Scottish Health Facilities Note 30

Infection control in the built environment – design and planning

NHSScotland, P&EFEx, January 2002

Contents

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About this Series

The Scottish Health Facilities Note series is intended to give advice on the briefing and design of healthcare premises in Scotland.

These Notes are prepared in consultation with representatives of NHSScotland and appropriate professional bodies. Scottish Health Facilities Notes are aimed at multidisciplinary teams engaged in:

- designing new buildings;
- adapting or extending existing buildings.

The intention is to give the reader informed guidance on which to base design decision.

This document has been adapted by the Property and Environment Forum Executive from the core text provided by NHS Estates, England.

Research and investigation have consistently confirmed that the healthcare environment is a secondary reservoir for organisms with the potential for infecting patients. If healthcare-associated infection is to be reduced, it is imperative that infection control is 'designed-in' at the planning and design stages of a healthcare-facility new build or renovation project.

Designed-in infection control means that designers, architects, engineers, facilities managers and planners work in collaborative partnership with infection control teams to deliver facilities in which infection control needs have been planned for, anticipated and met.

This guidance discusses the various stages of a capital build project from initial concept through to post-project evaluation and highlights the major infection control issues and risks that need to addressed at each particular stage to achieve designed-in infection control. (A project development chart is included for quick reference.)

The most important points raised by the document are that there is a:

- need for timely, collaborative partnership to achieve infection control goals specific to each construction project;
- need to understand and assess the risks of infection relating to construction projects and the built environment;
- need for all stakeholders to understand the basic principles of 'designed-in' infection control;
- need for good project management in relation to infection control considerations for all new build and refurbishment projects;
- need for quality control throughout the duration of the construction project;
- need to continually monitor developments.

1. Scope of SHFN 30

Introduction

1.1 This SHFN is not an infection control manual nor is it intended as a comprehensive guide to the principles underpinning the global issues surrounding infection control.

The document's principal aim is to provide guidance on infection control, and on the prevention of cross-infection in healthcare facilities, to those responsible for the planning, design and maintenance of such facilities. It is therefore intended as a first point of reference on infection control for healthcare estates and facilities managers, architects, builders, engineers, surveyors, health planners and infection control teams working on healthcare-estate new-build and refurbishment projects. It will also be useful as a guide for best practice in existing healthcare facilities.

Origins

1.2 The idea for a generic document on infection control in relation to healthcare facilities was born out of the need to pull together information on infection control that is already available, but not always widely known. This relevant information on Topics relating to the planning, design and maintenance of buildings for healthcare estates and facilities is required by all parties involved with this design process.

At the inception of a new-build or refurbishment project, infection control and its implications for planning and design have all too often been overlooked. This often leads to costly alterations and delays further down the line. This document will clearly define the planning process with the aim of promoting early, and continual, collaboration between all key project members.

Purpose

1.3 The document aims to:

- encourage timely communication between professionals involved in the planning, design and maintenance of healthcare buildings where prevention of cross-infection in healthcare premises and infection control issues impinge upon project management;
- outline initiatives and policies that underpin present infection control practice related to the planning, design and maintenance of healthcare buildings both for refurbishment and new-build;
- draw together the present guidance on infection control for healthcare estates and facilities managers, architects, builders, engineers, surveyors,

health planners and infection control teams working on health estates projects;

- act as a single resource for refurbishment projects or new-build and as guidance for existing buildings.

The document includes references to pertinent literature and other sources, but does not provide an exhaustive literature search.

Structure

1.4 The document is structured to enable the reader to access the relevant points quickly and easily and, where only brief information has been included, highlight further useful references.

Background

1.5 This Chapter provides an overview of initiatives and policies that impact both on the prevention of cross-infection in healthcare premises and on healthcare estates and facilities management, an explanation of the range and purpose of NHS publications and the evidence presently available.

Infection control risk management

1.6 This Chapter outlines the infection control implications for planning, construction and renovation. It also highlights where risk assessment will help to mitigate environmental sources of microbes and prevent infection through architectural design:

- hand-wash facilities;
- separation of patients with communicable disease;
- ventilation.

Controls assurance is also discussed in this Chapter.

Understanding the planning process

1.7 The planning process is explained and each professional's responsibility during the project in relation to infection control issues is discussed.

A project development chart of the process is included in Chapter 4.

Planning and designing a healthcare facility: issues to consider

1.8 A planning guide is provided as a checklist for quick and easy access to the relevant areas of interest in the planning process. It is suggested that each area is checked against the project plans at the appropriate time in the design and planning process (see the project development chart). Timing will vary from project to project but the suggested time-scale will aid the novice involved in the planning of a healthcare building for the first time.

1.9 Appendices

Appendix 1

This includes a brief description of problem organisms with the emphasis on routes of transmission in the built environment and methods of control or prevention.

Appendix 2

This describes the four categories of equipment supplied for new building schemes.

Appendix 3

Summary of principles and approach to infection control.

Appendix 4

Glossary of terms used in the guidance.

References

2. Background

Introduction

2.1 The profile of infection control throughout the UK has been raised significantly in recent years. There have been major reports on the subject from the National Audit Office (February 2000) and the House of Commons Committee of Public Accounts (November 2000). The importance of infection control in tackling the universal problem of antimicrobial resistance has been made clear in reports on that subject from the House of Lords Select Committee on Science and Technology (March 1998) and the Standing Medical Advisory Committee (England) (September 1998)(Department of Health, 1998).

2.2 There have been many books and articles written on the subject — but none have issued comprehensive guidance on infection control as it relates to healthcare-facility construction and renovation projects.

Extant guidance and research on infection control issues are disseminated across a broad range of publications worldwide, making search and retrieval of material time-consuming, unwieldy and often non-productive for those seeking timely information. This book seeks to redress the balance and provide an up-to-date, 'first stop' guidance for all those involved in the design and planning stages of such healthcare building projects. This is done by reviewing and collating this fragmentary wealth of knowledge on infection control and outlining its implications for the built environment. This is a crucial part of the action and strategy to tackle and reduce healthcare-associated infection.

The built environment and quality care

Infection control and the built environment

2.3 Owing to major technical and therapeutic advances, the control of infection in healthcare today has become an even greater challenge than ever before. In addition, microbial resistance has become a major public health threat, making infections difficult to treat and sometimes resulting in life-threatening complications or a prolonged stay in hospital.

2.4 Architects, engineers, planners and trust chief executives increasingly find themselves having to compromise when building a modern healthcare facility as there are many requirements and conflicts of interest:

- patient-centred healthcare and efficiency needs;
- finance and 'humanising' the environment (e.g. furnishing health premises with works of art); and
- infection control needs, space constraints and aesthetics.

2.5 The design demands of emerging technologies also conflict with the need to control and contain resistant organisms that cause cross-infection.

Furthermore, the lifespan of healthcare facilities has contracted and buildings may be reconfigured for other uses several times during their existence. This becomes more difficult or complex depending on their original design or use, for example:

- altering side rooms without en-suite facilities to form isolation rooms;
- a six bedded bay converted to a pacing room;
- a primary care consulting room changing to a minor surgery area.

2.6 Research and investigation have consistently confirmed that the healthcare environment is a secondary reservoir for organisms with the potential for infecting patients. Thus, if this burden of healthcare-associated infection is to be reduced, it is imperative that architects, engineers, designers and builders be partners with healthcare staff and infection control teams when planning new facilities or renovating older buildings.

There are huge challenges ahead for architects, engineers, planners, hospital managers and those staff with responsibility for advising on infection control issues. Investment has to accompany these reforms and cost containment will still play a major role in the redevelopment or upgrading of healthcare buildings.

2.7 Tomorrow's healthcare will also be consumer-driven and it is the convenience of the patient rather than that of the provider which will drive facility design. There will be an increasing emphasis on decentralising facilities for certain types of care, e.g. minor surgery. These facilities will not only need to be patient-friendly but also offer a safe environment for quality care. Healthcare building design will need to facilitate such care, but be informed by evidence-based research too.

Infection control and quality care

2.8 Good risk management awareness and practice at all levels is a critical success factor for any organisation (see Chapter 2). Risk is inherent in everything that an organisation does:

- treating patients;
- managing projects;
- processing equipment;
- purchasing new medical equipment;
- managing services such as water supply, wastewater, ventilation, waste disposal and laundering;
- environmental pollution control, etc.

The aim is to ensure that patients receive safe care practices that are up to date and timely. Risk assessment, organisational control and clinical governance

frameworks all need to be integrated to support the operation of a successful infection control policy.

3. Infection control risk management

Risk Management

3.1 Risk management involves three stages:

1. Identifying risk.
2. Assessing risk.
3. Managing the identified risks by elimination or by using controls to reduce the risk.

Identifying risk

3.2 The time taken to plan or refurbish a healthcare facility can vary from a relatively short period, in the case of urgent renovation, to as long as three or four years for a major capital build project. It is therefore important that infection control teams are notified of capital bids or contracts to architects at the earliest possible time. The microbiologist and infection control team needs to be involved in the first planning meetings. Most meetings thereafter will require some input from them.

3.3 To avoid mistakes and pitfalls, infection control teams must determine the real issues:

- how will the product, equipment, room or clinic be used?
- what possible solutions are available?
- what are the budgetary limitations?
- what infection control principles or external regulations apply?
- what does the evidence suggest in relation to the specific context?
- what are the laws governing the project?
- what are the standards and guidelines from architectural and engineering bodies, government departments and accrediting agencies?
- which product or design best balances the infection control requirements with employee and patient safety and satisfaction, and cost constraints? (Carter and Barr, 1997).

Common pitfalls

3.4 Common pitfalls arise from a number of pressures, for example, the pressure to choose the cheapest products or design. As many authors have argued, the best products or designs may be more expensive initially but in the long term they will probably realise cost benefits as they may prevent outbreaks of cross

infection. They may also last longer and require less maintenance and be more durable.

Common errors

3.5 Common errors in design and construction identified by Carter and Barr (1997) due to inept or non-existent risk management include:

- air intakes placed too close to exhausts or other mistakes in the location of air intakes;
- incorrect number of air changes;
- air handling system functions only during the week or on particular days of the week;
- airvents not reopened after construction is finished;
- no negative air-pressure rooms built in a large, new inpatient building;
- carpet placed where vinyl should be used;
- wet-vacuum system in the operating suite pulls water up one floor into a holding tank rather than down one floor;
- aerators on taps;
- sinks located in inaccessible places;
- patient rooms, or treatment rooms, with no clinical wash basins in which healthcare workers [and visitors] can wash their hands;
- doors too narrow to allow beds and equipment to be moved in an out of room.

Carter and Barr reported these errors during construction projects they encountered in their practice of infection control. They recommend that infection control personnel inspect the construction site frequently to make sure the workers are following the correct guidance.

Assessing risk

3.6 Outbreaks of infection have been directly related to the design, plan, layout, function and/or finish of the built environment. Thus, risk assessment is a fundamental imperative in the planning and design stages of a healthcare facility. This is often overlooked or compromised throughout the lifecycle of the project. Disseminating good specialist knowledge and involving infection control teams throughout all phases of construction and renovation projects will reduce risks. Failure to assess infection control risk properly can lead to expensive redesign later.

Managing the risk

3.7 Infection control teams need to help non-clinical professionals to understand the main principles of how infection is spread in the context of the built environment. These principles should inform the design and planning stages of health service facilities projects. When evaluating the spread of infection and its control, three aspects should be considered:

1. Source.
2. Mode of transmission.
3. Susceptible recipient.

Source

3.8 Building professionals must be convinced about the risks associated with construction projects, and that the environment can be a reservoir for potentially infective agents. The source is the person, animal, object or substance from which an infectious agent is transmitted to a host. The immediate hospital environment can be a potential reservoir of micro-organisms and source of infection or contamination. Designers and planners need to consider eliminating potential sources of infection by practising good design, for example:

- sufficient suitable storage facilities (see 'Storage' in Chapter 5);
- choice of materials, avoiding unnecessary surfaces that may become reservoirs for infectious agents (see 'Finishes' in Chapter 5); and
- ensuring materials and surfaces can be cleaned and maintained.

3.9 It has been reported that antibiotic-resistant bacteria, such as methicillin-resistant staphylococcus aureus (MRSA), may survive and persist in the environment leading to recurrent outbreaks (see the table of common infective agents associated with construction in Appendix 1).

3.10 Attention to prevention of airborne infection by the use of ventilation in specialist areas, and correct engineering and mechanical services, contribute greatly to reducing potential reservoirs of infection in the built environment.

3.11 Elimination of other environmental sources of infection, e.g. pests, litter, insects, birds, small mammals and waste, should be considered at the outset of a project and reviewed throughout. Common pests include rats, mice, ants, cockroaches, pigeons and flies. All carry micro-organisms on their bodies and in their droppings. Hospital hygiene is dependent on eradicating pests and ensuring they do not return.

Mode of transmission

3.12 A basic understanding of modes of transmission of infection assists in promoting joint responsibility for infection control. Micro-organisms can be transmitted in three main ways:

- **direct** transmission involving direct transfer of micro-organisms to the skin or mucous membranes by direct contact;
- **indirect** transmission involving an intermediate stage between the source of infection and the individual,
  e.g. infected food, water or vector-borne transmission by insects;
- **airborne** transmission involving inhaling aerosols containing micro-organisms, e.g. legionnaires' disease or tuberculosis.

3.13 Environmental dispersal of micro-organisms during construction, resulting in healthcare-associated infections, should also be emphasised to non-medical members of the project teams.

There is a need to assess the infection risks during construction and how construction activity itself may be a mechanism for infection. For example, environmental airborne contaminants and infectious agents are closely related to water and moisture conditions and figure prominently in construction activity.

Susceptible recipient

3.14 Preventing transmission of infectious agents to vulnerable patient populations, healthcare workers and visitors is an important component of infection control programmes.

Outbreaks affecting immunocompromised patients have been reported, and construction professionals need to understand the concept of the at-risk patient. Some groups of patients are especially susceptible to certain infectious agents to which they may be exposed in the hospital construction environment (see Appendix 1).

Conclusion

3.15 The integration of infection control risk management and construction is in its infancy. It represents a significant change in the management of healthcare facilities design and planning that will take time to develop to a level at which the greatest benefits can be achieved. Just as important is the need to carry out research in the area of risk management, infection control and the built environment to produce sound irrefutable evidence on which to base further risk management strategies. The guidance outlined in Chapter 5 aims to demonstrate, in general terms, the areas where basic infection control principles and risk management, if applied, will promote prevention of cross-infection in the built environment.

IMPORTANT

- always consult the infection control team at an early stage:
  - whenever refitting or refurbishment is planned
  - whenever major capital bids are planned.
- do not wait until patients are ready to move in;
- do not wait until fixtures, fittings and furnishings have been purchased;
- do not let cost or space consideration override reason!;
- most advice will be common sense but not always popular financially.

4. Understanding the planning process

Strategic planning and the role of infection control

4.1 In the UK, there are no regulations prescribing that infection control personnel should participate in strategic planning for construction. In the USA, the current authority for construction design for federal and healthcare providers is the 1996–1997 edition of Guidelines for Design and Construction of Hospital and Healthcare Facilities, published by the American Institute of Architects/Academy of Architecture for Health (1996) with assistance from the US Department of Health and Human Services; www.e-architect.com/pia/pubs/aah.asp . The latest version strongly supports infection control input at early planning and design stages

For infection control teams to effectively participate in the planning process for both renovation and new-build, it is necessary for them to understand the process from its inception to completion.

Project roles and responsibilities

4.2 A comprehensive approach to planning needs to include consultation with the participation of appropriate specialists from its inception through to post-project evaluation.

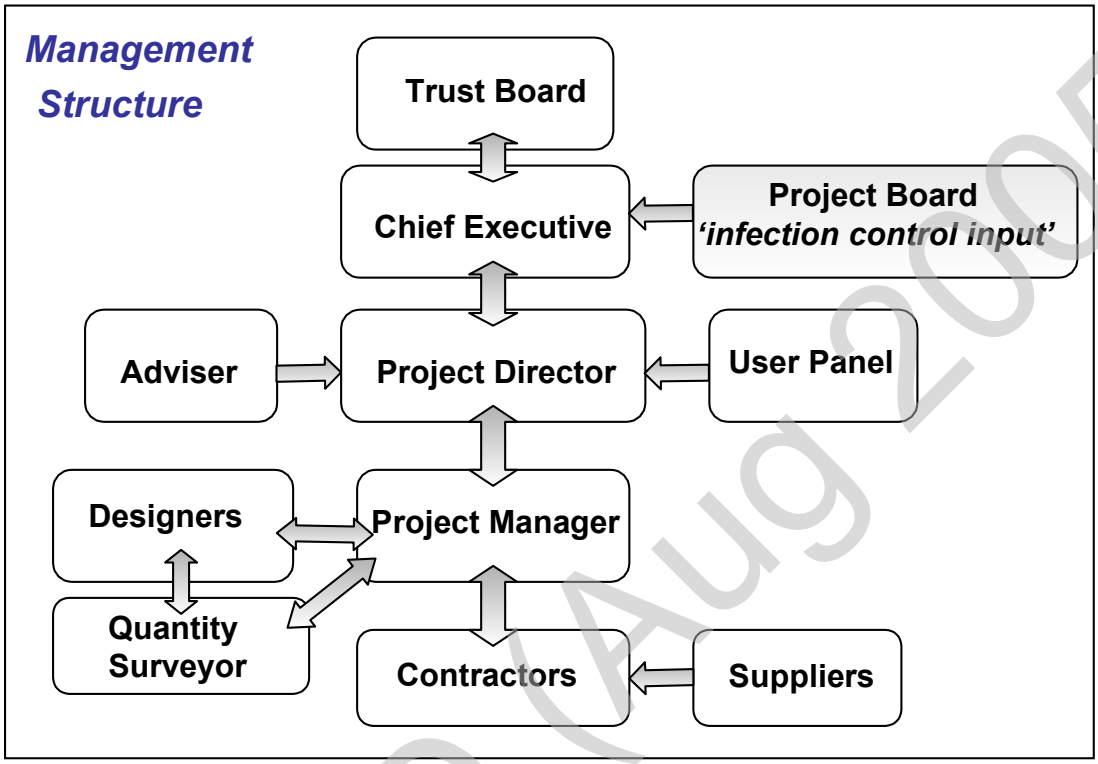
Key project roles

4.3 In general terms the project organisation should comprise:

- Trust internal organisation based on Scottish Capital Investment Manual:
  - (i) **Trust** - monitor cost and progress of all capital investment projects at regular meetings. If problems are identified, it needs to be satisfied that appropriate steps are being taken;
  - (ii) **Chief Executive Officer** - (given the project-specific role, title, and responsibility of project owner;
  - (iii) **Project Board** - comprising senior staff within the trust who have an interest in the project and whose activities will be affected by the project, e.g. staff from clinical areas such as infection control;
  - (iv) **Project Director** - responsible for project management;
  - (v) **Professional Adviser** - experienced in construction and design, especially of healthcare facilities;
  - (vi) **User Panel** - representatives of each of the relevant service departments, in each case authorised to define their department's needs and to review and agree how those needs are to be met.
- External resources:

(i) Project Manager;

(ii) other consultants.



The planning process

4.4 This Chapter explains the general planning process, although refurbishment work may be different, which comprises the following stages:

- the concept/feasibility study;
- sketch plans;
- the preparation of a business case to support the viability of the project;
- project funding;
- the design stage;
- project monitoring;
- commissioning the facility;
- post-project evaluation.

4.5 Its aim is to prompt those with overall responsibility for managing capital schemes or private finance initiatives (PFI/PPP), to include infection control advice at the right time in order to prevent costly mistakes.

These points will now be expanded upon in more detail.

Concept/feasibility study

4.6 The planning process starts with the identification of a 'need' by the users. The development of this need will involve feasibility studies to enable a design brief or output specification to be developed. The infection control team should review operational policies and procedures at this stage and there may be some 1/200 designs to give a broad overview of the scheme. The infection control team needs to consider:

- what effect additional beds or departments will make to policies such as waste disposal, linen and catering, etc.;
- the effect of extra theatres on disinfection services, workflow, etc.;
- additional specialist areas in that they will probably require extra infection control and laboratory input as well as specialist advice that may not be available in-house;
- bed space and size of departments, etc., plus engineering facility needs such as ultra-clean ventilation, showers versus baths, etc.

Sketch plans

4.7 The remaining 1/200 designs will be available at this stage and the infection control team needs to give a broad view of infection control issues such as:

- rooms missing;
- wards without ancillary areas.

Additional considerations at this point will include:

- storage;
- ancillary areas;
- single rooms;
- isolation rooms;
- changing facilities;
- lifts;
- pneumatic delivery systems.

The business case

Outline business case

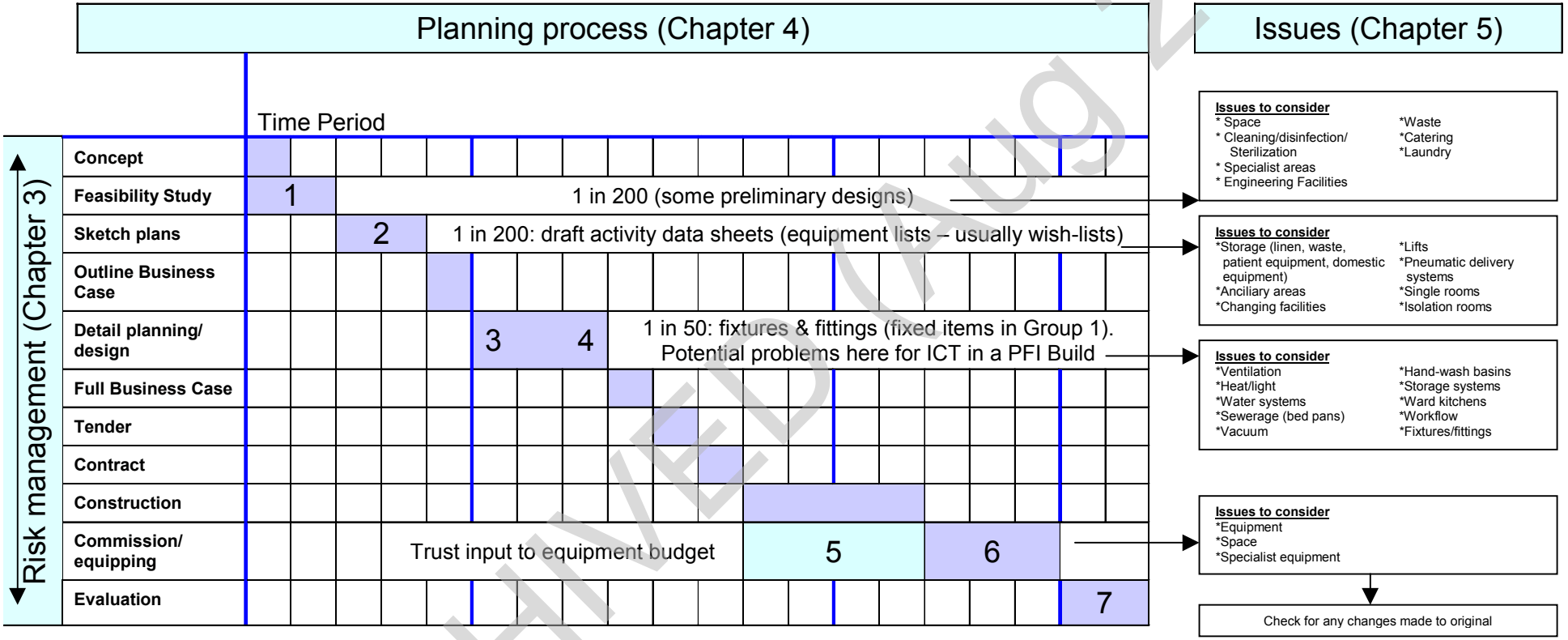
4.8 The preparation of a business case is the process that supports Trust submissions for funding of new capital projects. A business case must convincingly demonstrate that the project is economically sound, is financially viable (affordable to the trust and purchasers) and will be well managed. In addition, a business case for any investment should show that it will benefit patients.

4.9 The involvement and support of a wide range of managers and staff may be vital to the success of the business case, both to determine the requirement and scope of the investment and also to participate in subsequent stages of planning. It is important therefore at this stage to identify and involve key people who have a direct interest in the end product. This will include members of the infection control team along with other leading clinicians, nursing managers and departmental heads. Specifically at this stage, infection control teams need to:

- establish the goals of infection control. What infection control risks are especially important for each specific context;
- agree the agenda for infection control design and planning;
- communicate infection control imperatives throughout the course of the project, but especially at the initial stages;
- monitor the progress of the building/refurbishment project in relation to compliance with infection control specifications;
- determine available resources that can be used and recognise the cost benefits of not cutting corners on infection control issues.

4.10 Normally the input from the team should be managed by the project director. For larger and more complex schemes a project manager, reporting to the project director, may be appointed to conduct the detailed work and manage the business case team.

Typical Project Development Chart



Issues to be addressed by the Infection Control Team

4.11 The infection control team must ensure that infection control implications are not compromised by reducing or overcrowding in clinical areas. The issues frequently addressed will include costs and space constraints which will impact on areas such as:

- storage and equipment cleaning areas;
- air-handling units;
- hand-washing facilities;
- furnishing;
- appropriate finishes;
- isolation rooms;
- specific products with infectious implications and applicable regulations.

Typical Stages of Infection Control Input

1. **Concept/feasibility study** – infection control team should review operational policies and procedures, e.g. 1/200 plans.

   Adding beds to ward area may mean extra sluice or side rooms.

   Adding extra theatres will need a review of decontamination facilities for instruments.

   Additional specialist areas will need extra infection control input.

2. **Sketch plans**: at this stage, the infection control team needs to give a broad view of infection control issues. For example:

   Rooms missing.

   Wards without ancillary areas such as disposal rooms or dirty utility.

3. **Detail planning/design** (1 in 50 designs – early period)

   There is a need to finalise locations of rooms for correct workflows/infection control practice, i.e. wards, theatres.

4. **Detail planning/design** (1 in 50 designs – later period)

   Need to discuss finer details within rooms: location and type of fixtures and fittings, e.g. wash-hand basins/types of basins; airflows in theatres, flooring.

5. **Equipment**. Decisions on equipment should be made as an ongoing process, but it is at this stage that it will be seen that previous equipment wish-lists may not fit the rooms/departments or are now outdated. It is important that infection control teams have input during this period (especially if it is a PFI/PPP build).

6. **Commission/equipping.** Infection control teams must have input during this stage if costly mistakes are not to be made.

7. **Evaluation.** This is an important stage in which lessons learnt can be highlighted for future projects.

Note: At the Construction stage, infection control team will need input if new-build is attached to existing healthcare building only to prevent risks to patients.

Detail planning

4.12 It is at this stage, when the outline business case is presented, that the 1/50 designs will be available. There will probably be two stages to the consultation process:

1. Early on in this period the infection control team will need to discuss location of rooms for correct workflow/infection control practice, i.e. wards, theatres and patient passage through out-patients or primary care facilities, etc.
2. Later there will be a need to discuss the finer details such as where fixtures and fittings are located, what type of flooring, cupboards or storage systems are to be used, and ventilation in theatres, etc.

4.13 The team will also need to think about the infection control issues around:

- workflow;
- wash-hand basins: types, numbers and location;
- fixtures/fittings/flooring;
- wastewater and sewage/body fluid disposal;
- ventilation;
- heating and lighting;
- water systems;
- suction/medical gases;
- storage systems;
- ward kitchens/pantry.

4.14 The business case process should highlight the variables that drive the facility's requirements with regard to infection control. This is not always an easy task in the initial stages of a project. Table 1 gives a range of initial ideas.

Table 1: Typical key issues in the capital investment process related to infection control (Note: this is not an exhaustive list)

Accommodation areas/internal environment/general services	*Key Issues and areas of concern*	
Accommodation areas		
Bed areas:		
• Single-bed rooms	En-suite facilities	
• 4-bedded bays versus 6-bedded bays	Doors on bays and en-suite facilities	
Dirty utility/clean utility	Standardisation of rooms	
	Space	
Workflow/layout	Standardise versus different needs of specialities	
Bed planning	Elective	
	Emergency	
Linen services and facilities	Internal laundrette versus commercial laundry	
Catering/kitchen areas	Furnishing, fixtures plus workflow crucial for HACCP.	
	Cook-chill versus commercial versus in-house systems.	
ITU/HDU	Single rooms versus 4/6/bed bays	
Wash-hand basins	1 to 2 versus 1 to 4 versus 1 to 6.	
	Complete picture: sinks, taps, soap, gloves, aprons.	
	Easily accessible for staff use	
Staff change areas/storage of uniforms	Type of uniform provided will dictate, i.e. 'greens' versus classic	
Sterilising/disinfecting/cleaning facilities (HSDU/CSSD/TSSU)	Operational policy dictated by choice of in-house SSD or commercial facility	
Equipment	Beds/mattresses	Purchase versus hire
	Scopes/instruments	Cleaning/disinfection requirement
	Patient-specific	Enough equipment available

Accommodation areas/internal environment/general services		*Key Issues and areas of concern*
Priority areas:		
• Critical care • UCV theatres • Hydrotherapy • Mortuaries • SCBUs and maternity	• Renal units • Oncology • Neurology • Paediatrics	Every specialist area will have different requirements and infection control issues so cannot be planned as standard departments
Internal environment		
Ventilation		Single rooms, bays, theatres, pacing rooms, treatment rooms, internal sanitary areas. Negative- and positive-pressure isolation rooms
Heating/ventilation		Dust-free options, i.e. hidden heat panels versus radiators
Lighting		Quality as well as quantity is important The use of sealed units
Furnishings and fittings and artwork		Walls/floors/ceilings – hygiene versus aesthetics
General services		
Disposal of waste		Cost versus new concepts/in-house versus commercial Storage
Drinking water		Potable Softened Water coolers/fountains
Communications		IT systems (timely information on pathology, etc., operational policies, infection control policies, procedures and training)
Emergency plans		Water storage if water cut off/heating/medical gases and vacuum/suction, emergency generator, ventilation, etc.

Accommodation areas/internal environment/general services	*Key Issues and areas of concern*	
Other		
New services and expertise needed	Renal satellite units	SSDs
	Near patient testing	Hydrotherapy
	Pneumatic tube system	Pharmacy/clean air room

Typical steps in the business case process.

(Shaded boxes include examples of issues related to infection control that might need to be considered)

1. Set the strategic context:

- where are we now?
- where do we want to be?
- is it affordable?
- in-patient/day cases;
- single room issues;
- controls assurance.

2. Define objectives and benefit criteria:

- antibiotic resistance;
- cost benefits of preventing healthcare-associated infection.

3. Generate options.

4. Measure the benefits.

5. Identify/quantify costs.

6. Assess sensitivity to risk.

7. Identify the preferred option.

8. Present the outline business case.

9. Develop the preferred option: full business case.

Funding the project: using private finance

The private finance initiative (PFI)/Public-private partnership (PPP)

4.15 The NHSScotland encourages the consideration of the strengths of the private sector and the use of privately raised capital. There are essentially two broad criteria against which all schemes are assessed: 'value for money' and 'assumption of risk'. Trusts today are expected to explore the private finance alternative whenever a capital investment scheme is being considered. The goals of PFI/PPP are to:

- achieve objectives and deliver services more effectively;

- use public money more efficiently;
- respond positively to private sector ideas;
- increase competition.

Key factors in PFI/PPP

4.16 The contract between the NHS and the private sector supplier is critical and it is important that the service representatives/key stakeholders and particularly in this instance the infection control team are clear about the options available and the evidence to back up any decisions they advise on. The infection control team will need to make sure that certain criteria are embedded into the contract in such a way that important decisions on design or build do not go ahead without being 'signed off' by them. The team will need:

- access to all relevant and up-to-date plans and information on operational policies;
- access to any meetings deemed relevant to them or timely minutes from those meetings that they cannot attend;
- access to sites and departments as building work progresses, e.g. environmental rounds with checklists based on project objectives;
- regular communication between both internal project manager and the PFI/PPP team;
- involvement in decision making for any category of equipment the PFI/PPP team will purchase;
- involvement in any contracts for support services such as catering, cleaning, linen, HSDU, etc., that the PFI/PPP team may be providing;
- access to certain high risk areas for any microbiological testing deemed necessary, e.g. theatres, isolation rooms, pharmacy and HSDU clean rooms.

Design stage

4.17 It is at the design stage that infection control teams will need to follow up any input they have had in the initial brief. Sketch plans should be available to them to explain how the brief fulfils their requirements at the 1/200 and 1/50 stages of the project. Suggestions for improvement in operability are encouraged at this stage. (For an approximate time-scale, see the project development chart on page 21.)

Consideration should also be given to the impact on local and existing facilities, e.g. ventilation, water supplies, etc.

Design

4.18 The team will need to consider:

- is the facility designed to support infection control practice?
- design, number and type of isolation rooms (i.e. airborne infection isolation or protective environments);
- heating, ventilation, and air-conditioning systems including recommended ventilation and filtration charts;
- mechanical systems involving water supply and plumbing;
- number, type and placement of hand-hygiene fixtures, clinical sinks, dispensers for hand-washing soap plus alcohol hand-rub, paper towels, and lotion;
- sharps disposal unit placement;
- accommodation for personal protection equipment;
- surfaces: ceiling tiles, walls, counters, floor covering and furnishings;
- utility rooms: soiled, clean, holding, workrooms;
- storage of movable and modular equipment;
- clinical waste;
- linen (clean)/laundry (used) [adapted from Bartley (2000)].

4.19 Equipment schedules for groups 2 and 3 based on room data sheets/layouts are prepared at this stage. They may consist of 'wish-lists' as well as equipment that is genuinely needed. It is important to remember that equipment will not be removed from lists at this stage. This will mean that at the commissioning/equipping stage many items/pieces of equipment may not fit into the finished design or out of date before they are used. Items available for transfer should also be identified which will allow schedules for new equipment to be prepared and costed. This is an important area for input by the infection control team if costly mistakes are not to be made. (For examples of equipment groups, see Appendix 2.)

4.20 The purchase of equipment for groups 2 to 4 will not normally take place until the operational commissioning period (see 'Commissioning the healthcare facility/equipping' section). However, it is important during the construction and equipment supply stage that there is involvement by the infection control team in discussion of group 2 equipment. Some group 2 equipment may require to be fitted by the main contractor and all may have significant design implications. This will ensure that this equipment is compatible with infection control needs and also that proper inspection and testing can be agreed.

4.21 Technical commissioning of the building, services and equipment should include any areas that require inspection and testing to demonstrate compliance with infection control standards, i.e. theatres, hydrotherapy pools, isolation rooms and clean rooms in pharmacy and HSDUs.

Tender/contract

4.22 At this stage of the project, there will be little or no involvement for the infection control team.

Monitoring the project

Construction (new build)

4.23 If the project is a new-build, monitoring will not normally be required by the infection control team until the healthcare premises are at a stage when site visits can be arranged. It is at this point that the team should visit the site as often as possible to familiarise themselves with the layout of the various departments. This will help them to detect any unidentified problems or ones caused by design changes.

Construction (new-build attached to existing site or refurbishment)

4.24 Infection control specialists agree that involvement of infection control teams in refurbishment projects is important not only for ensuring that 'designed-in' infection control is achieved, but also for assessing the potential risks to patients in existing buildings from dust, dirt and pathogens.

4.25 Measures that may limit the spread of dust, dirt and pathogens during construction include the following:

- schedule major projects during the winter when the risk is lower for *Aspergillus* spp. and other fungal infections;
- clean and vacuum areas under construction and the surrounding areas frequently;
- place adhesive floor strips outside the door to the construction area to trap dust;
- seal windows, doors and roof-space to control dust;
- wet-mop the area just outside the door to the construction area daily or more often if necessary;
- use a high-efficiency particulate air (HEPA) filtered vacuum to clean areas daily or more often if necessary;
- shampoo carpets when the construction project is completed;
- transport debris in containers with tightly fitting lids, or cover debris with a wet sheet;
- remove debris as it is created; do not let it accumulate. Use dust extraction equipment where feasible;
- remove debris through a window when construction occurs above the first floor;
- do not haul debris through patient-care areas;

- remove debris after normal work hours through an exit restricted to the construction crew;
- designate an entrance, a lift and a hallway that the construction workers must use and that are not used by patients, visitors or healthcare workers;
- commission hotel services with regard to cleaning during construction projects (adapted from Carter and Barr, 1997).

4.26 There is a need to ensure that infection control teams document advice given on building developments and that this advice is followed and recorded. Similarly, Carter and Barr (1997) advise that a daily checklist is maintained during the progress of the construction project (see Table 2).

Table 2: Daily construction survey (Carter and Barr, 1997)

Barriers	
Construction signs posted for the area	Yes/No
Doors properly closed and sealed	Yes/No
Floor area clean, no dust tracked	Yes/No
Air handling	
All windows closed behind barrier	Yes/No
Negative air at barrier entrance	Yes/No
Negative air machine running	Yes/No
Project area	
Debris removed in covered container daily	Yes/No
Trash in appropriate container	Yes/No
Routine clearing done on job site	Yes/No
Traffic control	
Restricted to construction workers and necessary staff only	Yes/No
All doors and exits free of debris	Yes/No
Dress code	
Appropriate for the area (e,g, OR, CSD)	Yes/No
Required to enter	Yes/No
Required to leave	Yes/No

Surveillance and monitoring during renovation or construction work

4.27 Routine bacteriological sampling of floors, walls, surfaces and air is rarely indicated (Aycliffe, 2000) but there have been several documented outbreaks due to construction work. In 1995 there was widespread contamination of potable water with Legionella pneumophila during a period of major construction resulting in two fatal cases of healthcare-associated legionellosis (Mermel et al., 1995). Multiple outbreaks of healthcare-associated aspergillosis have also been described, including one specifically attributed to hospital renovation (Flynn et al., 1993). Mermel et al. (1995) suggest that heightened surveillance and preventive measures may be warranted during periods of excavation on hospital grounds or when potable water supplies are otherwise shut down and later depressurised.

4.28 NHS Estates (Wearmouth, 1999) advises:

Where vulnerable patients may be placed at risk, it is important that an appropriate risk assessment be carried out with the trust microbiologist/infection

control officer [doctor] at an early stage in advance of any demolition works or disturbance/alterations to the building fabric/ventilation systems.

Since the airborne spores of *Aspergillus* spp. can travel significant distances, this will apply generally to all works in the immediate vicinity or within the boundary of the hospital site. It is strongly advised that any recommendations by the microbiologist/infection control doctor should be incorporated into the building or engineering works so as to minimise risk.

Surveillance and monitoring during renovation or construction work may prove difficult; environmental assessment to detect *Aspergillus* spp. and to confirm epidemiological investigations may not be within the remit of all infection control teams. However, implementation of adequate infection control measures during construction are, and have been proven to be, an effective means of protecting highly susceptible or high risk patients from environmental contaminants (Thio *et al*., 2000).

Commissioning/equipping the healthcare facility

4.29 Upon completion of construction, the facility must be brought into use; the complexity of the task involved generally means that a commissioning manager and team will be needed. Senior managers, specialist teams and users should be fully involved in the process. The commissioning entails:

- drafting operational procedures;
- establishing baseline and future staffing profiles;
- establishing baseline and future revenue budgets;
- establishing final equipment requirements;
- identifying policy issues for referral to the commissioning team or the construction project team;
- identifying staff training needs;
- establishing the occupation programme, for each user function, for incorporating into the overall masterplan.

4.30 By understanding the commissioning process, infection control teams can ensure that they are included in any working groups in which their speciality will have an impact or in which requirements to modify services may have repercussions on other aspects of the prevention of infection.

4.31 The infection control team may also need to be involved in processes for:

- transfer of facilities;
- phased or staged occupation;
- decorating;
- strategy for equipping;
- selection of equipment;
- storage and subsequent cleaning/disinfection of any furniture or equipment;

- commissioning hotel services for cleaning;
- site visits;
- artwork;
- furnishing and fittings;
- interior finishes and fixtures;
- post-handover period;
- decommissioning of redundant facilities;
- period of handover to operational management.

Post-project evaluation

4.32 The purpose of the post-project evaluation is to improve project appraisal, design, management and implementation. It is a learning process and should not be seen as a means of allocating blame. There are three stages:

1. Project appraisal.
2. Monitoring and evaluation of project.
3. Review of project operations. It is at the third stage when it is useful for the infection control team to be included in the evaluation teams that are reviewing project objectives. The outcomes (activity and its consequences) of the project will not be amenable to evaluation until the facility has been in use for some time.

4.33 It is important that the project is evaluated in terms of its original objectives, not in light of any new legislation or development. Performance indicators may be used if these can be measured retrospectively. Measurable objectives may include:

- bed turnover;
- readmission rates;
- incidence of day surgery;
- activity data;
- infection rates;
- patient satisfaction surveys, etc;
- process measures – air sampling, audit.

5. Planning and designing a healthcare facility: issues to consider

Introduction

5.1 Infection control teams are often not involved in the planning process until key decisions have been made. Changes to design or equipment may then result in costly adjustments, additions or replacements.

5.2 This Chapter offers a planning check list which can be used throughout the design and planning process. Not all items will need to be included in every project, but using the checklist will ensure areas with Infection Control implications are not missed.

Planning guide checklist:

- sizing/space;
- single rooms/isolation facilities/ventilation;
- clinical sinks – design for clean hands;
- ancillary areas;
- engineering and mechanical services;
- storage;
- finishes – floors, walls, ceiling, doors, windows, interior design, fixtures and fittings;
- design for a clean, safe environment;
- decontamination: cleaning, disinfection and sterilization;
- laundry and linen services;
- catering/food hygiene;
- waste – segregation, storage and disposal;
- changing facilities;
- construction and the role of cleaning;
- refurbishment/expansion;
- service lifts;
- pneumatic air tube delivery systems.

5.3 Timing will vary from project to project but a suggested time-scale is included to help those involved in planning for the first time.

5.4 This checklist provides a brief overview. It will be expanded upon in subsequent publications to include research evidence and greater detail for specific departments.

Basic rules for the delivery of an optimal built environment

5.5 This guidance can be used by anyone involved in planning. Further details can be provided by local infection control teams.

Sizing/space

5.6 The principle should be to maintain sufficient space for activities to take place and to avoid transmission of organisms either by air or by contact with blood or body fluid or equipment. The exact space needed will vary according to numbers and activity of staff, type of patient, and environmental factors such as ventilation, humidity and overcrowding.

Current space recommendations require a minimum of 2.7m between bed centres. Bed groupings should contain the smallest possible number of beds.

5.7 Healthcare facilities must provide sufficient sanitary facilities, showers and bathrooms to ensure easy access, convenience and independence where possible. Baths are difficult to clean and showers are less likely to be associated with cross-infection, although they have been implicated in outbreaks of infection. All WCs must have provision for hand-washing and SHPN 04 recommends that toilet facilities should be no more than 12m from the bed area or dayroom.

Single rooms/isolation facilities/ventilation

5.8 Single en-suite rooms provide greater privacy and quiet, and are preferred by many patients. Single rooms can also be used for isolating patients with communicable infections. There is currently no definitive guidance on size, ventilation or the equipping of isolation rooms.

5.9 Provision of single-room accommodation with ventilation will help prevent the spread of organisms, especially those transferred by the airborne route or easily disseminated into the immediate patient environment. SHPNs, HBNs and the Scottish Infection Manual for relevant departments such as wards, theatres and other specialist areas, and also SHTM 2025, give advice on natural ventilation, and general extract and supply ventilation for specialist areas.

Clinical sinks – design for clean hands

5.10 Hand-washing is without doubt the most important intervention in the control of cross-infection. Healthcare workers are aware of its importance, but compliance

among them is very poor. Good departmental design, with sufficient wash-hand basins appropriately placed, should help increase compliance.

There must be enough wash-hand basins to encourage staff to conform to hand-washing protocols.

5.11 Taps should be elbow, knee or sensor-operated. Disinfectants and soaps should be wall-mounted near the sinks and wash-hand basins. They should not be refillable, but be of a disposable, single-cartridge design. Paper towels should be conveniently placed. Foot-pedal-operated bins should be provided and situated by each clinical wash basin.

5.12 Separate sinks such as slop-hoppers should be provided in areas where contaminated wastewater or blood and body fluids are disposed, i.e. dirty utility rooms and domestic store rooms provided for cleaning equipment.

Ancillary areas

5.13 It is important that ancillary areas are of an acceptable standard and do not put the user at risk of cross-infection. The infection control issues will depend on what the ancillary area is to be used for, who will have access and what type of activity will be carried out there. Specific areas include the following.

Dirty utility room

5.14 Space and facilities for holding and reprocessing of bedpans, urinals and vomit bowls are required where inpatients are looked after (SHTM 2010: Sterilization and SHTM 2030: Washer-disinfectors) SSD returns can also be held here, along with storage of sani-chairs, commodes and linen bag carriers. Hand-wash facilities are necessary plus the provision of a slop-hopper for disposal of body-fluid waste.

Clean utility room

5.15 Space/storage for sterile supplies equipment and other clean supplies is needed and it is important that planners think about the type of storage facilities provided. They must be able to be cleaned easily and quickly while protecting clean stores and equipment from dust and contamination.

Engineering and mechanical services

5.16 Heating and general ventilation grilles should be easily accessible for cleaning.

5.17 Lighting should be planned so that lamps can be easily cleaned, with no ledges or ridges where dust can gather.

5.18 The use of vacuum-controlled units with overflow protection devices for mechanical suction is essential to avoid contaminating the system with aspirated body fluid.

5.19 Contamination of the water supply can occur due to:

- poor design of pipework;

- inappropriate storage during renovation and refurbishment.

Such problems can be overcome by:

- cleaning water-storage tanks;
- maintaining a consistently high temperatures in hot-water supplies;
- maintaining plant regularly;
- minimising dead-legs;
- keeping cold water systems cold;
- minimising water storage.

Refer to SHTM 2027: 'Hot and cold water supply, storage and mains services' and SHTM 2040: 'The control of legionellae in healthcare premises – a code of practice'.

Protection of patients with special needs

5.20 Patients who have a lowered immune response are also at risk from certain organisms found in water supplies in hospital and will need to be protected from this problem both in potable water and wash-water facilities.

Storage

5.21 Storage is required for bulky items of equipment, as well as the smaller items used in the clinical setting, to provide protection from dust or contamination. The need for sufficient storage should not be underestimated.

5.22 Patients need lockers or wardrobes for their personal possessions and clothing.

5.23 Domestic cleaning equipment, laundry and clinical waste all need to be stored in separate purpose-built areas to prevent cross-contamination.

5.24 All healthcare premises need a storage area for large pieces of equipment such as beds and mattresses that are not currently in use.

Finishes – floors, walls, ceilings, doors, windows, interior design, fixtures and fittings

5.25 Guidance on the selection of finishes is provided in SHPNs, SHTMs, HBNs and HTMs pertinent to the area that is being planned, e.g. catering department, operating theatres, etc. In Scotland the appropriate Reference Guides indicates the current status of HBNs and HTMs. The quality of finishes in all areas should be of a high standard and cost allowances make due recognition of this need.

Hard flooring

5.26 Flooring should be smooth, easily cleaned and appropriately wear-resistant. There should be coving between the floor and the wall to prevent accumulation of dust and dirt in corners and crevices. Avoid wood, unsealed joints and tiles as they may provide a reservoir for infectious agents.

5.27 In areas where frequent wet cleaning methods are employed (e.g. theatres), floors should be of a material which is unaffected by germicidal cleaning solutions. Floors subject to traffic when wet (bathrooms, kitchens) should have a non-slip surface.

Carpets

5.28 Carpets will normally be avoided in clinical areas. Carpets are extremely difficult to keep clean. The use of carpets within any healthcare premises should be very carefully considered and, if used, they should be meticulously monitored and maintained. Carpets should also be avoided in areas where sterilising fluids are used e.g. parts of maternity units.

Finishes

5.29 Materials and finishes should be selected to minimise maintenance and be compatible with their intended function. All finishes in clinical areas should be chosen with cleaning in mind, especially where contamination with blood or body fluid is a possibility.

5.30 Design should ensure that surfaces are easily accessed, will not be physically affected by germicidal cleaning agents and will dry quickly.

Fixtures and fittings

5.31 Fixtures and fittings should be accessible for cleaning. If they are not cleaned on a regular basis, they may be potential reservoirs of infection.

Walls

5.32 Smooth paint surfaces are easier for cleaning.

Ceilings

5.33 Ceilings are often used to produce visually appealing areas that can then be difficult or time-consuming to access for cleaning, e.g. hidden lighting or box-work. See HTM 60 (current in Scotland).

Doors

5.34 All bays and side-rooms need doors if they are to be used for cohort barrier nursing or isolation nursing in an effort to contain infection. See HTM 58 (may be used with general caution in Scotland).

Windows

5.35 Windows, although not directly an infection control issue (except in areas like theatres and some special care areas), allow patients in isolation to feel less shut off from the world. Glass partitions instead of solid walls enable patients to see what is happening in the ward. See HTM 55 and HTM 56 (both may be used with caution in Scotland).

Curtains and blinds

5.36 Curtains are easily contaminated. For good infection control, it is important that policies are in place for regular laundering. Venetian blinds are not recommended because they are extremely difficult to clean. If used they should be enclosed between two panes of glass. The use of vertical blinds should be carefully considered for some areas, again due to cleaning difficulties.

Soft furnishings

5.37 Where it is likely that they will be contaminated, soft furnishings should be covered in a material that is impermeable to fluids.

Pipework and radiators

5.38 Pipework should be contained in a smooth-surfaced boxing that is easy to clean.

Work surfaces

5.39 Surfaces should be designed for easy cleaning. Surfaces, particularly near plumbing fixtures, should be smooth, non-porous and water-resistant. They should be free of fissures, open joints and crevices that will retain or permit the passage of dirt particles. All joints must be sealed.

Design for a clean and safe environment

5.40 The importance of a clean environment should not be underestimated and it is important that healthcare buildings are designed to enable thorough access for cleaning to take place.

Areas to consider are:

- surfaces that are easy to clean (smooth, hard, impervious finishes of floors, walls, and ceilings);
- welded/sealed joints to prevent water ingress;
- sealed skirting;
- low dust retention fixtures/fittings;
- splashbacks to sinks and intact seals around sinks;
- storage of clinical equipment not in use;

- bed storage/cleaning facilities;
- storage for cleaning equipment;
- adequate supplies of equipment and Personal Protection Equipment (PPE);
- colour-coded segregation of cleaning equipment;
- communication and time to clean additional areas such as isolation rooms/bays involved in outbreaks;
- training and regular updating.

Good design should aim to make cleaning easier.

5.41 Accommodation must be provided where cleaning equipment can be stored and cleaned and this should include a slop-hopper sink for disposal of potentially contaminated cleaning water. Hand-washing facilities are also required.

Decontamination: cleaning, disinfection and sterilization

5.42 The effective decontamination of medical devices is essential in reducing risks to patients from healthcare associated infection. See HDL (2001) 10: Decontamination of Medical Devices, HDL (2001) 53: Managing the Risk of Healthcare Associated Infection a NHSScotland and HDL (2001) 66: Healthcare Associated Infection Review of Decontamination Services Provisions Across NHSScotland.

5.43 SCOTPAT can be used as a useful checklist for planning areas in the built environment that are involved in purchasing, processing, maintaining, storing and using medical devices.

Laundry and linen services

5.44 Central Sterilising Club – Laundry Working Group Discussion paper (Sept 1998) CSC Bulletin; Vol. 3: issue 1 and HBN 25 (NHS Estates) include design guidance and arrangements for dealing with healthcare associated linen.

Catering/food hygiene

5.45 There are many requirements to consider when planning a new catering facility or upgrading an existing building. Any initial planning and design meetings should include the local authority environmental health inspector as well as key managers and the infection control team.

Areas to consider are:

- sound construction of walls, floors and windows (fly screens and pest control);
- equipment specifications – dishwashers (thermodisinfection), fridges, freezers (maintain food at temperature advised by Food Services Registration), surfaces (cleaning);

- storage facilities/segregation of high-risk foods, preparation areas;
- temperature control – to maintain a comfortable environment for staff and prevent premises and equipment from overheating;
- hand washing facilities;
- staff change/occupational health;
- workflow (HACCUP);
- maintaining temperature of food from completion of preparation/cooking to serving patient;
- pest control;

Waste – segregation, storage and disposal

5.46 There are stringent legislative controls and clear working guidelines for the management of healthcare waste. Good design can minimise problems with waste segregation, storage and disposal.

5.47 Space at 'shop-floor' level is needed for provision of suitable waste containers, whether the area served produces large or small amounts of clinical waste. The storage facilities provided will vary with type of healthcare facility and method of final disposal.

5.48 In healthcare premises such as nursing/residential homes and primary care settings, all waste must be contained in bags inside a lockable container.

Changing facilities

5.49 Facilities should be provided for staff not only to encourage them to change their uniform in the workplace but also to be able to store their small personal effects safely. Patients also need changing/storage facilities. Wash-hand basins should be provided and shower facilities for staff in event of blood or body fluid splashes.

Construction and the role of cleaning

5.50 Construction inevitably generates dirt. Dust and debris control are essential along with the need to plan for regular and increased cleaning during and after completion of the building work. A planned cleaning programme is essential.

Refurbishment/expansion

5.51 The standards set out in NHSScotland Property and Environment Forum's guidance essentially apply to new buildings; however, the principles should be applied as far as possible if existing accommodation is being upgraded (for a summary of these principles, see Appendix 3).

6. Appendices

Appendix 1

Description of some infectious agents commonly associated with construction and healthcare-associated infections.

Name of organism	*Type of organism/ transmission*	*References*	*Population affected*	*Epidemiological factors*
Aspergillus fumigatus	A ubiquitous fungus, spore-forming. Airborne (inhalation); also contact transmission	Bartley (2000); Cornet *et al*. (1999); Manual and Kibbler (1998); Richardson *et al*. (2000); Thio *et al*. (2000); Room (1998)	Bone marrow transplant, haematological malignancies with prolonged neutropenia e.g. acute leukaemia	Increased risk during construction and renovation. Reservoirs of *Aspergillus fumigatus* include soil, dust, bird droppings, building materials, window air-conditioners/filters, false ceilings, tiles, humidified cell incubators, lifts, carpeting, air-filter replacements
Bacillus cereus	A Gram-positive, spore-forming bacillus	Dancer (1999)	At-risk patients. Associated with food poisoning, but also non-gastrointestinal cases recorded in maternity, surgical and ICUs	Association with building work
Clostridium difficile	Anaerobic, Gram-positive bacillus	McCulloch (2000); Dancer (1999)	Older adults, children	Spores may survive for months on furniture, toilets, etc., contaminated or in the environment

Name of organism	*Type of organism/ transmission*	*References*	*Population affected*	*Epidemiological factors*
Escherichia coli	Gram-negative bacillus	McCulloch (2000)	Children, older adults – may lead to renal failure	Environmental sources are many and varied. Good food hygiene, hand and environmental hygiene. Exclude from work affected food handlers
Klebsiella spp.	Gram-negative bacillus	Dancer (1999)	At-risk patients	Known to survive well on surfaces. Once a reservoir is established, the organisms may be transferred to patients directly or indirectly, generally by hands
Legionellaceae family – 29 species isolated and named, but four have been associated with outbreaks of legionellosis Infectivity predominantly lined L. pneumophila 90% infections	Gram-negative bacteria. Waterborne, spread by inhalation of aerosol. May cause Pontiac fever and legionnaires' disease	Brundrett (1992); Bartley (2000) NHS Estates (1993b); Dobson et al. (1997) all discuss engineering design; McCulloch (2000)	All age groups may become infected, most susceptible are patients with serious underlying diseases. Men typically affected more that women (2:1), and higher between 40 and 70 years of age (Brundrett, 1992). May progress to pneumonia	Soil, water, cooling towers; water storage tanks, infrequently used showers. Optimum growth for Legionella spp. At 35-37°C although environmental isolates grow best around 30°C

Name of organism	*Type of organism/ transmission*	*References*	*Population affected*	*Epidemiological factors*
Methillin-resistant Staphylococcus aureus (MRSA)	Gram-positive bacterium. Environmental contamination contact. Can withstand dessication and is thus a frequent component of hospital dust.	McCulloch (2000); Dancer (2000); Ayliffe et al. (1998); Wagenvoort et al. (2000)	Epidemic in hospitals and the wider community; at-risk patients	MRSA has penetrated virtually every hospital and a chronic endemic state remains in most with episodes of cross-infection and outbreaks. S. aureus has been isolated from the knobs on TVs, cushions, computer keyboards, pens, curtains, bedding, nurses' uniforms.
Mycobacterium xenopi	Waterborne	Bartley (2000)	Endoscopy	Portable water, scopes
Penicillum spp.	Airborne	Bartley (2000)	Bone marrow transplant	Rotted wood cabinet ventilation ducts, fibre-glass insulation
Pseudomonas paucimobilis	Waterborne	Bartley (2000)	ICU	Portable water used to fill flush water bottles
Vancomycin-resistant enterococcus (VRE)	Human and animal gastrointestinal tract, persists in its host long term	Dancer (1999)	In at-risk patients, VRE sepsis is extremely difficult to treat	More resistant to disinfectants; survives well in hospital environment; no effective regimens to clear human carriage

Appendix 2

Equipment groups

Equipment supplied for new building schemes can be one of four categories:

Group 1

Group 1 items are specified at the design stage and are supplied and fixed under the terms of a building/engineering contract and funded within the works cost. These are generally large items of plant/equipment which are permanently wired/installed, i.e.:

1. Specialised equipment items best suited to central purchasing arrangements.
2. Excluded from this group will be items subject to late selection due to considerations of e.g. radiodiagnostic equipment.

Taps and basins also fall into Group 1 equipment.

Group 2

Items which have implications in respect of space/construction services and are installed under the terms of building engineering contracts, but are purchased by the trust under a separate equipment budget, e.g.:

- paper towel dispensers;
- soap/scrub dispensers;
- shelving;
- washer/disinfectors;
- washing machines.

Group 3

Items which have implications in respect of space and/or construction/engineering services and are purchased and delivered/installed directly by the trust, e.g.:

- small refrigerators;
- furniture;
- ventilators;
- monitors;
- trolleys.

Group 4

Items which may have storage implications but otherwise have no impact on space or engineering services, e.g. surgical instruments.

Appendix 3

Summary of principles and approach to infection control in capital planning projects

1. Draw up and agree Policy prior to commencement of work to include:
   - Gantt chart to outline expected timescale for:
     (i) patient area closure as appropriate (who is responsible?);
     (ii) isolating air handling units (plumbing) (who is responsible?) services;
     (iii) O_2/suction/air as appropriate;
     (iv) education (for whom?).
   - traffic patterns for patients, healthcare staff and visitors;
   - transport, disposal and route for waste;
   - cleaning schedules for dust/debris control:
     (i) during construction;
     (ii) in event of incidence;
     (iii) post construction/completion.
   - infection control rounds/meetings with contractor;
   - patient assessment – who is at risk?;
   - any other controls necessary.

   This must be agreed and signed by all parties prior to commencement of work.

2. Involvement in initial planning and approval meetings at design stage of project:
   - number and type of hand-wash basins and complete system (soap, towels, alcohol dispenser, waste bins);
   - number and type of single rooms/bays;
   - heating, temperature-control, ventilation and grilles;
   - plumbing, radiators, inspection hatches;
   - number and fixings for sharps dispensers;
   - fixtures and fittings – ease of cleaning;
   - surfaces – ceilings, walls, worktops, floors;
   - ancillary rooms – dirty utility, clean utility, disposal hold, washing facilities, etc;
   - type of storage facilities.

3. Ensure major design components are in place to support infection control practice (see Chapter 4).
4. Ensure preparations for demolition and construction are complete and that all parties understand the importance of compliance with the policies concerned, i.e. contractors, managers, healthcare staff and patients.
5. Environmental site inspections should check:
   - dust, debris control;
   - traffic control;
   - barrier systems in place if appropriate;
   - cleanliness of the site and any adjoining areas;
   - airflow;
   - vibration/disturbance;
   - temperature/humidity;
   - contamination of patient rooms, supplies and equipment.
6. Check post-construction clean-up by:
   - contractors;
   - domestic staff;
   - estates;
   - specialist teams for 'clean' areas.
7. Check design to support infection control practice has been achieved. See Bartley (2000) for further guidance.
8. Providing a built environment that promotes good infection control depends on the following factors:
   - ascertaining who is to responsible for infection control needs;
   - establishing specific goals of infection control in relation to the function of the facilities to be built or refurbished;
   - agreeing the agenda for achieving 'designed-in' infection control;
   - planning the built environment in relation to infection control considerations;
   - implementing the programme and co-ordinating the involvement of the infection control team;
   - improving communication between professionals in the health facilities management and building sectors;
   - sharing findings related to best practice in design for good infection control and where possible, using tried and tested design components with proven built in infection control;
   - improving the information base for building industry professionals and infection control teams;

- monitoring new developments based on research evidence, e.g. the use of new biomaterials designed to reduce bacterial attachment (Montdargent and Letourneur, 2000, pp. 404-410).

9. Common pitfalls arise from a number of pressures, for example, the pressure to choose the cheapest design or product. The best designs or products may be more expensive initially, but in the long term they will inevitably realise cost benefits. They will probably last longer, require less maintenance, be more durable and easier to clean thus preventing infection outbreaks.

Appendix 4

Glossary

Acquired Immune Deficiency Syndrome (Aids): The late clinical stage of infection with Human Immunodeficiency Virus (HIV). The opportunistic or indicator diseases associated with AIDS include:

- protozoal and helminth infections (notably *Pneumocystis carinii* pneumonia and toxoplasmosis);
- fungal infections (notably candidiasis of the oesophagus, trachea, bronchi or lungs; and cryptococcosis, especially affecting the central nervous system);
- bacterial infections (notably with certain mycobacteria including *Mycobacterium tuberculosis*);
- viral infections (notably cytomegalovirus and herpes simplex); and
- cancer (notably Kaposi's sarcoma, lymphoma limited to the brain, and invasive carcinoma of the cervix (Last, 1995)).

Airborne infection: A mechanism of transmission of an infectious agent by particles, dust, or droplet nuclei suspended in the air (Last, 1995).

Aspergillosis: A fungal infection caused by *Aspergillus* spp., commonly found in soil, decaying vegetable matter, damp cellars, building materials and ventilation systems. The most common mode of transmission is by the airborne route, e.g. dispersal of a contaminated aerosol. Contact transmission has been reported, e.g. a recent cluster of cases in Manchester suggested a contaminated stockinette was the source of infection. The density of *Aspergillus* spp. spores in hospital air is increased considerably during construction, and there is evidence that healthcare associated aspergillosis is caused by decontamination of ward air from outside. Hospital ventilation systems can draw in contaminated outside air because of either malfunction or inadequate mechanical ventilation and air filtration (Manuel and Kibbler, 1998; Cornet *et al*., 1999; Mahieu *et al*., 2000; Richardson *et al*., 2000; Thio *et al*., 2000).

At-risk patient: Susceptible patient: a patient with considerably reduced immunological competence who has a pre-existing pathology that may compromise their immune status (e.g. cancer, diabetes, chronic cirrhosis, hypoparathyroidism), or who is subjected to extensive invasive procedures (Worsley *et al*., 1990; Manuel and Kibbler, 1998). The vulnerability of a patient in relation to developing an infectious disease after contact with any given causal agent is governed by a number of factors including the virulence and dose of the infectious agent, previous exposure to the organism or an antigenic component, e.g. vaccination, age of the individual, nutritional state of the person, the presence of other diseases and whether the individual is receiving immunosuppressive therapy (Donaldson and Donaldson, 2000).

Clinical governance: A framework through which NHS organisations are accountable for continuously improving the quality of their services, safeguarding high standards by creating an environment in which excellence in clinical care will flourish (NHS Executive, England 1998).

Communicable disease: (synonym = infectious disease) an illness due to a specific infectious agent or its toxic products that arises through transmission of that agent or its products from an infected person, animal, or reservoir to a susceptible host, either directly or indirectly through an intermediate plant or animal host, vector, or the inanimate environment.

Contact: Association with an infected person or animal or a contaminated environment such that there is an opportunity to acquire the infection.

Contamination: The presence of an infectious agent on a body surface; also on or in clothes, bedding, toys, surgical instruments or dressings, or other inanimate articles or substances including water and food. Contamination does not imply a carrier state.

Cross-infection: An infection either due to a microbe that came from another patient, member of staff or visitor in a healthcare establishment or due to a microbe that originated in the inanimate environment of the patient.

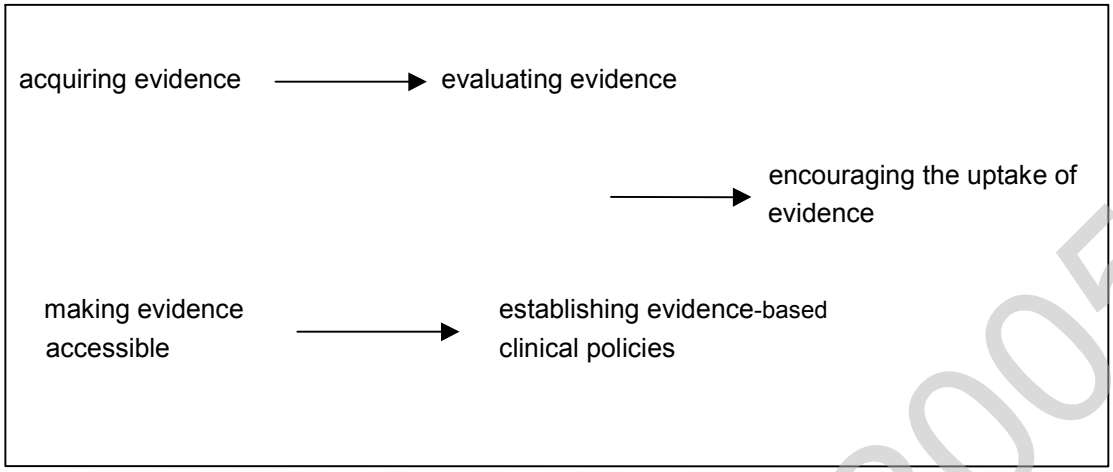
Direct contact: Refers to a mode of transmission of infection between an infected host and a susceptible host. Direct contact occurs when skin or mucous surfaces touch, e.g. hand contact.

Emerging infections: Certain communicable diseases are designated as emerging infections by the World Health Organisation and warrant detailed investigation in order to determine their current and future impact (Donaldson and Donaldson, 2000).

Evidence-based practice: A process of life-long, self-directed learning in which caring for one's own patients creates the need for clinically important information about diagnosis, prognosis, therapy, and other clinical and healthcare issues, and in which clinical practitioners:

- convert information needs into answerable questions;
- track down, with maximum efficiency, the best evidence with which to answer them (whether from clinical examination, the diagnostic laboratory, the published literature, or other sources);
- critically appraise that evidence for its validity and usefulness;
- apply the results of this appraisal in clinical practice;
- evaluate performance.

The key steps and activities in evidence-based practice (Donaldson and Donaldson, 2000) are:



Fomites: Articles that convey infection to others because they have been contaminated by pathogenic organisms. Examples include hospital equipment, instruments, kidney dishes, hospital bed tables, drinking glasses, door handles, clothing and toys (Last, 1995).

Fungi: Unicellular, multicellular or syncytial spore-forming organisms that feed on organic matter; includes yeasts and moulds (Baril, 2000). The most common fungal infections are caused by *Candida* spp. (see, for example, O'Connell and Humphreys, 2000).

Gram-negative bacteria: The Gram stain was developed in 1884 by a Dane, Christian Gram, and is an important technique still used in diagnostic microbiology. The bacteria to be stained are spread on to a glass slide. Methyl violet, followed by iodine, is applied at this stage; the cells are stained blue; they are then treated briefly with acetone. Gram-positive bacteria retain the methyl violet, but Gram-negative bacteria are decolorised by the acetone. Another dye, safranin, is applied and is taken up by the Gram-negative bacteria. When viewed under the microscope, Gram-positive cells appear blue and Gram-negative cells are stained red.

Gram-positive bacteria: see Gram-negative bacteria

Healthcare-associated infections: Infections that are acquired during a visit to, or related to a stay in, a healthcare facility.

Iatrogenic infection: Illness resulting from professional activity of healthcare workers.

Immunocompromised patient: A patient whose immune response is deficient because of an impaired immune system. See also At-risk patient.

Indirect contact: A mode of transmission of infection involving fomites or vectors. Vectors may be mechanical or biological.

Laminar airflow: A system of ventilation in which the entire body of air in a confined area moves with uniform velocity along parallel flow lines (Gardner and Peel, 1991).

Mode of transmission: see Transmission.

Pathogen: A bacterium, virus, or other micro-organism that can cause disease.

Prion: A virus-like particle, an infectious protein, to which several so-called slow virus diseases (e.g. Creutzfeldt-Jakob disease, scrapie, and bovine spongiform encephalopathy) are attributed. The word was coined in 1982 by S. Prusiner, from *pro*teinaceous *in*fectious particles, reversing the order of the vowels.

Protozoa: A group of organisms comprising the single-celled microscopic animals, which includes amoebas, flagellates, ciliates, sporozoans, and many other forms.

Reservoir (of infection): Any person, animal, plant, soil, or substance, or a combination of these, in which an infectious agent normally lives and multiplies, on which it depends primarily for survival, and where it reproduces itself in such a manner that it can be transmitted to a susceptible host: the natural habitat of the infectious agent.

Spore: Some species of bacteria, particularly those of the genera *Bacillus* and *Clostridium*, which are significant cause of infection in humans, develop highly resistant structures called spores when they are exposed to adverse conditions, such as a lack of nutrients or water. Spores are resistant to disinfectants and to high or low temperatures. They may remain viable for many years but when the environment conditions improve the spores germinate and the bacterial cell inside starts to multiply again.

Transmission: Any mechanism by which an infectious agent is spread from a source or reservoir to a person. Modes of transmission of infection include direct transmission involving direct transfer of micro-organisms to the skin or mucous membranes by direct contact; indirect transmission involves an intermediate stage between the source of infection and the individual, e.g. infected food, water or vector-borne transmission by insects; airborne transmission involving inhaling aerosols containing micro-organisms, e.g. legionnaires' disease or tuberculosis.

References

Scottish Infection Manual, Scottish Executive Health Department, SOHD/CMO (98) 22.

Decontamination of Medical Devices, HDL (2001) 10.

Managing the Risk of Healthcare Associated Infection in NHSScotland, HDL (2001) 53.

Healthcare Associated Infection Review of Decontamination Services Provision across NHSScotland, HDL (2001) 66.

NHSScotland Decontamination Guidance: Version 1 – August 1999, CD-ROM available from Property and Environment Forum Executive (P&EFEx).

Scottish Hospital Planning Note 15: Accommodation for Pathology Services, MEL 94/12 (HMSO).

Scottish Hospital Planning Note 26: Operating Department, MEL 92/65 HMSO) (to be read on conjunction with HTM 26).

Scottish Hospital Planning Note 27: Intensive Care Unit, Property and Environment Forum Executive (2001).

Scottish Hospital Planning Note 13: Sterile Services Department, MEL 94/63 (HMSO).

Scottish Health Technical Memorandum 2040: Control of Legionellae in Healthcare Premises – A Code of Practice – Parts 1 to 6, Property and Environment Forum Executive (1999).

Scottish Health Technical Memorandum 2025: Ventilation in Healthcare Premises – Parts 1 to 4, Property and Environment Forum Executive, (1999).

Scottish Health Technical Memorandum 2010: Sterilization – Parts 1 to 5, Property and Environment Forum Executive (1999).

Scottish Health Technical Memorandum 2027: Hot and Cold Water Supply, Storage and Mains Services – Parts 1 to 4, Property and Environment Forum Executive (1999).

Scottish Health Planning Note 04: Patient Accommodation: Options for Choice, Property and Environment Forum Executive (2000).

Scottish Health Technical Memorandum 2030: Washer-disinfectors – Parts 1 to 3, Property and Environment Forum Executive (1999).

Scottish Capital Investment Manual, Scottish Executive Health Department (HMSO).

Guidelines for Design and Construction of Hospital and Healthcare Facilities, American Institute of Architects/Academy of Architecture for Health (1996), The American Institute for Architects Press, Washington, DC.

Working party report: revised guidelines for the control of methicillin-resistant Staphylococcus aureus infection in hospitals, Ayliffe, G. *et al*. (1998), *Journal of Hospital Infection*, Vol. 39, pp. 253–290.

APIC state-of-the-art report: the role of infection control during construction in health care facilities, Bartley, J.M. (2000), *American Journal of Infection Control* (*AJIC*), Vol. 28 No. 2, April, pp. 156–169.

Infection control issues in construction and renovation, Carter, C. and Barr, B. (1997), *Infection Control and Hospital Epidemiology*, Vol. 18 No. 8, August, pp. 587–596.

Forty-second Report: The Management and Control of Hospital Acquired Infection in Acute NHS Trusts in England, Commons Public Accounts Committee (2000), 23 November, London, HC 620 ISBN 0 10 269500 8.

Efficacy of prevention by high-efficiency particulate air filtration or laminar airflow against Aspergillus airborne contamination during hospital renovation, Cornet, M. *et al*. (1999), *Infection Control and Hospital Epidemiology*, Vol. 20 No. 7,pp. 508–513.

Mopping up hospital infection, Dancer, S. (1999), *Journal of Hospital Infection*, Vol. 43, pp. 85–100.

Hospital Laundry Arrangements for Used and Infected Linen, Department of Health (1995b), HSG(95)18.

Management of Food Hygiene and Food Services in the NHS, Department of Health (1996), HSG(96)20.

The Path of Least Resistance, Department of Health (1998), Standing Medical Advisory Committee Sub-Group on Antimicrobial Resistance, http://www.doh.gov.uk/smac1.htm

Governance in the New NHS: Controls Assurance Statements 1999/2000 – Risk Management and Organisational Controls, Department of Health (1999a), HSC 1999/123, http://www.doh.gov.uk/coinh.htm.

Resistance to Antibiotics and Other Antimicrobial Agents, Department of Health (1999b), HSC 1999/049, http://www.doh.gov.uk/coinh.htm.

The Management and Control of Hospital Infection, Department of Health (2000b), HSC 2000/002, http://www.doh.gov.uk/coinh.htm.

UK Antimicrobial Resistance Strategy and Action Plan, Department of Health (2000d), http://www.doh.gov.uk/arbstrat.htm

Silver/copper ionisation treatment of water to reduce the risk of Legionella in NHS healthcare premises, Dobson, C. *et al*. (1997), *Health Estate Journal*, May, pp. 7–10.

Aspergillus terreus during hospital renovation, Flynn, P.M., Williams, B.G., Hetherington, S.V., Williams, B.F., Giannini, M.A. and Pearson, T.A. (1993), *Journal of Infection Control and Hospital Epidemiology*, Vol. 14 No. 7, July, pp. 363–365.

Resistance to Antibiotics and Other Antimicrobial Agents, House of Lords Select Committee on Science and Technology (1998), The Stationery Office, London.

A prospective study on factors influencing aspergillus spore load in the air during renovation works in a neonatal intensive care unit, Mahieu, L. et al. (2000), *Journal of Hospital Infection*, Vol. 45, pp. 191–197.

The epidemiology and prevention of invasive aspergillosis, Manuel, R. and Kibbler, C. (1998), *Journal of Hospital Infection*, Vol. 39, pp. 95–109.

Association of legionnaires' disease with construction: contamination of potable water?, Mermel, L.A., Josephson, S.L., Giorgio, C.H., Dempsey, J. and Parenteau, S. (1995), *Journal of Infection Control and Hospital Epidemiology*, Vol. 16 No. 2, February, pp. 76-81.

Towards new biomaterials, Montdargent, B. and Letourneur, D. (2000), *Infection Control and Hospital Epidemiology*, Vol. 21 No. 6, pp. 404–410.

Health Building Note 10: Catering Department, NHS Estates (1986), Department of Health, HMSO, London.

Health Technical Memorandum 64: Sanitary Assemblies, NHS Estates (1989a), Department of Health, HMSO, London.

Health Technical Memorandum 60: Ceilings, NHS Estates (1989b), Department of Health, HMSO, London.

Health Technical Memorandum 58: Internal Doorsets, NHS Estates (1989c), Department of Health, HMSO, London.

Health Technical Memorandum 55: Windows, NHS Estates (1989d), Department of Health, HMSO, London.

Health Technical Memorandum 56: Partitions, NHS Estates (1989e), Department of Health, HMSO, London.

Health Building Note 26: Operating Department, NHS Estates (1991b), Department of Health, HMSO, London.

Health Building Note 25: Laundry, NHS Estates (1994b), Department of Health, HMSO, London.

Intensive care unit design and environmental factors in the acquisition of infection, O'Connell, N. and Humphreys, H. (2000), *Journal of Hospital Infection*, Vol. 45, pp. 255–262.

Socioeconomic Burden of Hospital-acquired Infection, Plowman, R., Graves, N., Griffin, M., Roberts, J.A., Swan, A.V., Cookson, B.D. and Taylor, L. (2000), Department of Health.

Fungal surveillance of an open haematology ward, Richardson, M. *et al*. (2000), *Journal of Hospital Infection*, Vol. 45, pp. 288–292.

Refinements of environmental assessment during an outbreak investigation of invasive aspergillosis in a leukemia and bone-marrow transplant unit, Thio, C.L., Smith, D., Merz, W.F., Streifel, A.J., Bova, G., Gay, L., Miller, C.B. and Perl, T.M. (2000), *Journal of Infection Control and Hospital Epidemiology*, Vol. 21 No. 1, January, pp. 18-23.

Better environmental survival of outbreak versus sporadic MRSA isolates, Wagenvoort, J. *et al*. (2000), *Journal of Hospital Infection*, Vol. 45, pp. 231–234.

Aspergillus infection – risks with demolition and building alterations, Wearmouth, P. (1999), letter to Heads of Estates and Facilities, NHS Estates, November.

Further Reading

Rx for SBS, Baril G. (2000), Health Facilities Management, April, p. 26.

Legionella and Building Services, Brundrett, G.W. (1992), Butterworth-Heinemann, Oxford.

Essential Public Health, Donaldson, L.J. and Donaldson, R.J. (2000), 2nd edition, LibraPharm Limited, Newbury.

Introduction to Sterilization, Disinfection and Infection, Gardner, J. and Peel, M. (1991), 2nd edition, Churchill Livingstone, Melbourne.

A Dictionary of Epidemiology, Last, J. (Ed.) (1995), 3rd edition, Oxford University Press, New York.

Control of Infection in Hospital. A Practical Handbook, Lowbury, E., Ayliffe, G.A.F., Geddes, A. and Williams, J. (1992), Chapman & Hall, London.

Infection Control: Science, Management and Practice, McCulloch, J. (Ed.) (2000), Whurr, London.

De-bugging hospitals, Room, P. (1998), Hospital Development, October, p. 35.

Infection Control: Guidelines for Nursing Care, Worsley, M. *et al*. (Eds) (1990), Infection Control Nurses Association.