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DISCUSSION

Poverty and infection in the developing world: Healthcare-related infections and infection control in the tropics

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Summary In many hospitals serving the poorest communities of Africa and other parts of the developing world, infection control activities are limited by poor infrastructure, overcrowding, inadequate hygiene and water supply, poorly functioning laboratory services and a shortage of trained staff. Hospital transmission of communicable diseases, a high prevalence of human immunodeficiency virus and multidrug-resistant tuberculosis, lack of resources for isolation and disinfection, and widespread antimicrobial resistance create major risks for healthcare-related infections. Few data exist on the prevalence or impact of these infections in such environments. There is a need for interventions to reduce the burden of healthcare-related infections in the tropics and to set up effective surveillance programmes to determine their impact. Both the Global (G8) International Development Summit of 2005 and the United Nations Millennium Development Goals (MDGs) have committed major resources to alleviating poverty and poor health in the developing world over the next decade. Targeting resources specifically to infection control in low-resource settings must be a part of this effort, if the wider aims of the MDGs to improve healthcare are to be achieved.

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Introduction

'The widening gap between the developed countries and the poorest communities of the developing world has become a central issue of our time.' This is not a quote from the Global (G8) International Development Summit of 2005, or from international awareness events such as the Live Aid and Live 8 Concerts — it is the opening sentence of the Pearson Report of 1969, a commission set up by the World Bank to investigate why, after a decade of 'development', little impact had been achieved for the poorest communities of the tropics.[1,2] In 1984, the Alma Ata Conference of the World Health Organization (WHO) stated as its aim 'Health for All by 2000'. A visit to a village affected by human immunodeficiency virus (HIV) and malaria in tropical Africa, to a shanty town in south Asia with inadequate water and sanitation (Figure 1), or to a displaced community in southern Somalia suffering from cholera, dysentery and Rift Valley fever, suggest that these aims are yet to be fulfilled.

Many medical journals are currently devoting part of their current issues to the themes of poverty and infection in the developing world, in recognition of the commitments made by the G8 Summit and the United Nations (UN) Millenium Development Goals (MDGs) to improve maternal healthcare, reduce childhood mortality and the impact of human immunodeficiency virus (HIV)/acquired immunodeficiency syndrome (AIDS), malaria and other communicable diseases.[3] If G8 and the UN MDGs are to be catalysts for change, it will be necessary to look beyond international conferences and mission statements and to concentrate on specific objectives that can be implemented in resource-poor settings.

From the viewpoint of hospital infection control, the concern is how hospital and healthcare-related infections affect poorer communities of the developing world, and what can be done to

Figure 1 Urban poverty in south Asia with inadequate water and sanitation.

begin to make a contribution to reducing the associated morbidity and mortality.

A visit to a sub-Saharan African country, where I had been looking at laboratory services and hospital infection control, left two particular memories. The first is the overwhelming disadvantages faced by health workers surrounded by HIV/AIDS, multidrug-resistant tuberculosis, overcrowding and lack of resources for the most basic of hygiene activities. The second is the impossibility of knowing the magnitude of hospital-related infections and optimum treatment strategies without effective laboratory services. These comments would certainly have been equally appropriate 10 or 15 years ago. Might 2007 be a turning point? With the current emphasis of governments and UN agencies to focus again on poverty and health, there is an opportunity to move healthcare-related infections, and the support required in terms of laboratory development, education, hospital infrastructure, and appropriate professional training, into a focused agenda, rather than the 'Cinderella' position that has until now been the case.

The pattern of healthcare-associated infections in the tropics

The Ebola virus outbreak in southern Sudan in 1976 was a vivid reminder of the potential magnitude of hospital-acquired infection in tropical Africa.[4] On 6 August 1976, a student from Nzara presented to the local district hospital at Maridi in Equatoria Province, southern Sudan, suffering from a severe febrile disease. He died a week later. Over the next week, a nurse, a cleaner, and a hospital messenger became unwell, and then further medical and auxiliary staff. By the time a Ministry of Health/WHO team arrived in Maridi approximately six weeks after the first case, one of the two doctors in the hospital had been infected and died, all six of the medical assistants had been infected and five had died, and twenty student nurses had died. Further spread and deaths occurred until the impact of basic infection control strategies, involving gloves, gowns and masks for healthcare workers, and hygienic measures in dealing with body fluids and the deceased, brought the outbreak to an end.

While the Maridi Ebola outbreak was an extreme case, it emphasised that the priorities for healthcare-associated infection control in the tropics, particularly away from tertiary or university hospitals in capital cities, cannot be a simple translation of expertise from the West.

While limited systematic data exist on the overall patterns and prevalence of infection, experience from the field, and a review of available literature, indicate that the following are the major groups of infection control areas:

- viral haemorrhagic fevers and other Category 3 and 4 infections
- HIV and tuberculosis
- nosocomial spread of other communicable diseases
- direct hospital-acquired infections
- spread of multi-resistant bacterial pathogens.

Viral haemorrhagic fevers

Since the 1976 outbreaks in Sudan and Zaire (now Democratic Republic of the Congo, DRC), nosocomial transmission of Ebola virus has been reported in DRC (Kikwit), Uganda, and probable cases in Gabon and Sudan. Nosocomial transmission of other viral haemorrhagic fevers has included Lassa fever in Nigeria, and Marburg haemorrhagic fever in Angola.[5–8]

Prevention of transmission is difficult in resource-limited settings, with no total protective clothing or isolation facilities available. Specific guidelines for control in district hospitals have been drawn up by WHO, and these cover issues including patient isolation, locally produced protective clothing, waste disposal, disinfectants, and community education.[9] Early diagnosis of the first cases, often in the community or peripheral health centres, is the mainstay of ensuring that preventive measures are initiated in a timely fashion and that transmission is kept to a minimum. If severe acute respiratory syndrome, pandemic influenza or H5N1 avian flu were to become pathogens in these under-resourced tropical areas, the pattern of the 1976 Ebola outbreaks could be repeated.

HIV and tuberculosis

In any hospital infection control programme in much of Africa, and large parts of Asia and Latin America, prevention of the spread of HIV, between patients, from patients to health workers, and from health workers to patients, is a priority. Largely due to the UN and WHO Global Aids Programme, there is considerable literature and guidance available.[10] At the level of the individual, poorly resourced hospital with limited reuseable equipment and disinfectants, HIV is a major concern for all health workers and local health education and support programmes have been shown to be effective.[11] With the rise in HIV, there has been an increasing prevalence of tuberculosis, both in HIV-affected patients but also in the wider community, and in many areas an increasing

prevalence of multidrug-resistant tuberculosis (MDRTB). This poses a risk for nosocomial transmission between patients, but particularly for health workers who will have direct contact, often with undiagnosed cases, and with less than adequate protective clothing.[12] There are likely to be few rural hospitals in Africa with a supply of PFR95 masks. The strict barrier precautions described by UK and Centers for Disease Control and Prevention (CDC) guidelines are unlikely to be practicable and workers dealing with these issues daily have developed more appropriate strategies.[13]

Nosocomial spread of other communicable disease

Where hospital hygiene is limited, and wards are crowded, the risk of transmission of communicable disease is high. The source may be an inadequately isolated index case, relatives who are staying in the hospital to provide food and general care for patients, or contaminated food or water in the hospital. Although from observation such transmission must occur, few such episodes have been recorded. Nosocomial outbreaks of cholera have been published from Tanzania and Mozambique and these reports suggest that outbreaks of other faecal-oral infections, particularly shigellosis, typhoid and hepatitis A and E, must also occur.[14,15] Other reported hospital communicable disease outbreaks have included measles and non-typhoidal salmonellae.[16,17] For communicable diseases in the tropics, the boundary between hospital and community infection is blurred. Among relatives camping within the hospital compound, there may be a case of undiagnosed tuberculosis? Is the infected person part of the community or part of the hospital? This distinction between public health and healthcare-related infection is particularly complex in the setting of refugee camps.[18,19]

Direct hospital acquired infections

Studies of surgical and other hospital-related infections have been published from several countries in Africa, including Kenya, Nigeria, Tanzania, Ethiopia and Burkina Faso.[20–24] These studies show a similar pattern of pathogens that are seen globally; staphylococci, Enterobacteriaceae and *Pseudomonas* spp., with high levels of antimicrobial resistance and a high and somewhat arbitrary use of antimicrobials. The studies are necessarily selective — only those hospitals in which there is a functioning microbiology laboratory, and which have sufficient staff, can undertake such work. In addition, with limited laboratory facilities, only the more easily culturable bacteria may be isolated and the results may give only a partial picture of the true prevalence and antimicrobial resistance patterns of pathogens.

In situations where more sophisticated microbiological studies have been undertaken in two particular non-Western environments — the tsunami area of south east Asia and repatriated combatants from Afghanistan — unusual and multiply resistant isolates have been found.[25,26]

Occurrence of multi-resistant bacterial pathogens

A common theme in all published studies of hospital infections in the tropics is the high prevalence of antimicrobial-resistant bacterial pathogens. This raises one of the major areas of concern. In terms of hygiene facilities, crowding and laboratory support, many hospitals in the tropics are like those of the 'pre-penicillin era', yet within them are the multi-resistant bacteria of the twenty-first century. Data in many areas are limited or non-existent, but, where surveys have been done, meticillin-resistant *Staphylococcus aureus* and extended-spectrum β-lactamase-producing and other multi-resistant Gram-negative bacteria have been shown to be widely disseminated.[27–31] The problem is compounded as antimicrobials, including quinolones and third-generation cephalosporins, are available without prescription, many areas have no laboratory facilities to provide accurate susceptibility data, and, despite several past attempts, there are no functioning international resistance surveillance programmes.[32,33]

Hospital infrastructure and facilities

The 'catalogue of disadvantage' for a rural district hospital in Africa demonstrates the commitment of local staff in providing even the most basic services (Figure 2). The catalogue includes: poor building infrastructure, inadequate water supply, electricity for perhaps only a few hours a day, overcrowded wards with patients lying on the floor as well as on beds, lack of resources for cleaning the environment, beds or equipment, often an absence of soap, and remoteness from regional centres or the capital city. Maridi, the hospital of the 1976 Ebola outbreak in southern Sudan, is 1800 km from Khartoum, with a road link not possible for three months in the rainy season. This situation is compounded by civil strife in the Democratic

Figure 2 Paediatric hospital in Khartoum, Sudan. Basic facilities and poor infrastructure provide few resources for infection control.

Republic of Congo, southern Somalia or Darfur, for example, where hospitals may have influxes of patients with both infected injuries and communicable diseases.[34,35] As patients with communicable diseases are admitted from crowded refugee camps, they may become the index cases for further spread within the hospital if infection control facilities are overstretched (Figure 3).

Personnel

There is no director of infection prevention and control in an African rural district hospital. Nor is there usually a dedicated infection control nurse, almost certainly not a clinical microbiologist, and rarely clinicians with sufficient time to work with the laboratory staff. There have been developments in training personnel specifically to work in infection control in larger hospitals, those supported in some way by outside agencies, and in teaching hospitals in larger cities. Most published work on training for infection control has been from South Africa, with an understandable emphasis on HIV transmission, but many hospitals will have developed local, basic policies.[36]

Strategies for a way forward

The requirements to improve hospital infection control in the tropics have been considered in a number of valuable papers.[37–39]

The key areas that have been identified include the following:

- introducing appropriate infection control teaching in medicine, nursing and laboratory training curricula
- improving infrastructure and facilities for basic hygiene, isolation precautions, sterilisation and waste disposal
- specific interventions in endemic HIV and tuberculosis areas
- promoting good infection control practice in relation to hand cleaning, dressing techniques and surgical procedures
- identifying staff with a specific responsibility for, and interest in, infection control, with support from clinicians and hospital management
- training and awareness for all staff in infection control
- improving laboratory facilities to detect specific pathogens, susceptibility testing and to guide antimicrobial use
- setting up of surveillance networks to build up data on hospital infections and changing prevalence of bacterial resistance
- setting up national and regional infection control networks.

Many of these will only occur when there are the resources for major economic change and that is why it is necessary to consider poverty reduction, institutional as well as individual, rather than to

Figure 3 Crowded refugees in endemic typhus area in northern Ethiopia. Transfer of patients to local hospitals increases risk of healthcare transmission of disease.

focus on improving infection control as simply a 'health' or 'medical' problem.

Whether G8 or the MDGs for 2015 can achieve this poverty reduction remains to be seen.[40] Past experience of the Pearson Commission and Health for All by 2000 suggests that targets alone, without addressing the fundamental causes of poverty or ill health, need to be handled with care. In the mean time, what can be done to assist the improvement of infection control in resource-poor settings?

Local health workers themselves are the most likely to achieve progress. The resources for HIV infection control that are part of the Global AIDS Programme represent one means for local improvement.

The main WHO strategy to improve infection control internationally is the Global Patient Safety Challenge.[41] This has involved many meetings and recommendations, but whether these will have a significant impact in resource-poor, tropical settings has yet to be seen. However, the initiative may give support to policy-makers in giving a priority to infection control. Certainly, links that have been established between hospitals in the UK and individual hospitals in Africa can provide much-needed resources, can share expertise and provide training opportunities.

The existence of the internet has in many ways revolutionised the ability of even remote hospitals to acquire information, to download WHO or CDC guidelines, to communicate with distant colleagues, and in some situations to be part of a telemedicine network. Such initiatives include the RAFT network in Francophone Africa (Réseau en Afrique Francophone pour la Télémédicine) and the WHO Health Initiative for Access to Research Information (HINARI) programme.[42,43] If the aim of an internet-linked computer in every village in Africa or Asia or Latin America, or at least in hospitals in those areas is to be achieved, there are practical issues of connectivity and band width that have to be faced. Providing laptop computers without adequate connectivity and support will not be productive.[44] Efficient internet links will enable very real possibilities of support between hospitals in the UK and rural tropical hospitals.

Conclusion

The absence of effective laboratory services at district hospital level is a major impediment to the long-term control of hospital-associated infections. Unless the causative pathogens can be

identified, and where appropriate the antimicrobial susceptibilities determined, there is a considerable risk that multiply resistant bacteria will become the dominant pathogens, with few antimicrobials available for treatment.

Within the MDGs, no specific mention is made of infection control or laboratories; without these, we cannot achieve the three specific health goals of: (i) improving maternal health, (ii) reducing child mortality and (iii) tackling AIDS, malaria and other communicable diseases.

Healthcare-associated infections have been near the top of the political agenda in the UK, resulting in increased funding and commitment for change. For the developing world the same priority is required if the aims of G8 and the MDGs are to be approached.

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None declared.

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References

1. Labonte R, Schrecker T. The G8 and global health: what now? What next? *Can J Public Health* 2006;**97**:35—38.
2. Pearson LB. *Partners in Development: Report of the Commission on International Development*. New York: Praeger; 1969.
3. Fenwick A, Molyneux D, Nantulya V. Achieving the Millennium Development Goals. *Lancet* 2005;**365**:1029—1030.
4. WHO. Ebola hemorrhagic fever in Sudan, 1976. Report of a WHO/International Study Team. *Bull World Health Organ* 1978;**56**:247—270.
5. Muyembe-Tamfum JJ, Kipasa M, Kiyungu C, Colebunders R. Ebola outbreak in Kikwit, Democratic Republic of the Congo: discovery and control measures. *J Infect Dis* 1999; **179**(Suppl. 1):S259—S262.
6. Centers for Disease Control and Prevention. Outbreak of Ebola hemorrhagic fever Uganda, August 2000—January 2001. *MMWR Morb Mortal Wkly Rep* 2001;**50**:73—77.
7. Fisher-Hoch SP, Tomori O, Nasidi A, *et al*. Review of cases of Lassa fever in Nigeria: the high price of poor medical practice. *Br Med J* 1995;**311**:857—859.
8. Fisher-Hoch SP. Lessons from nosocomial haemorrhagic fever outbreaks. *Br Med Bull* 2005;**73**:123—137.
9. Centers for Disease Control and Prevention and World Health Organisation. *Infection control for viral haemorrhagic fevers in the African health care setting*. Atlanta, GA: Centers for Disease Control and Prevention; 1998. p. 1—198.
10. WHO. The Joint United Nations Programme on HIV/AIDS. Project update. *Pac AIDS Alert Bull* 1999;**18**:15—16.
11. Chelenyane M, Endacott R. Self reported infection control practices and perceptions of HIV/AIDS risk amongst emergency department nurses in Botswana. *Accid Emerg Nurs* 2006;**14**:148—154.
12. Kayanja HK, Debanne S, King C, Whalen CC. Tuberculosis infection among health care workers in Kampala, Uganda. *Int J Tuberc Lung Dis* 2005;**9**:686—688.
13. Harries AD, Maher D, Nunn P. Practical and affordable measures for the protection of health care workers from tuberculosis in low income countries. *Bull World Health Organ* 1997;**75**:477—489.
14. Mhalu FS, Mtango FD, Msengi AE. Hospital outbreaks of cholera transmitted through close person to person contact. *Lancet* 1984;**ii**:82—84.
15. Cliff JL, Zinkin P, Martelli A. A hospital outbreak of cholera in Maputo, Mozambique. *Trans R Soc Trop Med Hyg* 1986;**80**: 473—476.
16. Marshall TM, Hlatswayo D, Schoub B. Nosocomial outbreaks — a potential threat to the elimination of measles? *J Infect Dis* 2003;**187**(Suppl. 1):S97—S101.
17. Vaagland H, Blomberg B, Kruger C, Naman M, Jureen R, Langeland N. Nosocomial outbreak of neonatal *Salmonella enteritidis* in a rural hospital in northern Tanzania. *BMC Infect Dis* 2004;**4**:35.
18. Shears P, Berry AM, Murphy R, Nabil MA. Epidemiological assessment of health and nutrition of Ethiopian refugees in emergency camps in Sudan. *Br Med J* 1987;**295**: 314—318.
19. Connolly MA, Gayer M, Ryan MJ, Salama P, Spiegel P, Heymann DL. Communicable diseases in complex emergencies: impact and challenges. *Lancet* 2004;**364**: 1974—1983.
20. Ngumi ZW. Nosocomial infections at Kenyatta National Hospital Intensive Care Unit in Nairobi, Kenya. *Dermatology* 2006;**212**(Suppl. 1):4—7.
21. Kesah CN, Egri-Okwaji MT, Iroha E, Odugbemi TO. Aerobic bacterial nosocomial infections in paediatric surgical patients at a tertiary health institution in Lagos, Nigeria. *Niger Postgrad Med J* 2004;**11**:4—9.
22. Fehr J, Hatz C, Soka I, *et al*. Risk factors for surgical site infections in a Tanzanian hospital: a challenge for the traditional National Nosocomial Infections Surveillance system index. *Infect Control Hosp Epidemiol* 2006;**27**:1401—1404.
23. Taye M. Wound infection in Tikur Anbessa hospital surgical department. *Ethiop Med J* 2005;**43**:167—174.
24. Sanou J, Traore SS, Lankoande J, Ouedraogo RM, Sanou A. Survey of nosocomial infection prevalence on the surgery department of the Central National Hospital of Ouagadougou. *Dakar Med* 1999;**44**:105—108.
25. Kallman O, Lundberg C, Wretlind B, Ortqvist A. Rare bacteria species found in wounds of tsunami patients. Gram negative bacteria from patients seeking medical advice in Stockholm after the tsunami catastrophe. *Scand J Infect Dis* 2006;**38**:448—450.
26. Davis KA, Moran KA, McAllister CK, Gray PJ. Multidrug resistant Acinetobacter extremity infections in soldiers. *Emerg Infect Dis* 2005;**11**:1218—1224.
27. Musa HA, Shears P, Khagali A. First report of MRSA from hospitalised patients in Sudan. *J Hosp Infect* 1999;**42**:74.
28. Seydi M, Sow AI, Soumare M, *et al*. *Staphylococcus aureus* bacteraemia in the Dakar Fann University Hospital. *Med Mal Infect* 2004;**34**:210—215.
29. Akoua Koffi C, Dje K, Toure R, *et al*. Nasal carriage of meticillin resistant *Staphylococcus aureus* among health care personnel in Abidjan (Cote d'Ivoire). *Dakar Med* 2004; **49**:70—74.
30. Ndugulile F, Jureen R, Harthug S, Urassa W, Langeland N. Extended spectrum beta lactamases among Gram negative bacteria of nosocomial origin from an intensive care unit of a tertiary health facility in Tanzania. *BMC Infect Dis* 2005;**15**:86.
31. Seid J, Asrat D. Occurrence of extended spectrum beta lactamase enzymes in clinical isolates of Klebsiella species from Harar region, eastern Ethiopia. *Acta Trop* 2005;**95**:143—148.

32. Blomberg B, Mwakagile DS, Urassa WK, *et al*. Surveillance of antimicrobial resistance at a tertiary hospital in Tanzania. *BMC Public Health* 2004;**4**:45.
33. Stelling JM, O'Brien TF. Surveillance of antimicrobial resistance: the WHONET programme. *Clin Infect Dis* 1997; **24**(Suppl. 1):S157—S168.
34. Lett RR, Kobusingye OC, Ekwaru P. Burden of injury during the complex emergency in northern Uganda. *Can J Surg* 2006;**49**:51—57.
35. Accorsi S, Fabiani M, Nattabi B, *et al*. The disease profile of poverty: morbidity and mortality in northern Uganda in the context of war, population displacement and HIV-AIDS. *Trans R Soc Trop Med Hyg* 2005;**99**:226—233.
36. Sidley P. South African health service must strengthen infection control measures. *Br Med J* 2004;**328**:366.
37. Newman MJ. Infection control in Africa south of the Sahara. *Infect Control Hosp Epidemiol* 2001;**22**:68—69.
38. Nyamogoba H, Obala AA. Nosocomial infections in developing countries: cost effective control and prevention. *East Afr Med J* 2002;**79**:435—441.
39. Simon F, Demortiere E, Chadli M, Kraemer P, De Pina JJ. Risk of nosocomial infection in tropical Africa. *Med Trop Mars* 2006;**66**:91—96.
40. Lawn JE, Costello A, Mwansambo C, Osrin D. Countdown to 2015: will the Millenium Development Goal for child survival be met? *Arch Dis Child* 2007;**92**:551—556.
41. Pittet D, Allegranzi B, Storr J, Donaldson L. 'Clean Care is Safer Care'; the Global Patient Safety Challenge 2005—2006. *Int J Infect Dis* 2006;**10**:419—424.
42. Geissbuhler A, Bagayoko CO, Ly O. The RAFT network: 5 years of distance continuing medical education and teleconsultations over the internet in French speaking Africa. *Int J Med Inform* 2007;**76**:351—356.
43. Aronson B. WHO's Health InterNetwork Access to Research Initiative (HINARI). *Health Info Libr J* 2002;**19**: 164—165.
44. Smith H, Bukinwa H, Mukasa O, Snell P, Adeh-Nsoh S, Mbuyita S, *et al*. Access to electronic health knowledge in five African countries: a descriptive study. *BMC Health Serv Res* 2007;**7**:72.