):2825–8.

38 Anderson AD, Garrett VD, Sobel J *et al.* Multistate outbreak of Norwalk-like virus gastroenteritis associated with a common caterer. *Am J Epidemiol* 2001 Dec 1;154(11):1013–9.

39 Bar-Dayan Y, Bar-Dayan Y, Klainbaum, Y, Shemer J. Food-borne outbreak of streptococcal pharyngitis in an Israeli Airforce Base. *Scand J Infect Dis* 1996;28(6):563–6.

40 Barker J, Naeeni M, Bloomfield SF. The effects of cleaning and disinfection in reducing Salmonella contamination in a laboratory model kitchen. *J Appl Microbiol* 2003;95(6):1351–60.

41 Bidawid S, Farber JM, Sattar SA. Contamination of foods by food handlers: experiments on hepatitis A virus transfer to food and its interruption. *Appl Environ Microbiol* 2000 Jul; 66(7):2759–63.

42 Bidawid S, Malik N, Adegbunrin O, Sattar SA, Farber JM. Norovirus cross-contamination during food handling and interruption of virus transfer by hand antisepsis: experiments with feline calicivirus as a surrogate. *J Food Prot* 2004 Jan;67(1):103–9.

43 Campbell ME, Gardner CE, Dwyer JJ *et al.* Effectiveness of public health interventions in food safety: a systematic review. *Can J Public Health* 1998 May–Jun; 89(3):197–202.

44 Chironna M. Outbreak of infection with hepatitis A virus (HAV) associated with a food handler and confirmed by sequence analysis reveals a new HAV genotype IB variant. *J Clin MIcrobiol* 2004;42(6): 2825–8.

45 Cote TR, Convery H, Robinson D. Typhoid Fever in the Park: epidemiology of an outbreak at a cultural interface. *J Community Health* 1995;20:541–8.

46 Cotterchio M, Gunn J, Coffill T, Tormey P, Barry A. Effect of a manager training Program on sanitary conditions in restaurants. *Public Health Rep* Jul/Aug 1998;113:353–8.

47 Daniels NA, Bergmire-Sweat DA, Schwab KJ *et al.* A foodborne outbreak of gastroenteritis associated with Norwalk-like viruses: first molecular traceback to deli sandwiches contaminated during preparation. *J Infect Dis* 2000 Apr; 181(4):1467–70.

48 Dunn RA, Hall WN, Altamirano JV *et al.* Outbreak of Shigella flexneri linked to salad prepared at a central commissary in Michigan. *Public Health Rep* Sep 1995, Oct 31;110(5):580–6.

49 Eriksen HM. Gastro-enteritis outbreak among Nordic patients with psoriasis in a health centre in Gran Canaria, Spain: a cohort study. *N Engl J Med* 2004 Oct 29;4:45.

50 Ethelberg S, Lisby M, Torpdahl M *et al.* Prolonged restaurant-associated outbreak of multidrug-resistant Salmonella Typhimurium among patients from several European countries. *Clin Microbial Infect* 2004;10:904–10.

51 Faustini A, Sangalli M, Fantasia M *et al.* An outbreak of Salmonella hadar associated with food consumption at a building site canteen. *Eur J Epidemiol* 1998 Jan;14(1):99–106.

52 Fitzgerald C, Helsel LO, Nicholson MA *et al.* Evaluation of methods for subtyping Campylobacter jejuni during an outbreak involving a food handler. *J Clin Microbiol* 2001 Jul;39(7):2386–90.

53 Fletcher M, Levy ME, Griffin DD. Foodborne outbreak of Group A rotavirus gastroenteritis among college students – District of Columbia, March–April 2000. *MMWR Morb Mortal Wkly Rep* 2000 Dec 22;49(50):1131–3.

54 Friedman DS, Heisey-Grove D, Argyros F *et al.* An outbreak of norovirus gastroenteritis associated with wedding cakes. *Epidemiol Infect* 2005 Dec;133(6):1057–63.

55 Gehrke C, Steinmann J, Goroncy-Bermes P. Inactivation of feline Calicivirus, a surrogate of Norovirus (formerly Norwalk-like virus), by two different types of alcohol in vitro and in vivi. *J Hosp Infect* 2004 Jan; 56(1):49–55.

56 Gotz H, de Jong B, Lindback J *et al.* Epidemiological investigation of a food-borne gastroenteritis outbreak caused by Norwalk-like virus in 30 day-care centres. *Scand J Infect Dis* 2002; 34(2):115–21.

57 Gustafson DR, Vetter EA, Larson DR *et al.* Effects of 4 hand-drying methods for removing bacteria from washed hands: a randomized trial. *Mayo Clin Proc* 2000 Jul; 75(7):705–8.

58 Hammond RM, Brooks RG, Schlottmann J, Johnson D, Johnson RJ. Assessing the Effectiveness of food worker training in Florida: opportunities and challenges. *J Environ Med* 2005 October; 68(3):19–24.

59 Hatakka M, Bjorkroth KJ, Asplund K, Maki-Petays N, Korkeala HJ. Genotypes and enterotoxicity of Staphylococcus aureus isolated from the hands and nasal cavities of flight-catering employees. *J Food Prot* 2000 Nov; 63(11):1487–91.

60 Hinkin J. Hand decontamination: what interventions improve compliance? *EDTNA ERCA J* 2002 Jul–Sept 30;28(3):134–7.

61 Hirakata Y, Arisawa K, Nishio O, Nakagomi O. Multiprefectural spread of gastroenteritis outbreaks attributable to a single genogroup II norovirus strain from a tourist restaurant in Nagasaki, Japan. *J Clin Microbiol* 2005 Mar;43(3):1093–8.

62 Honish L, Bergstrom,K. Hepatitis A infected food handler at an Edmonton, Alberta retail food facility: public health protection strategies. *Can Commun Dis Rep* 2001 Nov 1;27(21):177–80.

63 Hundy RL, Cameron S. An outbreak of infections with a new Salmonella phage type linked to a symptomatic food handler. *Commun Dis Intell* 2002;26(4):562–7.

64 Hutin YJF, Pool V, Crammer EH. A Multistate foodborne outbreak of hepatitis A. 1999;340:595–602.

65 Jones TF, Kellum ME, Porter SS, Bell M, Schaffner W. An outbreak of community-acquired foodborne illness caused by methicillin-resistant Staphylococcus aureus. *Emerg Infect Dis* 2002 Jan;8(1):82–4.

66 Kassa H. An outbreak of Norwalk-like viral gastroenteritis in a frequently penalized food service operation: a case for mandatory training of food handlers in safety and hygiene. *J Environ Health* 2001 Dec;64(5):9–12,33.

67 Katzenell U, Shemer J, Bar-Dayan Y. Streptococcal contamination of food: an unusual cause of epidemic pharyngitis. *Epidemiol Infect* 2001 Oct;127(2):179–84.

68 Kilgore P, Belay ED, Hamlin DM *et al.* A University outbreak of gastroenteritis due to a small round-structured virus: application of molecular diagnostics to identify the etiologic agent and patterns of transmission. *J Infect Dis* 1996;173:787–93.

69 Kimura AC, Palumbo MS, Meyers H *et al.* A multi-state outbreak of Salmonella serotype Thompson infection from commercially distributed bread contaminated by an ill food handler. *Epidemiol Infect* 2005 Oct;133(5):823–8.

70 Lachlan M, Licence K, Oates K, Vaughan S, Hill R. Practical lessons from the management of an outbreak of small round structured virus (Norwalk-like virus) gastroenteritis. *Commun Dis Public Health* 2002 Mar;5(1):43–7.

71 Lee R, Peppe J, George H. Pulsed-field gel electrophoresis of genomic digests demonstrates linkages among food, food handlers, and patrons in a food-borne Salmonella javiana outbreak in Massachusetts. *J Clin Microbiol* 1998 Jan;36(1):284–5.

72 Levy M, Johnson CG, Kraa E. Tonsillopharyngitis caused by foodborne group A streptococcus: a prison-based outbreak. *Clin Infect Dis* 2003 Jan 15;36(2):175–82.

73 Lillquist DR, McCabe ML, Church KH. A comparison of traditional hand washing training with active hand washing training in the food handler industry. *J Environ Health* 2005 Jan–Feb;67(6):13–6,28.

74 Lin CM, Wu FM, Kim HK *et al.* A comparison of hand washing techniques to remove Escherichia coli and caliciviruses under natural or artificial fingernails. *J Food Prot* 2003 Dec; 66(12): 2296–301.

75 Lynch RA, Phillips ML, Elledge BL, Hanumanthaiah S, Boatright DT. A preliminary evaluation of the effect of glove use by food handlers in fast food restaurants. *J Food Prot* 2005 Jan;68(1):187–90.

76 Maguire H, Pharoah P, Walsh B *et al.* Hospital outbreak of Salmonella virchow possibly associated with a food handler. *J Hosp Infect* 2000 Apr;44(4):261–6.

77 Massoudi MS, Bell BP, Paredes V *et al.* An outbreak of hepatitis A associated with an infected food handler. *Public Health Rep* 1999 Mar–Apr30;114(2):157–64.

78 Mohle-Boetani JC, Stapleton M, Finger R *et al.* Communitywide shigellosis: control of an outbreak and risk factors in child day-care centres. *Am J Public Health* 1995;85(6):763–4.

79 Naikoba S, Hayward A. The effectiveness of interventions aimed at increasing hand washing in healthcare workers – a systematic review. *J Hosp Infect* 2001 Mar;47(3):173–80.

80 Olsen SJ, Hansen GR, Bartlett L *et al.* An outbreak of Campylobacter jejuni infections associated with food handler contamination: the use of pulsed-field gel electrophoresis. *J Infect Dis* 2001 Jan 1;183(1):164–7.

81 Parashar UD, Dow L, Fankhauser RL *et al.* An outbreak of viral gastroenteritis associated with consumption of sandwiches: implications for the control of transmission by food handlers. *Epidemiol Infect* 1998 Dec;121(3):615–21.

82 Patrick DR, Findon G, Miller TE. Residual moisture determines the level of touch-contact-associated bacterial transfer following hand washing. *Epidemiol Infect* 1997 Dec;119(3):319–25.

83 Patterson W, Haswell P, Fryers PT, Green J. Outbreak of small round structured virus gastroenteritis arose after kitchen assistant vomited. *Commun Dis Rep CDR Rev* 1997 Jun 27;7(7):R101–3.

84 Prato R, Lopalco PL, Chironna M, Germinario C, Quarto M. An outbreak of hepatitis A in Southern Italy: the case for vaccinating food handlers. *Epidemiol Infect* 2006 Aug;134(4):799–802.

85 Quiroz ES, Bern C, MacArthur JR *et al.* An outbreak of cryptosporidiosis linked to a food handler. *J Infect Dis* 2000 Feb;181(2):695–700.

86 Sarvghad MR, Naderi HR, Naderi-Nassab M *et al.* An outbreak of food-borne group A Streptococcus (GAS) tonsillopharyngitis among residents of a dormitory. *Scand J Infect Dis* 2005;37(9): 647–50.

87 Shane AL, Tucker NA, Crump JA, Mintz ED, Painter JA. Sharing Shigella: risk factors for a multicommunity outbreak of shigellosis. *Arch Pediatr Adolesc Med* 2003 Jun;157(6):601–3.

88 Telfer B, Capon A, Kolbe T *et al.* A large outbreak of norovirus gastroenteritis linked to a catering company, New South Wales, October 2003. *NSW Public Health Bull* 2004 Sep–Oct 31;15(9–10):168–71.

89 Wei HL, Chiou CS. Molecular subtyping of Staphylococcus aureus from an outbreak associated with a food handler. *Epidemiol Infect* 2002;128:15–20.

90 Weltman AC. An outbreak of hepatitis A associated with a bakery, New York 1994: the 'West Branch, Michigan' outbreak repeated. *Epidemiol Infect* 1996;117:333–41.

91 Xercavins M, Llovet T, Navarro F *et al.* Epidemiology of an unusually prolonged outbreak of typhoid fever in Terrassa Spain. *Clin Infect Dis* 1997 Mar 24(3):506–10.

92 Yamamoto Y, Ugai K, Takahashi Y. Efficiency of hand drying for removing bacteria from washed hands: comparison of paper towel drying with warm air drying. *Infect Control Hosp Epidemiol* 2005 Mar;26(3): 316–20.

93 Yoon J, Segal-Maurer S, Rahal JJ. An outbreak of domestically acquired typhoid fever in Queens, NY. *Arch Int Med* 2004 Mar 8;164(5):565–7;2004 Mar 8;164(5):565–7.

94 Reij M, Van Asselt E, Cordier J-L, Gorris L. Recontamination as a source of pathogens in processed foods – a literature review. *ILSI Europe Report Series* 2005:1–28.

95 Harbarth S, Pittet D, Grady L *et al.* Interventional study to evaluate the impact of an alcohol-based hand gel in improving hand hygiene compliance. *Pediatr Infect Dis J* 2002 Jun;21(6):489–95.

Further copies of these guidelines are available from NHS Plus:
Email: nhsplus@nhs.net

ISBN 978-1-86016-335-7

NHS Plus
Email: nhsplus@nhs.net

www.nhsplus.nhs.uk

Occupational Health Clinical Effectiveness Unit
Royal College of Physicians of London
11 St Andrews Place, Regent's Park, London NW1 4LE

www.rcplondon.ac.uk

Supported by:
The Faculty of Occupational Medicine
of the Royal College of Physicians
6 St Andrews Place, Regent's Park, London NW1 4LB

www.facoccmed.ac.uk