

“A design team which produces a total, balanced, efficient design can help to produce a better environment.”

Sir Ove Arup, November 1968



4th European Conference on Healthcare Engineering

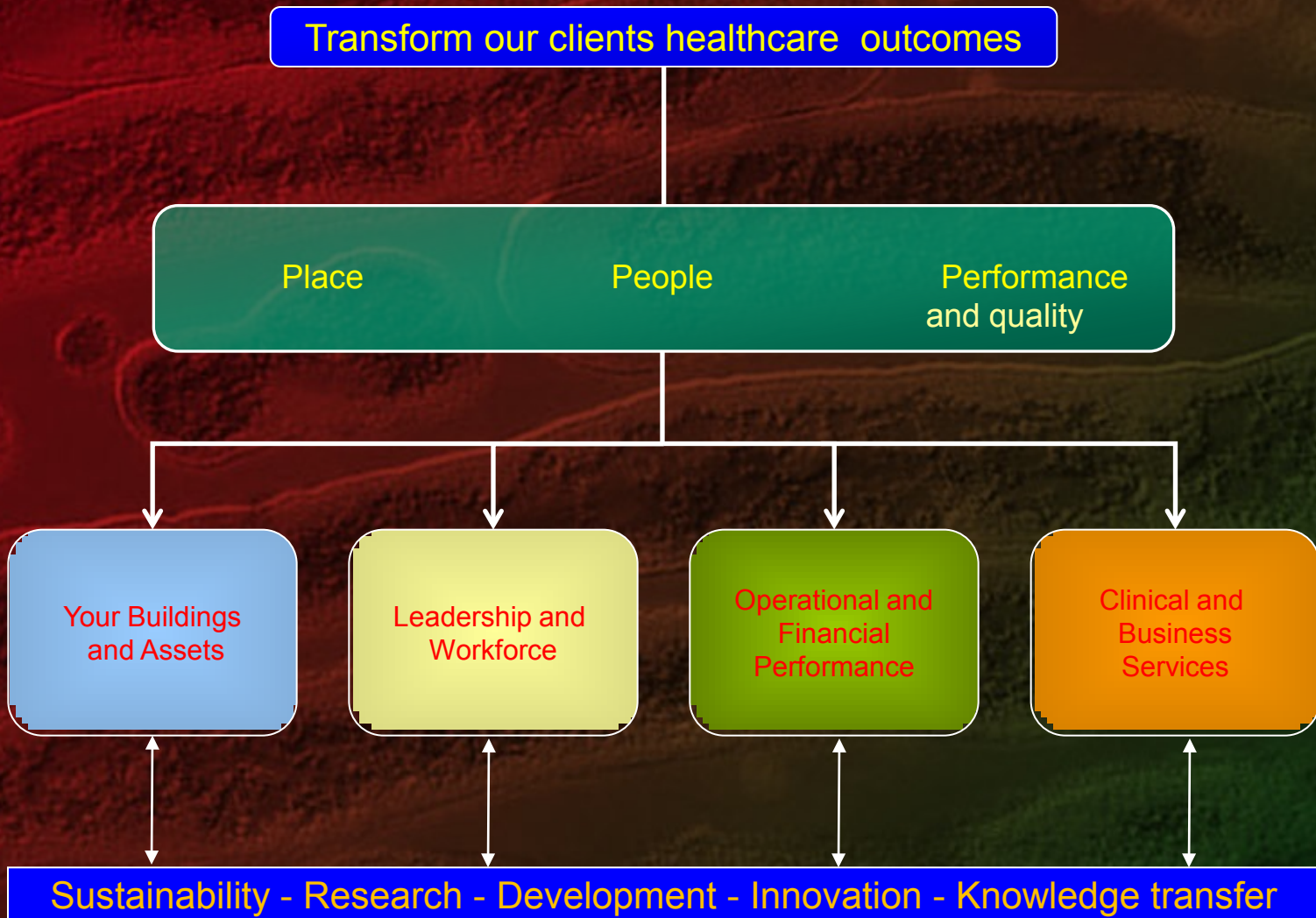
**WG1 – Infection control precautions
during building and reconstruction of
hospitals**

Phil Nedin

Director – Healthcare global business leader

ARUP

Our Business Goal



Shaping our business through design



Altnagelvin hospital clinical block
Northern Ireland



Pembury Hospital Kent.
UK.



Moorfield children's eye
hospital .London



Basildon Cardiothoracic
hospital. Essex UK



Medicover hospital Poland



Alfred ICU Melbourne Aus.



Kenema clinic Sierra Leone



Hospital Del Norte Madrid



Ysbyty Altwen Wales



St Helens PFI hospital England



OASTSIH Aus.

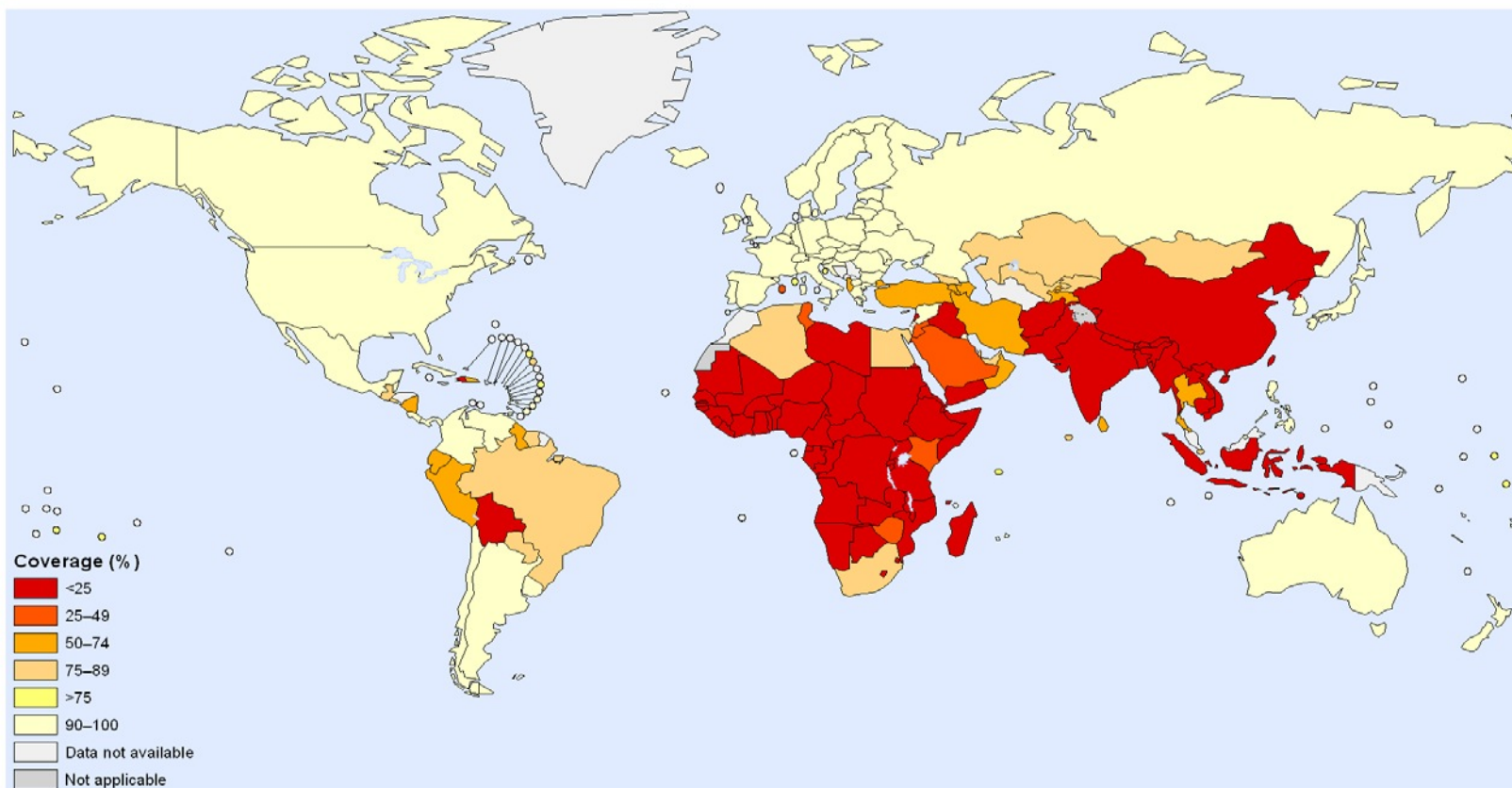


Kaiser - Antioch
USA

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Mortality and burden of disease

Coverage of vital registration of deaths, 2000–2008



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Data Source: World Health Organization
Map Production: Public Health Information
and Geographic Information Systems (GIS)
World Health Organization



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Beware complacency!

1969

**“Infectious disease have been
conquered”**

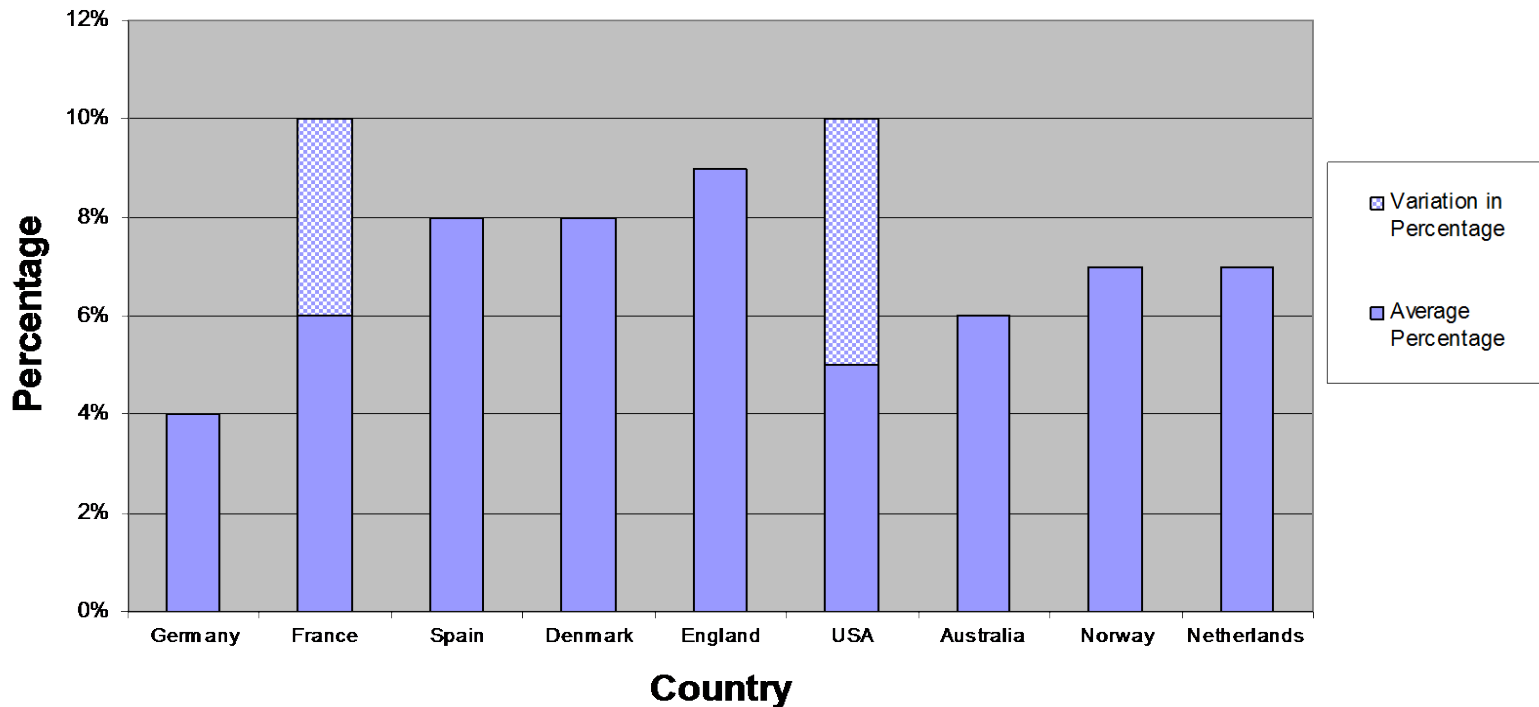
William Stewart

Surgeon General, USA

The risk - HAI Statistics - 2005

IMPROVING PATIENT CARE BY REDUCING THE RISK OF HOSPITAL ACQUIRED INFECTION

Estimated Prevalence of Hospital Acquired Infection

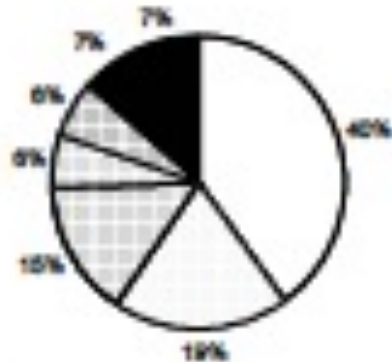


Do we see infection increasing or decreasing over the next 10 years???

Infection control has a cost.



FM Cost in the OR – Sample of 4 Hospitals



- Sterile goods supply
- Cleaning
- Maintenance of biom. equipment
- Maintenance
- Laundry services
- Administration, controlling, other
- Other

FM Product	Cost driver
OR-sterile goods supply	Number of STE per procedure
OR-cleaning	TP1: operation time TP2: number of operations
OR-maintenance of biomedical equipment	fix
OR-maintenance	Fix and partly variable: time
OR-laundry services	TP1: operation time TP2: number of operations

5 FM products cause about 85% of the total FM cost in the operation unit.

MRSA 2001 – 10, UK NHS

- 2001/2 7291
- 2002/3 7426
- **2003/4 7700**
- 2004/5 7212
- 2005/6 7097
- 2006/7 6383
- 2007/8 4451
- **2008/9 2932** *62% reduction*
- **2009/10 1898** *75% reduction*

The task - Infection control – A holistic design process

Operational

Maintenance

**ZERO
TOLERANCE
STRATEGY**

Design

Product

Validation

Research

Best practice

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The route -The transmission routes of Infection

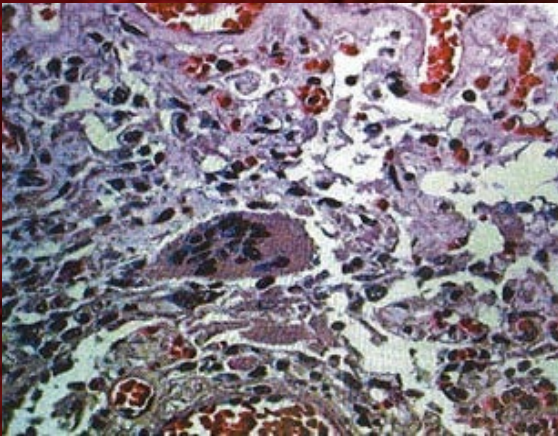
Contact transmission

Droplet transmission

Airborne transmission

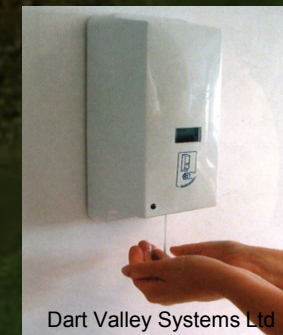
**Common vehicle
transmission**

**Vector borne
transmission**



Contact transmission

- Easy to clean surfaces, finishes, fixtures & fittings
- Hygienic surfaces
- Eliminate cills & ledges
- Hard wearing surfaces
- Vinyl or carpet
- Immediate damage repair
- Position of hand wash facilities
- No touch appliances
- Anti bacterial coatings – take care!
- Vaporised hydrogen peroxide decontamination
- Alcohol gels – take care!
- On-going staff training
- Human behavioural training
- The use of smart card technology



Droplet transmission

- Coughing sneezing and talking
- Suctioning & bronchoscope procedures
- Droplets propelled short distances
- Deposited on conjunctivae, nasal mucosa or mouth



Methods of Spread

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Airborne Transmission – Droplet nuclei

- Rapid evaporation
- Relative humidity important
- Concentration of dissolved substance increases
- Typically 5 μ m smaller in size
- Droplet settling rate can be 4 hours
- Spread by convective air currents



Methods of Spread

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Common Vehicle Transmission

- Food
- Water
- Medication
- Devices
- Equipment



Common vehicle transmission - Water

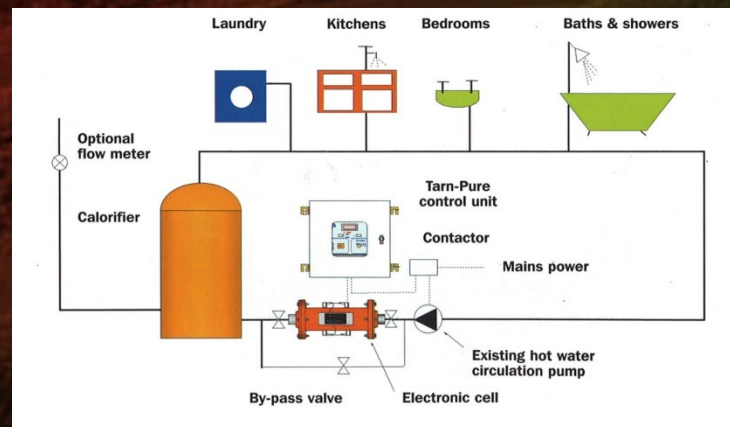
Legionnaires disease

Chain of causation

- Contaminated water supply
- Reservoir
- Nutrient
- Temperature
- Aerosol spray
- Susceptible host

Treatment

- Chlorine
- Heat treatment
- Biocides
- UV
- Ozone
- Ionization



Vector borne transmission

- Beware under-crofts
- Beware incoming services openings
- Eliminate interconnections
- Complete builders-work details
- Fine mesh behind openings
- Easy clean facilities
- Cleanliness

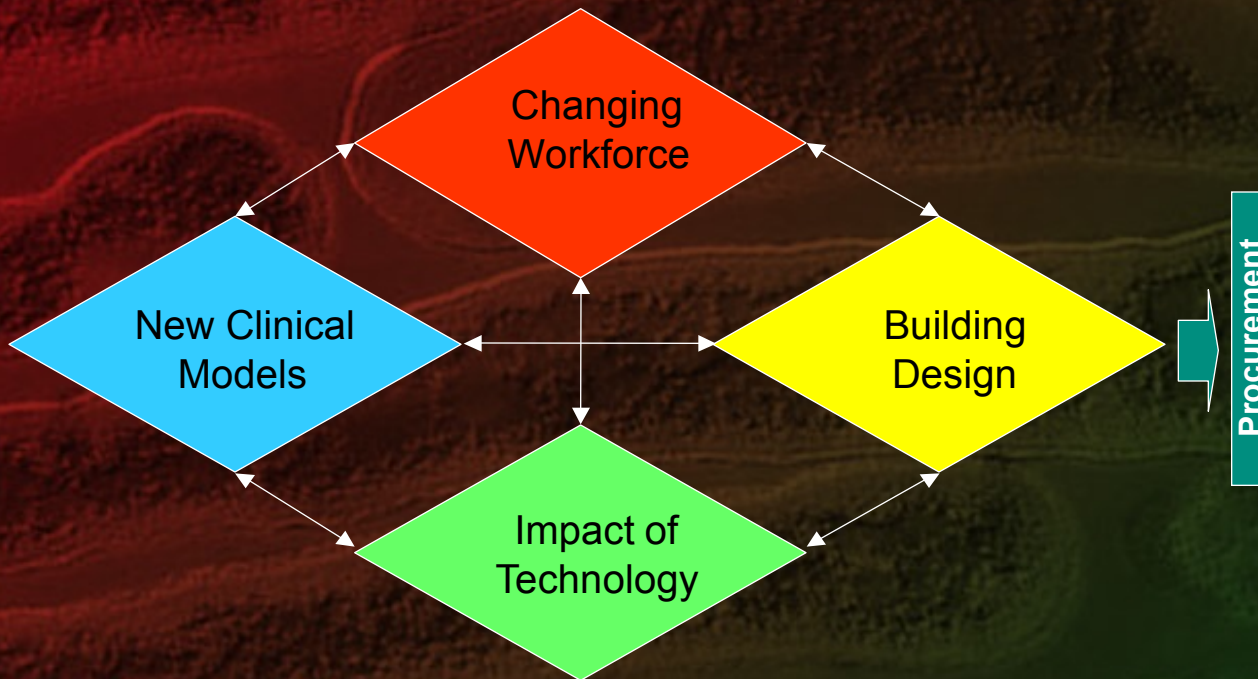


Things are changing ?

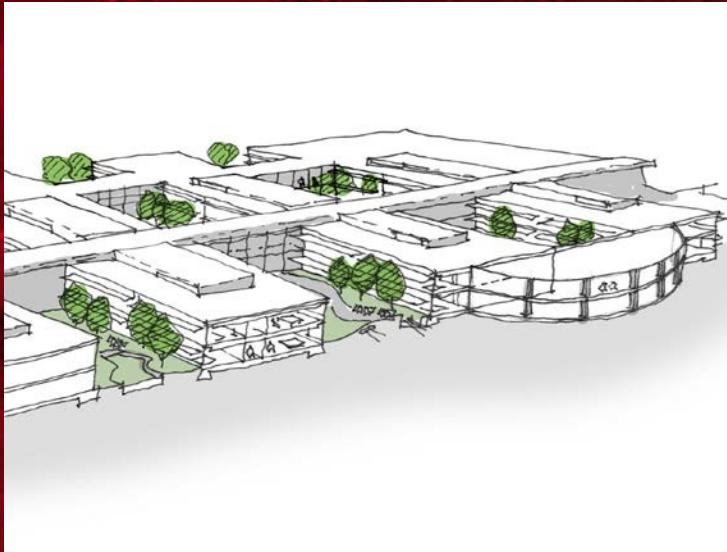
Inside
Hospitals



Outside
Hospitals



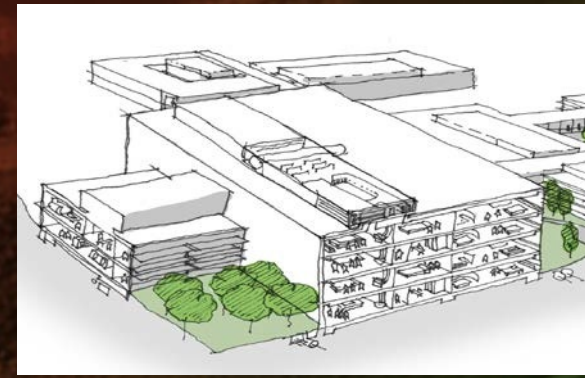
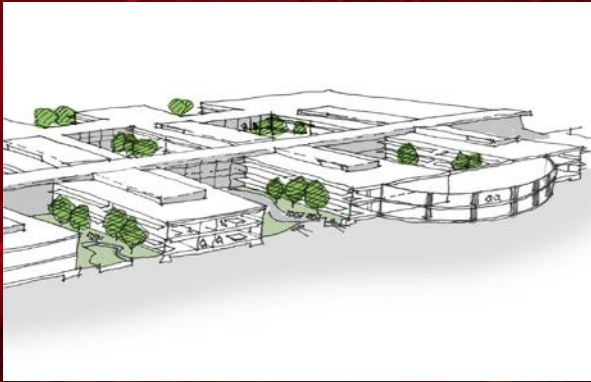
The role of design – space planning



Does the close coupling of spaces help or hinder the spread of infection ?

- Departmental adjacencies = Clinical efficiencies
 - Does an outbreak affect clinical efficiency?
- With mechanical ventilation help or hinder the spread of infection?

Space planning

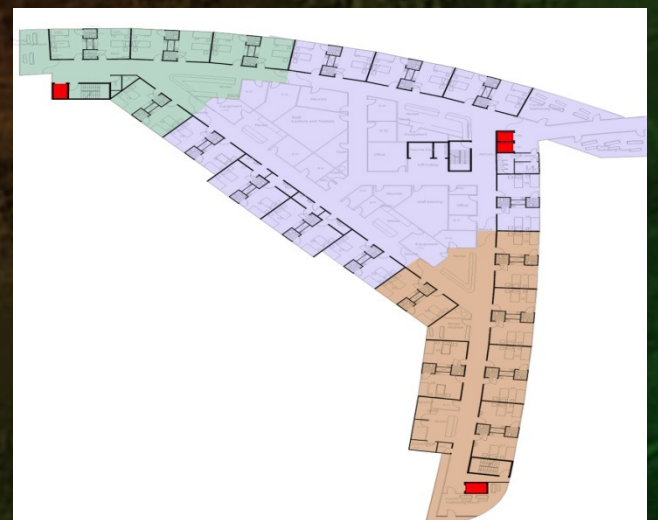
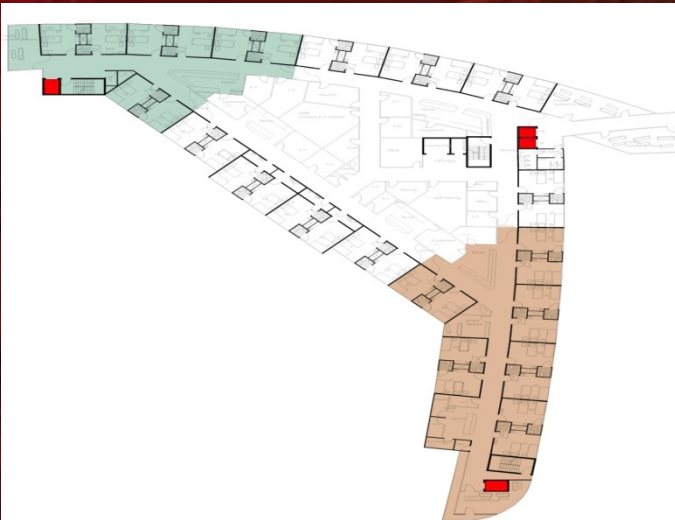
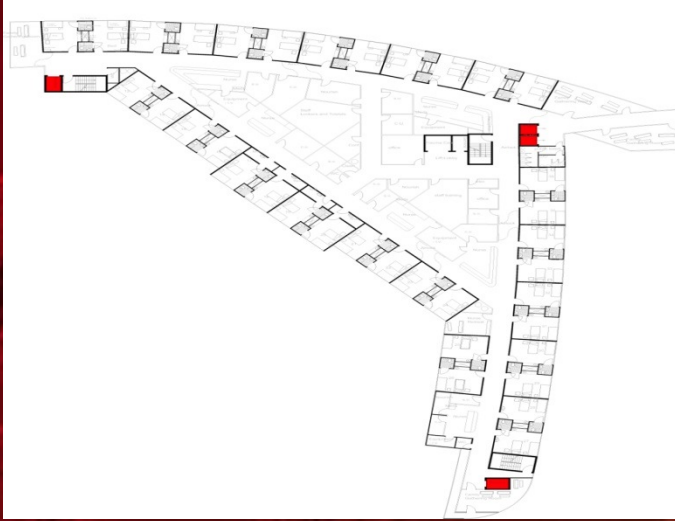


Should we plan for an epidemic ?

Should we plan for refurbishments

- *Isolated patient pathway*
- *Decontamination (including supplies)*
 - *diagnosis*
 - *Inpatient*
 - *theatre*
 - *acute stay*
 - *visitors*
 - *recovery*

Department isolation flexibility



Space planning – Crimea model - circa 1850

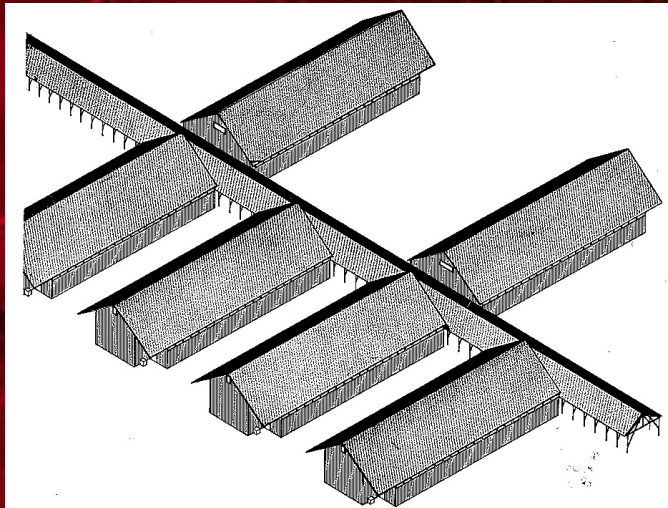


Fig. 11
Isometric drawing illustrating the linear organization of Brunel's standard ward units: pavilions either side of a connecting corridor, characteristic of indeterminate buildings. (Drawn by David Toppin)

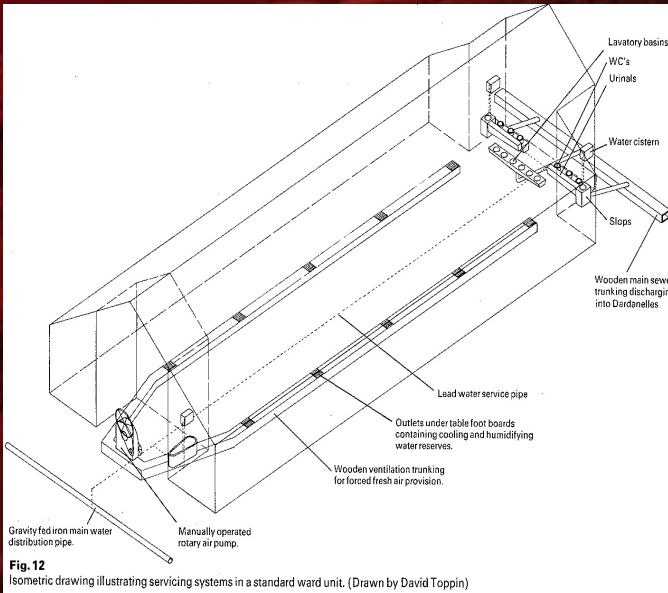


Fig. 12
Isometric drawing illustrating servicing systems in a standard ward unit. (Drawn by David Toppin)

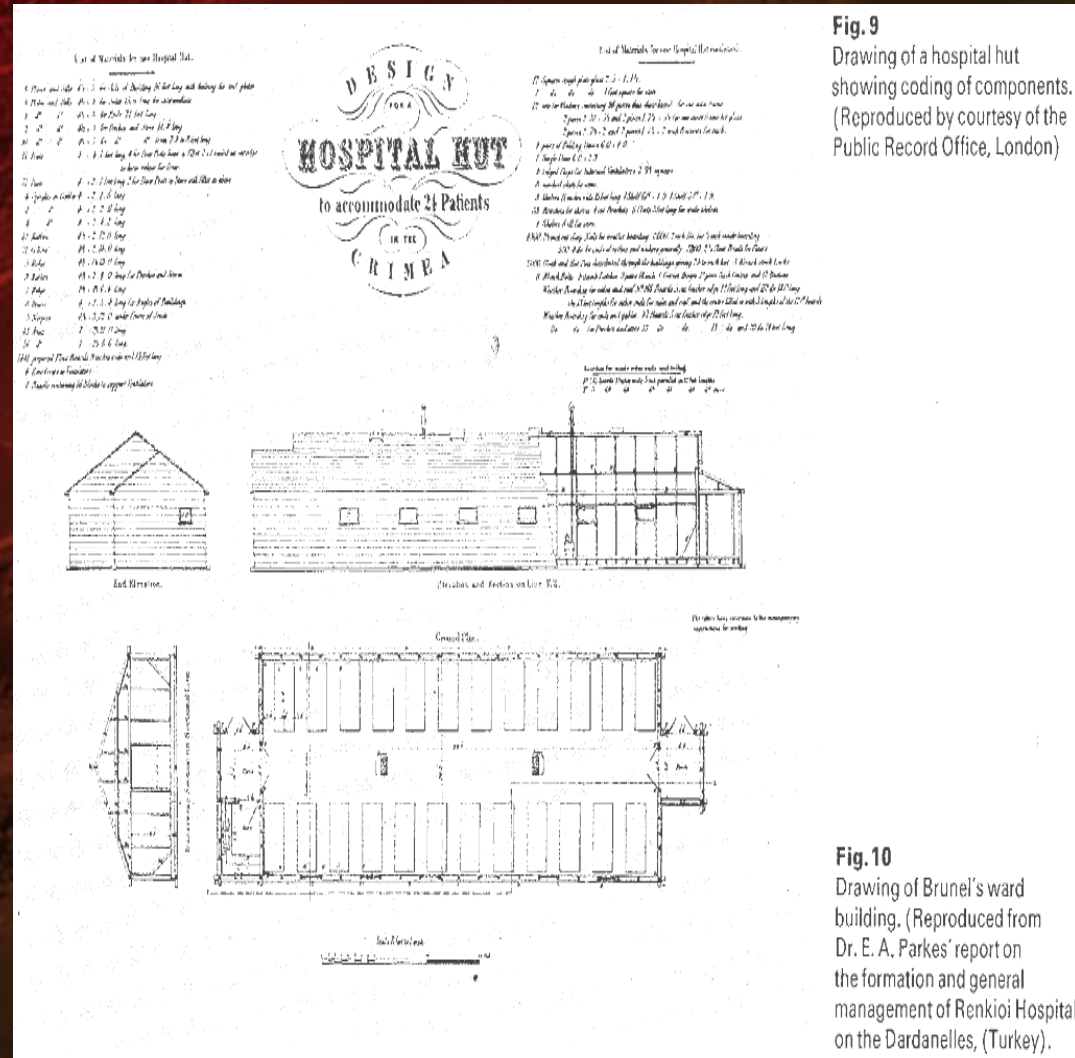


Fig. 9
Drawing of a hospital hut showing coding of components. (Reproduced by courtesy of the Public Record Office, London)

Fig. 10
Drawing of Brunel's ward building. (Reproduced from Dr. E. A. Parkes' report on the formation and general management of Renkioi Hospital, on the Dardanelles, (Turkey).

Airborne Transmission – Droplet nuclei

- Rapid evaporation
- Relative humidity important
- Concentration of dissolved substance increases
- Typically 5 μ m smaller in size
- Droplet settling rate can be 4 hours
- Spread by convective air currents



Methods of Spread

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Impact of bed making & other activities

Item	Inside Patient Room (cfu/m ³)	Hallway near Patient Room (cfu/m ³)
Background	1200	1060
During bed making	4940	2260
10 mins. after bed making	2120	1470
30 mins. after bed making	1270	950
Background	560	n.a.
Normal bed making	3520	n.a.
Vigorous bed making	6070	n.a.

Impact of bed making

Table 1 Influence of bed making on airborne bacterial count in hospitals (30)

Site sampled	Number of microorganisms Settling in 5 mins. during Bed-making	Number of microorganisms Settling in 5 mins. During Shaking curtains	Number of microorganisms Settling in 5 mins. during High activity	Number of Microorganisms Settling in 5 mins. during Wet cleaning
Cotton gauze (60 cm ²)	19.8	8.4	27.0	2.4
Forceps (approx. 10 cm ²)	3.3	1.4	4.5	0.4

Impact of activity

Table 2 Contamination of clinical equipment by airborne microorganisms (40)

NHS Smart Ideas Programme

**Design
Bugs Out**

Design
Council

Patients expect
hospitals to be
clean and safe.

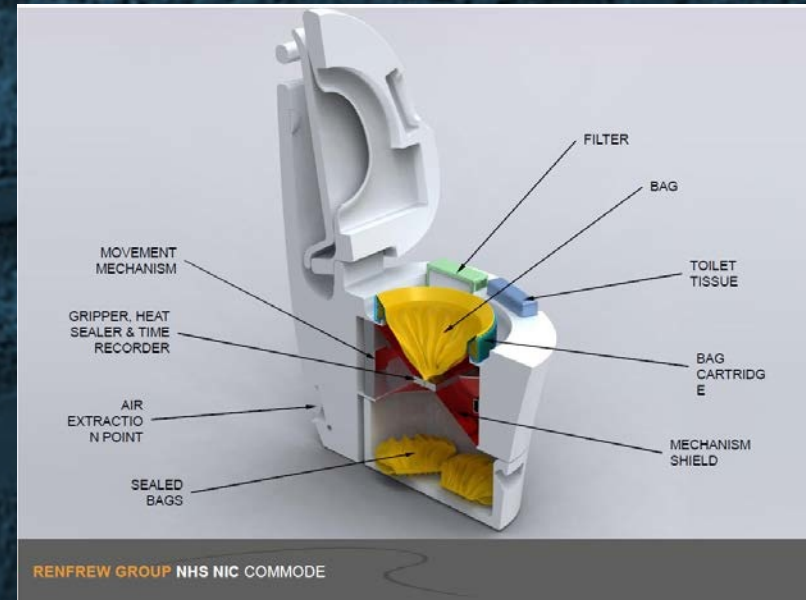
Good design can help
make that happen by
developing furniture and
equipment that's easy to
clean and easy to use.

DH Department
of Health

NHS Smart Ideas Programme - Cleanliness



RENFREW GROUP NHS NIC COMMODE

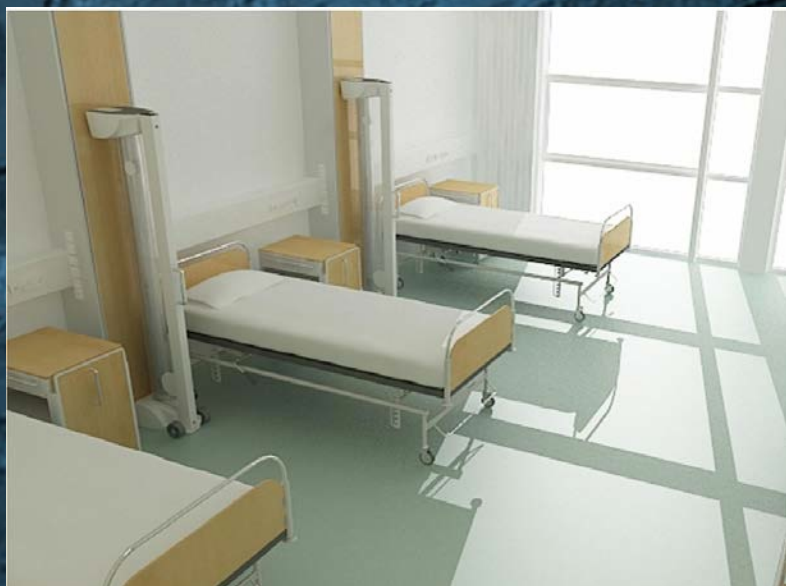


RENFREW GROUP NHS NIC COMMODE

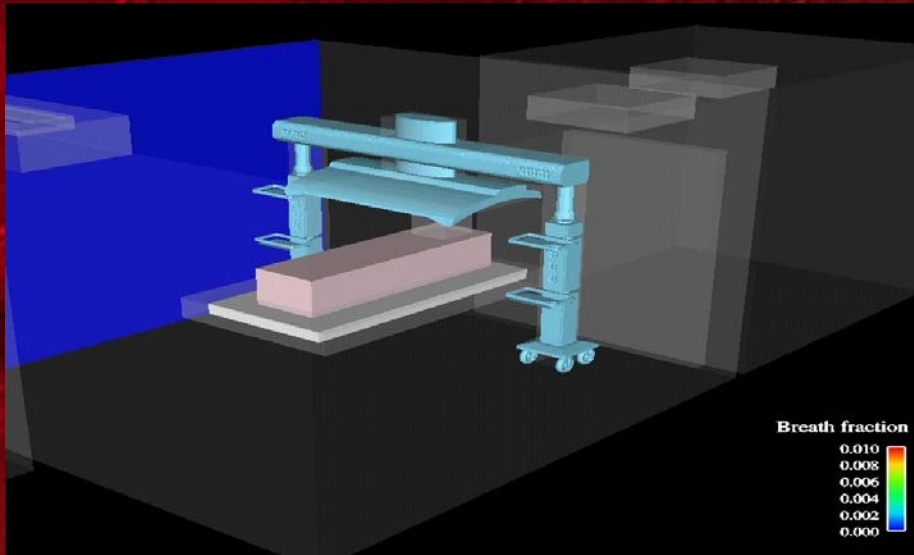
NHS Smart Ideas Programme - separation



NHS Smart Ideas Programme - separation



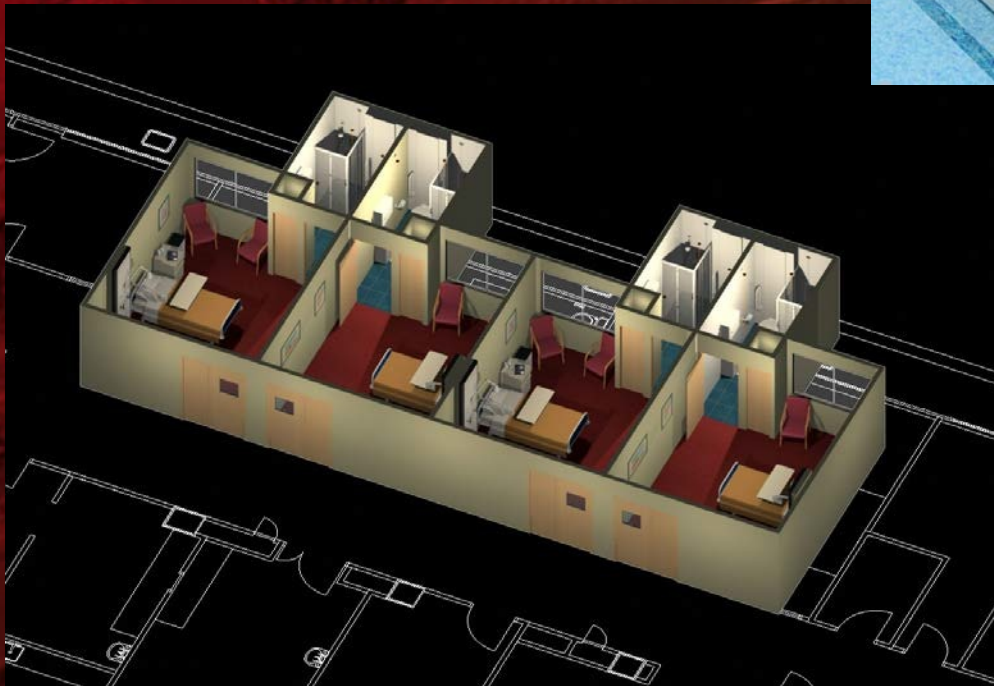
Portable isolation system



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A key debate – single room v's multi bed

Which planning arrangement has the most potential to reduce the spread of infection?



Cleaning effectiveness is compromised in multi bed wards due to occupation rates!

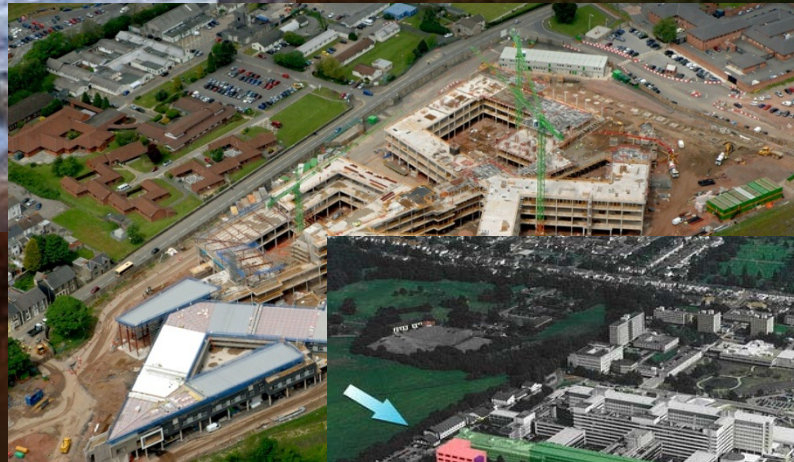
Airborne transmission – Dust - Internal

Refurbishment projects

- Reduce dust generation
- Decontamination tent
- Additional cleaning regime in place
- Awareness of activity on adjacent floors
- Communicate with staff regularly
- Programme to reflect testing process



The existing estate – our starting position!



Space planning - refurbishments



exploring space - MPEG4

Airborne transmission – Dust - External

Site contamination



Engineering design – Aspergillus strategy

- Internal and external space audit
- Internal spaces – treat as asbestos removal
- Additional cleaning regime in place for internal spaces
- Awareness of activity on adjacent floors and define contamination risk
- Communicate with staff regularly
- Review building demolition strategy including had demolition or wetting
- Wind speed and direction audit
- Adjacent buildings to be sealed
- Vulnerable patient audit – remove patients
- Ventilation grille audit related to prevailing wind
- Ventilation filtration check during demolition for blockage and downstream filter duct contamination.
- Strategy agreed with hospital micro-biologist.

Engineering design – Aspergillus strategy



Alfred Hospital ICU Melbourne

Strategies to reduce dust and moisture intrusion during demolition process

- Shroud the site
- Careful positioning of dust generating equipment
- Isolate construction materials storage
- Seal off air intakes as appropriate
- Maintain pressure gradients in AHU systems
- Regularly check filters
- Seal windows to prevent airborne spores entry
- Door management essential
- Locate all water services to prevent intrusion of dust into system
- Ensure pipe-work subject to vibration during construction is checked
- Close off rooftops to public during construction work
- Water down dust generation wherever possible
- Create protected routes for immuno-compromised patients
- Manage pedestrian traffic to prevent dust intrusion
- Manage motor vehicle traffic
- Manage a staff and visitor education and awareness strategy

Scottish Health Facilities Note 30: Version 3



Infection control in the built environment:
Design and planning



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HAI-SCRIBE (Healthcare Associated Infection System for Controlling Risk In the Built Environment)



Version 2



There are key issues to be considered in assessing the hazard with a view to managing the risk. Therefore, in each situation where there is to be construction and refurbishment or repair work, the multi-disciplinary team of specialists referred to in the 'Introduction' of this document should be involved and the following questions need to be addressed.

Consideration should be given to the likelihood of patient movement outwith their speciality care area and the need for appropriate measures to control infection risk.

- | | Yes | No |
|---|--------------------------|--------------------------|
| 4.1 Has the type and extent of construction and refurbishment or repair work been addressed in terms of infection risk? | <input type="checkbox"/> | <input type="checkbox"/> |
| 4.2 Has the likelihood of contaminating adjacent patient care areas, and those on levels immediately below and above been addressed? | <input type="checkbox"/> | <input type="checkbox"/> |
| 4.3 Has the impact on traffic and supply routes been addressed in terms of infection risk? | <input type="checkbox"/> | <input type="checkbox"/> |
| 4.4 Has the impact on sterile stock storage areas been addressed? | <input type="checkbox"/> | <input type="checkbox"/> |
| 4.5 Has the impact of airflow patterns and ventilation systems been addressed in terms of infection risk from construction and refurbishment or repair work? | <input type="checkbox"/> | <input type="checkbox"/> |
| 4.6 Has the extent of the dust, noise and infection risk from the construction and refurbishment or repair work been addressed? | <input type="checkbox"/> | <input type="checkbox"/> |
| 4.7 Have the hours of operation of the construction work and the impact of this in terms of infection risk been addressed? | <input type="checkbox"/> | <input type="checkbox"/> |
| 4.8 Have the areas of the healthcare facility most likely to be affected by the dust, noise and infection risk been identified and the infection risks addressed? | <input type="checkbox"/> | <input type="checkbox"/> |
| 4.9 Have the population groups most susceptible to infection been identified and the risks associated with noise, dust, and infection been addressed? | <input type="checkbox"/> | <input type="checkbox"/> |
| 4.10 Has the particular risk of fungal infection from demolition and refurbishment construction been identified and measures put in place for the infection risk to be managed effectively to minimise impact on patients and visitors? | <input type="checkbox"/> | <input type="checkbox"/> |
| 4.11 Have measures been designed in to eliminate or minimise the impact of the dust, noise and infection risk? | <input type="checkbox"/> | <input type="checkbox"/> |

The answers to the above questions should be 'yes'. Where a potential hazard is identified a careful assessment of that hazard must be undertaken.

Certain situations will require the use of barrier structures to contain contamination. Therefore the following questions need to be addressed for each of these situations:

- | | Yes | No |
|--|--------------------------|--------------------------|
| 4.12 Has the use of barrier structures to contain contamination been addressed in the following situations? - | <input type="checkbox"/> | <input type="checkbox"/> |
| 4.13 Demolition of walls, plaster, ceramic tiles, ceilings and ceiling tiles? | <input type="checkbox"/> | <input type="checkbox"/> |
| 4.14 Removal of flooring and carpeting, windows and doors? | <input type="checkbox"/> | <input type="checkbox"/> |
| 4.15 Work with sinks or plumbing which could give rise to aerosol water droplets in high risk areas? | <input type="checkbox"/> | <input type="checkbox"/> |
| 4.16 Exposure of ceiling spaces? | <input type="checkbox"/> | <input type="checkbox"/> |
| 4.17 Elevator shaft demolition and construction? | <input type="checkbox"/> | <input type="checkbox"/> |
| 4.18 Repairs to water damage? | <input type="checkbox"/> | <input type="checkbox"/> |
| 4.19 Has the type and extent of construction and refurbishment or repair work been addressed in terms of infection risk? | <input type="checkbox"/> | <input type="checkbox"/> |

The answers to the above questions should be 'yes'. Where a potential hazard is identified a careful assessment of that hazard must be undertaken.

Measures to minimise risk of infection should be addressed. Therefore the following question needs to be addressed.

- | | Yes | No |
|--|--------------------------|--------------------------|
| 4.20 Have measures to minimise risk of infection been investigated, including the following? - | <input type="checkbox"/> | <input type="checkbox"/> |
| 4.21 Relocation of susceptible patients? | <input type="checkbox"/> | <input type="checkbox"/> |
| 4.22 Prevention of weather/water entry and protection of interior? | <input type="checkbox"/> | <input type="checkbox"/> |
| 4.23 Prevention of contamination by dust etc. with particular attention to air systems e.g. ducts, air handlers, coils, fans, grills by creation of temporary barrier structures or exhaust ventilation to isolate work areas? | <input type="checkbox"/> | <input type="checkbox"/> |



Scribe Video



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WG1 Original membership list

First Name	Surname	Company	Email
Henk	Nicolaas	College Bouw	hj.nicolaas@bouwcollege.nl
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Martin	Scherrer		martin.scherrer@fkt.de
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Niina	Agthe	National Public Health Institute	niina.agthe@ktl.fi
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		Norconsult AS	

Sample literature search

APIC State-of-the-Art Report: The role of infection control during construction in health care

ICBOFS PLANNING - apicgd.org

Section I outlines the broad semi-regulatory foundation for direct infection control participation in strategic planning for construction. Section II describes initial steps of planning through policy development

Air quality control during renovation in health care facilities

D Rask, B Dziekan, W Swiencicki, P Heinsohn, D - Design, construction, and operation of healthy buildings; , 1998

Environmental interventions to control nosocomial infections

WA Rutala, DJ Weber - Infection control and hospital epidemiology, 1995 - cat.inist.fr

ENVIRONMENTAL INTERVENTIONS TO CONTROL NOSOCOMIAL INFECTIONS. WA RUTALA, DJ WEBER

Infection control and hospital epidemiology 16:88, 442-443, Slack, 1995.

Aspergillosis and construction

AJ Streifel - Architectural Design and Indoor Microbial Pollution, 1988 - books.google.com

9 Aspergillosis and Construction ANDREW I. STREIFEL Continuous advances in utilities such as communication and energy- efficient technology require updating of building services.

Infection control during construction: planning is key.

SE Brace - Healthc Facil Manag Ser, 1993 - ncbi.nlm.nih.gov

Healthc Facil Manag Ser. 1993 Apr;;1-14. Infection control during construction: planning is key. Brace SE. Ohio State University Hospitals, Columbus.

Controlling construction dust in the hospital environment; a quality improvement project

G Turner, R Sumner, L Ornelas, M Martin - AJIC Am J Infect Control, 1995

Keeping the air clean—lessons from a construction project

K Gartner, M Blank, R Volosky - AJIC Am J Infect Control, 1996

Guidelines for Environmental control in healthcare-care facilities

US Department of Health and human services, 2003

“A design team which produces a total, balanced, efficient design can help to produce a better environment.”

Sir Ove Arup, November 1968



4th European Conference on Healthcare Engineering

WG1 - The next step

Phil Nedin

Director – Healthcare global business leader

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