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Infection Control in Developing World

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1. Introduction

Infectious diseases are a global concern and the second commonest cause of death in the world. Of the annual 15 million deaths, 95% occur in the developing world, with predominance of acute respiratory infections, diarrhoeal diseases, measles, AIDS, malaria and tuberculosis (World Health Organization, 2008). More than 1 billion inhabitants in this part of the world do not have access to safe water and basic sanitation (Moe & Rheingans, 2006).

Health care-associated infections (HCAIs) constitute an important health challenge worldwide and pose a major threat to patient safety. Risks for acquiring infections during health care delivery have increased dramatically with advances in diagnostic and treatment procedures. In developing world this challenge is more highlighted because infection prevention and control policies are either nonexistent, poorly adapted or insufficiently funded by governments (Ponce-de-Leon & Macias, 2003). Therefore, infections are between 2-6 times higher than those in developed world.

Hospitals are main facilities for the risk of acquiring an infection during the delivery of care. Therefore infection control and prevention activities are focused mainly at the hospital level. The rates of HCAIs within a hospital represent the best indicator for the quality of services offered, where a high frequency of HCAIs is evidence of a poor quality of health service delivery. But, nowadays their occurrence is increasing in outpatient clinics and in nursing homes as well.

HCAIs impact on the population in many ways. They affect patients directly, causing increased morbidity and mortality; they may lead to disability and may reduce quality of life (Pittet et al., 2008). They also impact on the healthcare system by extending hospitalization of affected patients and driving up the costs of diagnosis and treatment. HCAIs may be transmitted from healthcare settings into the community. They also may be a subject of indictment by the treated patients in hospitals, decreasing the reputation of healthcare institutions in the eyes of the public.

The endemic burden of HCAIs is significantly higher in developing countries, in particular in patients admitted to intensive care units and in neonates (Raka, 2008). Most developing countries lack surveillance systems for HCAI. They usually have limited and low quality data (Allegranzi et al., 2011). In developing world there are many determinants, which are specific to settings with limited resources described below.

2. Challenges of infection control in developing countries

2.1 Health care and hospitals in developing world - Constraints and outcomes

2.1.1 Resources and incomes

Resources and incomes are unequally distributed throughout the world. Country economies are divided among income groups according to 2008 gross national income (GNI) per capita, calculated using the World Bank Atlas method. Countries with low income (\$975 or less) and lower middle income (\$976–3,855) are referred to as developing countries and they represent more than 75% of the world population. Prevention and control in low and middle income countries differs substantially from that in the developed world with high income. Limited resources represent the main challenge for governments in developing countries (Lynch et al., 2007). There may be a lack of commitment to healthcare by policy-makers in the developing world and allocation of funds is often disproportionate to the priorities set by providers. Priority in the allocation of funds is often directed to visible targets within society such as schools, infrastructure and security. Healthcare frequently is far behind. Even in countries where the healthcare budget is given high priority, the proportion devoted to prevention of HCAs is usually insufficient.

2.1.2 Health care system and society

Health systems in developing countries are hospital-dominated, with 50-80% of resources allocated to hospitals in urban centres, which often have tertiary academic affiliations. On the other hand a large number of people present to the other regional hospitals, which have inadequate resources, staff training, and motivation with an impact on the health of millions of people (Duke et al., 2006).

Corruption and nonformal payments are frequent in developing countries. Inadequate salaries lower the healthcare workers' motivation for quality care. Information systems are not fully developed. There are limited grants available for research and no legislation mandating accreditation of hospitals and infection control programmes. In-service training for employees is highly variable and often minimal. Patients and their families may be required to provide care materials such as syringes, surgical gowns, and drugs. Frequent movement of patients and staff between hospitals wards results in an increased risk of transmission of multidrug-resistant microorganisms (Clements et al., 2008). Such transmission is often exacerbated by overcrowding, with patients sometimes sharing beds and supplies.

During the last few decades, infection control activities in developing countries have increased, particularly in South America, South East Europe and countries of the former Soviet Union (Morris, 2008). Public pressure to improve the quality of hospital care, the increased cost of HCAs in healthcare systems, the emergence of multiresistant microorganisms, the approach of occupational hazards have played an important role in this development.

In many hospitals of developing countries adequate supplies to control and prevent infections are not available. Compliance with hand hygiene is often very low. Many other problems abound; for example, sterilisation departments are not centralised and there is lack of quality control in disinfection and sterilisation. Although many hospitals in the

developing countries may have infection control programmes and committees on paper, in practice they barely exist. Inadequate numbers of trained personnel work in infection control, and face continual resistance from clinical staff. This litany of problems means that the response to common outbreaks of disease in high risk units by management and staff is mainly reactive rather than proactive. Lack of ongoing surveillance results in delays in detecting outbreaks, with increasing costs and mortality.

Baseline endemic infection rates are not established by the hospital authorities in vast majority of developing countries and usually there is no anticipation of the possible risks of acquiring a HCAI. Infection control does not exist as a medical or nursing speciality, and formal training programmes on infection control are not available in medical schools of developing world. In addition to mentioned constraints, frequent malnutrition and other types of infection and diseases contribute to increase the risk of HCAs in developing countries. Poverty, war, economic and political disturbances all significantly increases HCAs (Lynch et al., 2007). As a result of the weakness and problems outlined above, developing countries face the challenge of high rates of HCAs and frequent outbreaks.

2.2 Blood and injection safety

Transfusion and injections may pose a risk for transmission of HIV and hepatitis in developing world. Between 5% and 10% of human immunodeficiency virus (HIV) infections worldwide are transmitted through transfusion of contaminated blood and blood products. Over 16 billion injections are administered each year in developing countries and the proportion of injections given by syringes and needles that are reused without sterilization ranges from 1.5 to 69.4% (Simonsen et al., 1999). Improper waste disposal is present in 18-64% of health care facilities of developing countries (World Health Organization, 2005). The 2000 Global Burden of Disease study, death and disability from injection-associated infections by hepatitis B virus (HBV), hepatitis C virus (HCV) and HIV revealed that patients received an average of 3.4 injections per year, 39.3% of which were given with reused equipment. Contaminated injections caused an estimated 21 million HBV infections, 2 million HCV infections and 260 000 HIV infections, accounting for 32%, 40% and 5%, respectively, of new infections (Hauri et al., 2004).

2.3 The burden and impact of health care-associated infections

HCAs represent one of the commonest adverse event during delivery of health care, complicating 5-10% of admissions to acute care hospitals in industrialised countries. Pooled prevalence of HCAI in Europe is 7.1% with range 3.5- 11.3% (ECDC, 2008). More than 4 million patients are affected by HCAI every year in Europe and 1.7 million in USA. In developed countries, approximately 25-30% of patients admitted to Intensive Care Unit (ICU) are affected by HCAI. Urinary tract infections constitute a predominant portion of HCAs with 30-40% of the overall infections.

In developing countries the global picture of the burden of HCAI is unknown due to lack of reliable data and the use of different definitions and methodologies. Many developing countries have not conducted any surveillance studies regarding HCAs and few studies provide information on etiology and risk factors for HCAs (Allegranzi et al., 2011). Only 23 developing countries of 147 (15.6%) reported a functioning HCAI national surveillance

system in 2010. Hospital-wide prevalence of HCAI in developing countries varied from 5.7% to 19.1%. A review of several studies in developing world showed that increased length of stay associated with HCAI varied between 5 and 29.5 days.

Surgical site infection (SSI) is the most surveyed and most frequent type of infection in developing countries with incidence rates ranging from 1.2 to 23.6 per 100 surgical procedures and a pooled incidence of 11.8%. By contrast, SSI rates vary between 1.2% and 5.2% in developed countries (Allegranzi et al., 2011). Incidence of ICU-acquired infection is at least 2–3 fold higher than in high-income countries; device-associated infection densities up to 13 times higher than in the USA were reported in some studies.

Ventilator-associated pneumonia (VAP) is a leading cause of death in hospitalised patients. A meta-analysis of articles concerning VAP in developing countries in MEDLINE (January 1966 to April 2007) showed rates from 10 to 41.7 per 1000 ventilator-days; crude mortality ranged from 16% to 94% and with increased length of stay in intensive care (Arabi et al., 2008). VAP attributable costs was US\$ 10 000–25 000 per case.

Many studies have shown the importance of HCAI among neonates in developing countries, where an average of 4384 children die every day of these infections (WHO, 2007). In a major review, reported rates of neonatal infections were 3–20 fold higher than those reported in industrialised countries (Zaidi et al., 2005). Neonatal infections are estimated to cause 1.6 million deaths annually, 40% of all neonatal deaths in developing countries (Lawn, 2004). From microbiological prospective of HCAI in developing world the most frequent microbial pathogens were *S. aureus* in mixed patient populations, and *Acinetobacter spp.* in high-risk patients.

The costs of HCAs are substantial everywhere, although they varies between countries due to different health care systems. In countries with prospective payment systems based on diagnosis- related groups, hospitals lose from \$583 to \$4,886 for each HCAI. Annual economic impact of HCAs in Europe is about 7 billion euro per year and 16 million extra-days of hospital stay (ECDC, 2008). In the USA, associated costs are approximately US\$ 6.5 billion (Klevens et al., 2007). The cost to the government of Trinidad and Tobago for HCAs was estimated at \$697,000 annually. In Mexico, the annual cost approaches \$1.5 billion; in Mexican ICUs, overall average cost of a HCAI episode was calculated at US\$ 12 155 (Higuera et al., 2007). In Thailand 10% of the annual hospital budget is spent on HCAs (WHO, 2005). Some investigators have attempted to measure costs related to hospital outbreaks of HCAs caused by multiresistant organisms. In a study of infections caused by MRSA it was estimated that average cost was \$4000 per infection, whereas costs of *C. difficile*-associated diarrhea was approximately \$4500 per patient (Stone, 2009). In an university hospital in Malaysia the cost of antibiotics prescribed to treat HCAI was estimated at US\$ 521 000 per year (Hughes et al., 2005).

2.4 Antimicrobial resistance

Resistance to antimicrobial agents is a global challenge in all healthcare facilities. In developing countries inappropriate and uncontrolled use of antibiotics is very common and antimicrobials are frequently available over the counter in pharmacies. In many developing countries resistance among common pathogens to cheap antimicrobials has already increased drastically, resulting in limited effectiveness. The quality and potency

of antibiotics are often suspected, with unregulated import, registration and distribution. Another factor contributing to resistance is lack of antibiotic policies or basic recommendations at governmental level or within hospitals. Between 20% and 50% of a hospital budget is spent on antimicrobials, which are used to treat more than half of all patients. Even in developed countries >50% of antimicrobials are prescribed incorrectly, either administered in suboptimal doses or for incorrect duration (Wenzel, 2000). Misuse has been identified as an important factor in the emergence of antimicrobial resistance (Kollef, 2001). In turn, this resistance makes the clinical management of the patients more difficult.

The use of antimicrobials in the veterinary area had an important impact on increase of antimicrobial resistance. Other factors contributing to increase of antimicrobial resistance are: limited number of new classes of antibiotics in pipeline by pharmaceutical companies and globalization, which enabled the rapid spread of multiresistant microorganisms worldwide (Okeke, 2005).

	Pooled mean (range) (interquartile range, 25-75%)	Pooled mean(range) (interquartile range, 25-75%)
Antibiotic resistant pathogen	INICC 2002-2007	US NNIS 1992-2004
Methicillin-resistant <i>Staphylococcus aureus</i> (MRSA)	80.8 (50.0-100.0)	52.9 (32.7-60.3)
Methicillin-resistant coagulase-negative staphylococci	75.2 (64.0-100.0)	76.6 (69.4-83.8)
Vancomycin-resistant enterococcus species	9.4 (0.0-6.3)	13.9 (5-24.3)
Ciprofloxacin/ofloxacin-resistant <i>Pseudomonas aeruginosa</i>	52.4 (40.0-75.0)	34.8 (17.4-41.3)
Imipenem-resistant <i>P. aeruginosa</i>	36.6 (0.0-52.4)	19.1 (8.3-25.5)
Ceftazidime-resistant <i>P. aeruginosa</i>	51.7 (33.3-72.7)	13.9 (5-16.9)
Piperacillin-resistant <i>P. aeruginosa</i>	50.8 (36.4-75.0)	17.50 (7.5-19.5)
Ceph3-resistant <i>Enterobacter</i> species	56.8 (30.8-80.0)	27.70 (17.4-36.4)
Carbapenem-resistant <i>Enterobacter</i> species	8.5 (0.0-0.0)	0.70 (0.0-0.0)
Ceph3-resistant <i>Klebsiella pneumoniae</i>	68.2 (33.3-85.7)	6.20 (0.0-8.0)
Ceph3-resistant <i>Escherichia coli</i>	53.9 (11.1-80.0)	1.3 (0.0-2.6)
Ciprofloxacin/ofloxacin-resistant <i>E. coli</i>	42.6 (12.7-78.9)	7.30 (0.0-8.2)

Table 1. Comparison of antimicrobial resistance rates (%) in the ICUs of the International Nosocomial Infection Control Consortium (INICCC) and the U.S. National Nosocomial Surveillance System (NNIS) (Rosenthal et al., 2010).

Table 1 presents overview of antimicrobial resistance rates in ICU between INICC and NNIS system. The frequencies of resistance of *Staphylococcus aureus* isolates to methicillin (MRSA) (80.8% vs 52.9%), Enterobacter species to ceftriaxone (50.8% vs 17.8%), and *Pseudomonas aeruginosa* to fluoroquinolones (52.4% vs 34.8%) were also far higher in the Consortium's ICUs.

2.5 Consequences

As a result of the weakness and problems outlined above, developing countries face the challenge of high rates of HCAI and frequent hospital outbreaks. Another consequence of insufficient infection control infrastructure is the spread of multidrug-resistant organisms, such are methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant *Enterococcus spp.* (VRE), extended-spectrum b-lactamase-producing Gram-negative bacilli, multidrug-resistant *Mycobacterium tuberculosis* and fluconazole-resistant *Candida spp.*

3. Solutions and perspectives for prevention and control

In order to improve the effectiveness of infection control in developing countries, a multifactorial initiatives needs to be implemented (Borg, 2010). Some of these initiatives are cheap and cost-effective, whereas others have a budget implications for governments.

3.1 Prevention comes first

Most countries address the problem of HCAI differently. As healthcare systems vary widely, so preventive strategies must be designed accordingly. The key component of solution is infection prevention. The prevention and control of HCAs requires a triangle partnership between health care workers (HCW), government and community. Most HCAs can be prevented with readily available and relatively inexpensive strategies. The Study on the Efficacy of Nosocomial Infection Control in 1974 showed that effective infection control programmes could reduce infection rates by as much as 32% and be cost-effective (Haley, 1980). In an overview of published reports on the effect of infection control programmes from 1990 to 2002, Harbarth et al. found that between 10% and 70% of HCAs were preventable (Harbarth, 2003). In the Hospital Sao Paulo in Brazil, there was a 71% decline in all HCAs in the ICU when an infection control programme was implemented, saving about US \$2 million (Cavalcante, 2001). Many other successful strategies have been documented.

3.2 Political commitment and support

In developing countries, the risk of patients and HCWs acquiring HCAs could be significantly reduced if governments make infection control a high priority. Administrative controls are amongst the most important steps in prevention and control of HCAs. Therefore a political support and commitment is essential in effectiveness of all other measures. National authorities must understand that without the proper resources, hospitals can be high risk areas. Therefore health care authorities must establish and support a comprehensive, effective national programme. Such a programme should set national objectives, and develop strategies, guidelines and policies for specific infection control issues, which are regularly updated. Many countries already have such

programmes. If these programmes are not available, those from the developed world should be adopted. Since developing countries have their own characteristic problems, these must be taken into account when formulating recommendations and policies (Raza et al., 2004). Due to their contact with patients or infected material from patients, many health care workers are at risk for exposure and possible transmission of infectious agents. Therefore occupational health and immunisation of HCWs is an essential part of prevention and infection control programmes (Randle, 2006). Moreover, education of HCWs and behavioural models complete the mosaic for prevention and control of HCAs.

3.3 Hand hygiene

Hand hygiene remains the simplest and the primary measure to prevent HCAI and reduce spread of multidrug resistant organisms. Although hand hygiene is a simple measure, the lack of compliance among healthcare workers is problematic worldwide, averaging <40% (Boyce & Pittet 2002). In 2002, the CDC recommended the use of alcoholic hand rubs which have the advantage that they can be placed at the bedside (Hugonet et al., 2003). Also, where hand-washing facilities are primitive or scarce, it is often easier to provide a hand rub than sinks with running water and a functioning sewage system. Introduction of alcohol-based hand rub has led to increased hand hygiene compliance among healthcare workers and fewer HCAs (Rosenthal et al., 2005). Today, many developing countries use WHO based formulation for alcoholic hand rub. In some developing countries, implementation of education, process surveillance, and performance feedback has considerably enhanced hand hygiene compliance (Damani, 2008).

3.4 Surveillance

Surveillance is an essential component in HCAs prevention, with the aims of outbreak identification, establishment of endemic baseline rates of infection and the evaluation of control measures. Surveillance data can be used to identify preventable infections in high risk areas, so that resources are targeted to high priority areas. Surveillance of most important HCAs should be accompanied by surveillance of antimicrobial use and resistance pattern. There is good evidence that antibiotic stewardship programmes have been successful in modifying antimicrobial prescribing practices, resulting in most instances in reduction of use (Gould, 1999). Unfortunately, such programmes are often lacking in developing countries, and antimicrobial resistance problems emphasise the importance of clinical microbiology laboratory services (Pfaller & Herwalt, 1997).

3.5 The bundle approach

In order to meet the required level of prevention, multiple strategies must be implemented simultaneously. Care bundles are part of a set of multiple intervention strategies to improve patient outcomes. They have been introduced in the USA by Institute for Healthcare Improvement and through the Saving Lives initiative produced by the UK Department of Health as high impact interventions. Bundles are directed generally at aseptic procedures that carry a high risk of HCAI if not done properly (Westwell, 2008). These usually represent a set of three to five practices that, when performed collectively, reliably, and continuously have been proven to improve patient outcomes. Bundles also incorporate a simple audit tool

to check that they are being implemented. The bundles are focused on the most important HCAs: catheter-associated bloodstream infection, catheter-associated UTI, ventilator-associated pneumonia and SSI.

Bundled interventions using systems quality improvement approaches for improved infection control in developing countries face many obstacles. Limited resources, poor infrastructure, insufficient equipment, lack of national guidelines, policies and evidence are key difficulties in successful implementation of bundle approach.

3.6 Global initiatives: World alliance for patient safety

Improving the safety of patient care is now a global issue. A growing awareness of HCAs and patient safety prompted the World Health Organization (WHO) to promote the creation of the World Alliance for Patient Safety to coordinate, spread and accelerate improvements in patient safety (Allegranzi et al., 2007). Prevention of HCAI is the target of the Alliance's First Global Patient Safety Challenge, 'Clean Care is Safer Care', launched in October 2005. Implementation strategies include the integration of multiple interventions in the areas of blood safety, injection safety, clinical procedure safety, and water, sanitation and waste management, with the promotion of hand hygiene in healthcare as the cornerstone. The main target of the campaign is 'Five Moments for Hand Hygiene' approach. It defines the key moments for hand hygiene with united vision. Various tools and resources have been developed to complement the Five Moments approach including localized country specific tool (Allegranzi & Pittet, 2009).

3.7 Research

One measure to improve the knowledge base of infection control is through research and development. Research resources for addressing infection control problems of developing countries remain disproportionately low compared with the disease burdens borne by these countries. National economies in developing countries remains too weak to support research and development. Research activities are sporadic and marginal, based mainly on individual initiatives in the university sector and with almost no support from governments. There is a need to focus these limited resources on research that will optimize health benefits with cost-effective interventions. Research priorities of developing countries in the field of HCAI are different compared to developed world. Research infrastructure should be focused on evaluating costs of HCAs, risk factors for developing HCAI, hand hygiene, gather surveillance data on HCAI, study on antibiotic consumption and resistance patterns and monitor impact of infection control programmes. Publications from developing countries are increasing daily. An important window for research in developing countries arose through the International Nosocomial Infection Control Consortium (INICC). The INICC is the first multinational research network established to control HCAs in hospitals in limited-resource countries. It has developed from South American hospitals in 1998 to a dynamic network of 450 healthcare centers in 108 cities, from 36 countries of 4 continents. It is the only source of aggregate standardized international data on HCAs epidemiology in intensive care.

INICC published a surveillance study from January 2003 through December 2008 in 173 ICUs in Latin America, Asia, Africa, and Europe. During the 6- year study, using CDC

NNIS/NHSN definitions for device-associated healthcare-associated infection, prospective data were collected from 313,008 patients hospitalized in the consortium's hospital ICUs for an aggregate of 2,194,897 days (Rosenthal et al., 2011). Despite the fact that the use of devices in the developing countries' ICUs was remarkably similar to that reported in US ICUs in the CDC's NHSN, rates of device-associated nosocomial infection were significantly higher in the ICUs of the INICC hospitals; the pooled rate of central line-associated bloodstream infection in the INICC ICUs of 6.8 per 1,000 central line-days was more than 3-fold higher than the 2.0 per 1,000 central line-days reported in comparable US ICUs. The overall rate of ventilator-associated pneumonia also was far higher (15.8 vs 3.3 per 1,000 ventilator-days), as was the rate of catheter-associated urinary tract infection (6.3 vs. 3.3 per 1,000 catheter-days) and the crude unadjusted excess mortalities of device-related infections ranged from 7.3% (for catheter-associated urinary tract infection) to 15.2% (for ventilator-associated pneumonia).

	INICC 2004-2009 Pooled Mean (95% CI)	U.S. NHSN 2006-2008 Pooled Mean (95% CI)
Medical Cardiac ICU		
CLAB	6.2 (5.6 - 6.9)	2.0 (1.8 - 2.1)
CAUTI	3.7 (3.2 - 4.3)	4.8 (4.6 - 5.1)
VAP	10.8 (9.5 - 12.3)	2.1 (1.9 - 2.3)
Medical-surgical ICU		
CLAB	6.8 (6.6 - 7.1)	1.5 (1.4 - 1.6)
CAUTI	7.1 (6.9 - 7.4)	3.1 (3.0 - 3.3)
VAP	18.4 (17.9 - 18.8)	1.9 (1.8 - 2.1)
Pediatric ICU		
CLAB	4.6 (3.7 - 5.6)	3.0 (2.7 - 3.1)
CAUTI	4.7 (4.1 - 5.5)	4.2 (3.8 - 4.7)
VAP	6.5 (5.9 - 7.1)	1.8 (1.6 - 2.1)
Newborn ICU (1501-2500 g)		
CLAB	11.9 (10.2 - 13.9)	1.5 (1.2 - 1.9)
VAP	10.1 (7.9 - 12.8)	0.8 (0.04 - 1.5)

CI, confidence interval; ICU, intensive care unit; DA-HAI, device associated health care associated infection; INICC, International Nosocomial Infection Control Consortium; NHSN, National Healthcare Safety Network; CAUTI, catheter-associated urinary tract infections; CLAB, central line-associated blood stream infection; VAP, ventilator-associated pneumonia.

Table 2. Device associated infections (DAI) rates (per 1000 device-days) in the ICUs of the low income countries participating in International Nosocomial Infection Control Consortium (INICC) and the U.S. National Healthcare Safety Network(NHSN)(Rosenthal et al., 2011).

3.8 Environment

Isolation precautions with disinfection and sterilization comprise another important brick in the wall of infection control. Isolation precautions are important step in preventing transmission of infectious agents within the hospital wards. Isolation systems enable health care workers to identify patients who need to be isolated and undertake appropriate precautions. In developing world there is a lack of isolation rooms and usually patients with infections caused by same microorganisms are cohorted in same rooms. Personal protective equipment support achievement of this objective. Education of healthcare workers regarding standard precautions and safe and appropriate use of injections are important for prevention and control of HCAI. Important steps in prevention of HCAI are introduction of validated processes for decontamination, cleaning and sterilisation or high level disinfection of soiled instruments and other items; and improving safety in operating rooms and other high risk areas (Rutala & Webber, 2004).

3.9 Infection control societies

Many countries have not yet established infection control societies or associations, and general professional societies of physicians, nurses, and laboratory staff are not effectively engaged in infection control and prevention activities. The International Federation of Infection Control (IFIC) is an umbrella organisation of societies and associations of healthcare professionals in infection control and related fields worldwide including majority of them coming from developing countries. Currently IFIC has 66 members from 51 countries, and provides guidelines and educational material. Many regional and international networks throughout the world also participate in IFIC.

3.10 Microbiology laboratory support for infection control

Clinical microbiology laboratory plays a pivotal role in patient care providing information on a variety of microorganisms with clinical significance and is an essential component of an effective infection control program (Kalenic & Budimir, 2009). Laboratory plays important duties in prevention of HCAs, which include: surveillance of HCAs and antimicrobial resistance, rapid communication of laboratory data relevant to infection control, epidemiology typing of isolated pathogens, storing laboratory data and isolates, outbreak investigation and management. A variety of methods can be used to identify microorganisms in clinical specimens, although in developing countries diagnostic capabilities are insufficient. Partnership between the infection preventionist and the clinical microbiology laboratory staff is crucial in combating against HCAs.

3.11 Combating antibiotic resistance

There is good evidence that antibiotic stewardship programmes have been successful in modifying antimicrobial prescribing practices, resulting in most instances in reduction of use. Unfortunately, such programmes are often lacking in developing countries, and antimicrobial resistance problems emphasise the importance of clinical microbiology laboratory services (Sosa et al., 2010). Key actions in prevention and control of antimicrobial resistance are: empower the surveillance systems of antibiotic use and antibiotic resistance,

prudent use in clinical practice (governmental measures, increase awareness of the public and health care workers, upgrading diagnostic capabilities), prudent use in veterinary, infection control in hospitals and community, implementation of Information technology, applied research and international cooperation.

4. Conclusion

HCAIs represent a major threat to patient safety and quality healthcare in developing countries. In many hospitals of developing world infection control activities are limited by many constraints in all levels of health care. As a consequence, these countries are facing the challenges of higher rates of hospital infections, frequent outbreaks, unsafe care and spread of infections in acute care facilities and community. The best solution for this challenge entail a multifactorial initiatives, which have to be sustainable in order to have a great impact on outcomes. Through focusing on infection control, countries with limited resources can improve the quality of healthcare in the future.

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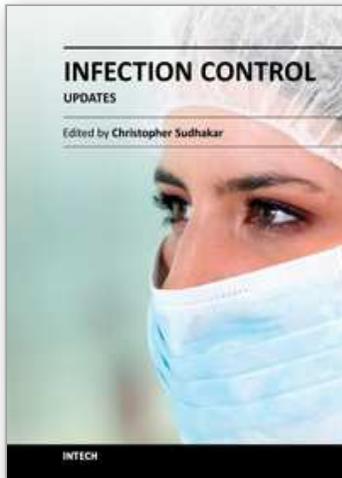
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Health care associated infection is coupled with significant morbidity and mortality. Prevention and control of infection is indispensable part of health care delivery system. Knowledge of Preventing HAI can help health care providers to make informed and therapeutic decisions thereby prevent or reduce these infections. Infection control is continuously evolving science that is constantly being updated and enhanced. The book will be very useful for all health care professionals to combat with health care associated infections.

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