

Diabetic foot infection and prevention measures: A literature review

Samira Alsenany¹ and Amer Al Saif²

¹Assistant Professor in Gerontology, Nursing Department, Faculty of Applied Medical science, King Abdulaziz University, Jeddah, Saudi Arabia. Salsenany@kau.edu.sa.

²Assistant Professor in Physical Therapy, Physical Therapy Department, Faculty of Applied Medical sciences, King Abdulaziz University, Jeddah, Saudi Arabia. Aalsaiif@kau.edu.sa

Abstract: Diabetic foot infection is both a common and potentially disastrous complication that can progress rapidly to irreversible septic gangrene necessitating amputation of the foot. Diabetic foot infection was obviously spreading in hospital. Much infection is sporadic, but outbreaks occur from time to time due to hospital-acquired infection. The factors involved in infection are complex; they include acquisition by patients or healthcare workers of many kinds of micro-organisms varying in virulence and distribution. Hospital Infection can cause patients with widely varying susceptibility to be exposed to these micro-organisms. There have been fluctuations in severity and prevalence of some infections, and some new kinds of infection have emerged. Furthermore, diabetic foot infection is the most common infectious cause of hospitalization in patients with diabetic mellitus in Saudi Arabia. Often ulceration is complicated by infection. The development of infection in diabetes is often poly-microbial, and the incidence of Methicillin Resistant Staphylococcus Aureus (MRSA) in diabetic foot disease is increasing. There are many different strains of MRSA, some of which may be epidemic in character, causing serious outbreaks. The consequence of not controlling MRSA in hospitals could lead to increased cost because of increased length of stay of patients in hospital. On the other hand, prevention of infection acquired in the care setting remains a major goal for all healthcare personnel and hand washing is the single most important method to prevent cross infection. Hand washing is therefore considered to be one of the most important procedures in the prevention of cross-infection in healthcare facilities. The efficacy of a hand wash depends on the technique and the time taken. Routine hand washing will render the hands clean and remove transient microorganisms provided that an effective technique is used. Moreover, all patients known to be infected or colonized with MRSA should be admitted directly to a single room with contact isolation precautions. In addition, healthcare workers must receive education and training in hand washing techniques. The education programme should be regularly updated in view of changing knowledge and work practice. The aim of this literature review is to explore the common health problems, which is diabetic foot infection, to identify the principal infective organisms (MRSA) and their conditions for growth and survival to control and prevent this incident through infection control measures such as hand washing techniques and implementing a change in strategy through the education programme in hand washing techniques. Moreover, the challenge of managing diabetic foot infections can help to reduce complication of these infections.

[Samira Alsenany and Amer Al Saif. **Diabetic foot infection and prevention measures: A literature review.** *Nat Sci* 2012;10(9):26-34]. (ISSN: 1545-0740). <http://www.sciencepub.net/nature>. 4

keywords: Diabetic, infection, foot infections, MRSA organism, septic ,gangrene, Hand washing.

1.Introduction

Foot infections are a major complication of diabetes mellitus disease and contribute to the development of gangrene and lower extremity amputation. Recent evidence indicates that persons with diabetes are at greater risk of infection because of underlying neuropathy, peripheral vascular disease, and impaired responses to infecting organisms (Foster, 2003; Qari and Akbar, 2000). Furthermore, diabetic foot problems are indeed a global concern and there is no area in the world that does not report the development of foot lesions due to increased rate of diabetic disease; it is an extremely common disorder in Saudi Arabia (Fatani, Mira and El-Zubier, 1985).

A medical report from Saudi Arabia (2004) was carried out on 24 percent of the adult population, who

are suffering from type-2 diabetes or have displayed signs of impaired glucose tolerance. Managing the diabetes problem, which is the leading cause of stroke, cardiovascular disease, blindness, kidney failure and limb amputation, costs the Saudi government over \$13 billion annually. Indeed, the problem of diabetes mellitus is very high in the adult population in the Saudi community (Karim, Ogbeide and Siddiqui, 2000). On the other hand (Qari and Akbar, 2000) found that foot infection is the commonest complication from diabetic disease in Saudi Arabia due to foot sepsis, which is problem among men as result of peripheral neuropathy and poor glycemic control. They are agreed that culture diabetic foot sepsis shows poly-microbial infection. Most of these patients required debridement; 23.5% of them ended

up having major limb amputation. They found in Saudi Arabia that the majority of patients were male above 50 years (mean age 59 +/- 9.6).

There is evidence to suggest that common reasons for hospitalization among diabetic patients is due to high prevalence of infections (24.1%) (Tarin and Khan, 2004). In addition, severity of this infection in diabetic foot ulcers can cause amputation (Berend, 2003; Candel, Alramadan, Matesanz, Diaz, González, Candel, Calle and Picazo, 2003; Foster, 2003; Reiber, Lipsky and Gibbons, 1989; Reiber, Vileikyte and Boyko, 1999; and Kucan and Robson, 1989). On the other hand, 30% of amputees lose their second leg within five years (Stanley and Stephanie, 2004). Furthermore, lower extremity infections are frequent, leading to substantial morbidity and mortality in the diabetic population (William and Harding, 2003). Moreover, these infections consume a large portion of resources expended on diabetic complications (Armstrong, 2004). In particular, if the infection is not treated properly, it can develop blood stream Bacteremia and cause a high rate of mortality (Mantey, Hill, Foster, Wilson, Wade and Edmonds, 2000). In addition, *Staphylococcus aureus* bacteremia carries high mortality rates in diabetic foot infection (Stijn, Blot, Koenraad, Vandewoude, Eric, Hoste, Francis and Colardyn, 2002). Furthermore, blood stream infection is the commonest type of infection of the total infections in diabetic patients and the mortality rate was high significantly when admitting diabetic patients at my working area (Akaber, 2003). The study suggests implementing infection surveillance measures and having a strict policy to control infection rates in hospitals.

The aim of this literature review is to explore the common health problems, which is diabetic foot infection, to identify the principal infective organisms (MRSA) and their conditions for growth and survival to control and prevent this incident through infection control measures such as hand washing techniques and implementing a change in strategy through the education programme in hand washing techniques. Moreover, the challenge of managing diabetic foot infections can help to reduce complication of these infections. Several studies were found in the literature reviews that are on diabetic foot infection. Studies were reviewed from the Cumulative Index of Nursing and Allied Health Literature (CINAHL); MEDLINE and ASSIA were searched using Ovid and CSA. The database Keywords for searching included: diabetic foot microbiology, foot infection in Saudi Arabia, change, hand washing, methicillin resistant *staphylococcus aureus*. The structure of this review is as follows. First, a background is given of the diabetic foot infection to identify the relevance of the topic. Then the literature is reviewed for the evidences and

critical evaluation of the research in diabetic foot infection to identify of the principle infective organisms and their conditions for growth and survival. Finally, the conclusion summarizes the important infection control measures to reduce diabetic foot infections in hospital.

A. Diabetic foot infection

Diabetic foot infection was obviously spreading in hospital. Much infection is sporadic, but outbreaks occur from time to time due to hospital-acquired infection. The factors involved in infection are complex; they include acquisition by patients or healthcare workers of many kinds of micro-organisms varying in virulence and distribution. Hospital Infection can cause patients with widely varying susceptibility to be exposed to these micro-organisms. There have been fluctuations in severity and prevalence of some infections, and some new kinds of infection have emerged. El-Tahawy (2000) pointed out that diabetic foot infection increased at my working area to reach in total 111 diabetic patients in three years at one hospital: 63 males (57%) and 48 females (43%) aged between 25-70 years with a duration of diabetes from 5-37 years. Moreover, *staphylococcus aureus* was the commonest isolate being recovered from 24% of cases, including methicillin-resistant *staphylococcus aureus*. Similarly Madani's (2002) study identified that, of *S. aureus* isolates, 111 (38%) were MRSA, or 6.0 MRSA isolates/1000 admissions, which represented a marked increase over MRSA prevalence and nosocomial acquisition occurred in 74.8% of isolates at my working area.

On the other hand, several studies support that incidence of MRSA in diabetic foot disease is increasing worldwide to develop into a problem for healthcare provision, and infection control measurement is an important element of reducing this infection (McConvill, Monaghan and Lee 2003; Tentolouris, Jude, Smirnof, Knowles and Boulton, 1999).

In Saudi Arabia these foot infections are mainly a consequence of ulcerations that result from foot deformities and sensory neuropathy as a diabetes mellitus complication (Qari and Akbar, 2000). However, neuropathy and vascular changes in patients with diabetes mellitus put them at risk of developing foot wounds after minor trauma or after pressure has caused a breakdown in integrity of the skin. Once the skin envelope is breached, bacteria can gain access to subcutaneous tissues and inflammatory signs and symptoms can be visible manifested (Foster, 2003).

These infections consume a large portion of resources expended on diabetic complications. Bilal, Gedebo and Al-Ghamdi (2002) point out the minimal

hospital cost estimate for both nosocomial infections and misused antibiotics in Saudi Arabia was US\$318,705. While, in the UK, the treatment of a carrier or an infected patient with methicillin-resistant *Staphylococcus aureus* cost £374 and £2454, respectively, the cost being due to an increased length of stay in hospital which was from two days to 10 days (Mehtar, 1995).

In this regard (Foster, 2003) argued that in 2003 globally we were facing an epidemic in foot amputation due to delayed detection and treatment of the infection. Similarly, Yetzer (2002) discovered that approximately 44%-85% of those foot diabetic amputations can be prevented. A prevention programme requires an understanding of the causes of diabetic foot skin breakdown. Furthermore, infection control measures should be taken immediately to prevent spread of the infection by implementing infections' surveillance measures and to have strict infection control procedures such as hand washing techniques.

In addition, Malone, Snyder, Anderson, Bernhard, Holloway, and Bunt (2004) demonstrate that a simple education programme significantly reduced the incidence of foot ulcers and limb amputation in diabetic patients and early screening and treatment of a diabetic foot can dramatically reduce hospitalizations (Lawrence, Lavery, Robert, Wunderlich and Tredwell, 2005).

B. Infection prevalence in Saudi Arabia

The problem of diabetic foot infection is longstanding and receives substantial mention in the literature research. This literature offers an extensive overview of the research that has been completed in Saudi Arabia. El-Tahawy (2000) describes the relative frequency of bacterial isolates cultured from diabetic foot infections and assesses their comparative *in vitro* susceptibility to the commonly used antibacterial agents. A retrospective study method was used with a review of the bacteriology results of specimens taken from 111 consecutive patients with diabetic foot infections at King Abdul Aziz University Hospital, Jeddah, Kingdom of Saudi Arabia. The specimens were cultured using optimal aerobic and anaerobic microbiologic techniques. Antimicrobial susceptibility testing to different agents was carried out using the disc diffusion method.

The study involved a total of 111 diabetic patients: 63 males (57%) and 48 females (43%), aged between 25-70 years and with a duration of diabetes from 5-37 year were investigated. Results showed that out of 111 lesions only three proved sterile; in the remaining 108 patients a total of 161 bacteria were isolated resulting in an average of 1.5 organisms per lesion. It is clear that *Staphylococcus aureus* was the

commonest isolate being recovered from 28% of cases, including methicillin resistant *Staphylococcus aureus* in nine of the 30 (30%) patient wounds. The other organisms isolated were *Pseudomonas aeruginosa* (22%) and *Proteus mirabilis* (18%), and anaerobic gram-negative organisms (11%), mainly *Bacteroides fragilis*. The antimicrobial susceptibility testing showed that vancomycin was the most effective against gram-positive cocci and imipenem was the most effective against gram-negative organisms.

El-Tahawy's study shows that *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Proteus mirabilis* and *Bacteroides fragilis* were the most common causes of diabetic foot infections. These wounds require use of combined antimicrobial therapy for initial patient management prior to susceptibility results. El-Tahawy emphasizes awareness of the causative organisms in diabetic foot infections and their antimicrobial susceptibility pattern is essential for the institution to control infection and prevent outbreaks in hospital. The previous study is limited to generalization and no specific suggestion is given on a beneficial infection control programme. More details on successful infection control measures would have been helpful.

In a similar vein, Madani (2000) argues that MRSA is high and rapidly increasing at the King Abdul Aziz University Hospital. The total mortality of patients with MRSA infection was 60.8%; 37.8% of deaths were the result of MRSA infection and 23% were the result of other diseases. His study was designed to describe the prevalence, demography and clinical characteristics of patients who were colonized or infected with methicillin-resistant *Staphylococcus aureus* (MRSA) at King Abdul Aziz University Hospital, Jeddah, Saudi Arabia. Results of the study report that 292 *S. aureus* isolates were identified: 111 (38%) were MRSA, or 6.0 MRSA isolates/1,000 admissions. Nosocomial acquisition occurred in 74.8% of isolates. All age groups were affected: the prevalence was highest in the medical ward (27%), followed by the paediatrics combined medical and surgical ward (20.7%), the outpatient department (18%), the adult surgical ward (17.1%) and the intensive care units (17.1%). Two-thirds (66.7%) of cases represented infection and the remainder represented colonization. Surgical wounds (31.1%), the chest (27%) and endovascular catheters (20.3%) were the most common sites of infection. Bacteremia occurred in 27% of patients. Local signs (68.9%) and fever (60.8%) were the most common clinical manifestations. Respiratory distress and septic shock occurred in 28.4% and 6.8% of cases, respectively. Of 74 patients with MRSA infection and 37 patients with MRSA colonization, 91.9% and 56.8% received antibiotics in the preceding six weeks, respectively

($P < 0.0001$). Madani also supports the infection control measures to prevent the spread of MRSA in hospitals with reinforcement of hygienic precautions and development of policies to restrict the use of antibiotics.

Following on these lines, Zaman and Dibb (1994) propose a similar view that Methicillin resistant *Staphylococcus aureus* (MRSA) is a common problem in Saudi Arabia comprising about 7.5% per annum of all *S. aureus* isolated in a general hospital in Jeddah, Saudi Arabia. Most isolates were from wound sites (71%). Resistance to gentamicin (83%) and tetracycline (93%) was frequently observed whilst resistance to ciprofloxacin (1%) and rifampicin (6%) was uncommon. Low levels of mupirocin resistance (MIC 8 mg l⁻¹), were detected in 3% of all MRSA isolates.

On the other hand Qari and Akbar (2000) claim that diabetic foot sepsis is a common health problem presented in Saudi Arabia particularly among men; peripheral neuropathy, as well poor glycemic control, are the most common precipitating factors. Their study data, collected from medical notes of 34 diabetic patients admitted to the King Abdul Aziz University Hospital in Jeddah with diabetic feet, were studied retrospectively. They found that foot infection is usually a poly-microbial infection, of which proteus and pseudomonas 7 (21%) then staphylococci 6 (18%) were the most common organisms isolated (see Table (1)).

Table (1): Types of microorganism isolated

Type of microorganism	Number of patients (%)
proteus	7(21)
pseudomonas	7(21)
staphylococci	6(18)
klebsiella	5(15)
Enterobacter	5(15)
E-coli	4(12)
anaerobes	4(12)
streptococci	4(12)

Mode of presentation (Table 2) showed that foot ulcer was the most common type of presentation at 20 (59%), cellulites and foot gangrene were 13 (38%), while toe gangrene was 12 (35%).

Table (2): Different modes of presentation

Type of presentation	Number of patients (%)
ulcer	20 (59)
cellulites	13 (38)
foot gangrene	13 (38)
toe gangrene	12 (35)

Types of surgical interventions are shown in Table (3). Twenty-two of 34 (65%) of the patients needed debridement. The mean duration of hospital stay was 21.44 +/-17.7 days, while the remaining patients needed major or minor leg amputation.

Table (3): Type of surgical intervention

Surgical intervention	Number of patients(%)
Debridement	22 (65)
Toe amputation	11(32)
Above knee amputation	5(15)
Below knee amputation	3(9)

They conclude their study by commenting that diabetic foot sepsis is a common health problem in Saudi Arabia, presenting most commonly with gangrene. Therefore the most common surgical treatment is minor or major amputations. Care of a diabetic foot includes preventive measures like foot care, good glycemic control either by insulin or oral hypoglycemic drug. They also suggested that preventive measures could lead to dramatic reduction in amputation rates in the Kingdom. Development of teamwork in care of those patients has been suggested and developing diabetic centres in different areas of Saudi Arabia was recommended.

C. Microbiology of diabetic foot infection

In diabetic foot infection most common organisms in the literature reviewed are the aerobic gram-positive cocci. The most frequent isolates in this group are usually *Staphylococcus aureus*, and Methicillin-resistant *S. aureus* (MRSA) has become increasingly prevalent in diabetic foot wounds as shown in a study (Tentolouris, Jude, Smirnof, Knowles and Boulton, 1999). They argue that prevalence of pathogenic organisms methicillin-resistant *Staphylococcus aureus* (MRSA) infection was of a high rate in foot ulcers in diabetic patients. Their study was done by retrospective analysis of wound swabs taken from infected foot ulcers in diabetic patients, selected from an outpatient diabetic foot clinic. They examined 75 patients (79 ulcers) with positive wound swabs and reported that Gram-positive aerobic bacteria were the commonest microorganisms isolated (56.7%) followed by Gram-negative aerobic bacteria and anaerobes (29.8% and 13.5%, respectively). Of the Gram-positive aerobes, *S. aureus* was found most frequently and 40% were MRSA. MRSA was isolated more commonly in patients treated with antibiotics prior to the swab compared to those who had not received antibiotics ($P = 0.01$). The study notes that patients whose foot ulcers were infected by MRSA had longer healing time than patients whose ulcers were infected by methicillin-sensitive *S. aureus* (mean (range) 35.4

(19–64) and 17.8 (8–24) weeks, respectively, $P = 0.03$).

Similarly, Abdulrazak, Bitu, Al-Shamali and Mobashe (2005) carried out a prospective study in infected wounds of 86 consecutive diabetic patients from diabetic foot clinics in the Adan Teaching Hospital. The patients did not receive antimicrobial therapy for 30 days prior to taking the cultures. The specimen was cultured using aerobic and anaerobic microbiological techniques. The result of the study shows that *Staphylococcus aureus* was the most common isolate, being recovered from 38.4% of cases. Other organisms were *Pseudomonas aeruginosa* (17.5%) and *Proteus mirabilis* (18%), and anaerobic gram-negative organisms (10.5%), mainly *Bacteroides fragilis*. They suggest that wounds may require use of combined antimicrobial therapy for initial management; for example, imipenem, meropenem, and cefepime were the most effective agents against gram-negative organisms. Vancomycin was the most effective against gram-positive organisms.

In a similar vein, Herwaldt (1999) asserts that Methicillin-resistant *Staphylococcus aureus* (MRSA) is a common cause of nosocomial infections in hospital. The study justified control efforts for several reasons: (1) the incidence of nosocomial MRSA reflects the general effectiveness of infection control practice; (2) MRSA infections cause substantial morbidity and mortality; (3) MRSA does not replace susceptible strains but instead increases the overall rate of nosocomial *S. aureus* infections; (4) serious MRSA infections must be treated with vancomycin. The study highlights the importance of a control plan for MRSA and must stress concern of the basic infection control measures, such as hand washing techniques; contact isolation precautions, decolonization of patients and staff, control of antimicrobial use and surveillance culture may be helpful too.

D. Infection control management and prevention measures

Huskins and Goldmann (2005) claim that Methicillin-resistant *Staphylococcus aureus* (MRSA) has been dubbed a “Superbug” by the mass media. MRSA spreads easily in health-care institutions, is resistant to most antibiotics, and causes serious, often fatal, infections. There is an urgent need for precaution measures to reduce transmission of MRSA. Moreover, Wenzel, Nettleman, Jones and Pfaller (1991) shed light on the efficacy of three measures to prevent transmission of MRSA: (a) identification of the entire patient reservoir (cases and carriers) for purposes of isolation; (b) strict hand washing between patients to prevent transmission; and (c) treatment of the carrier state in healthcare workers and patients

during periods of high infection rates with safe and effective topical agents such as mupirocin.

A) Hand washing

Hand washing precaution is supported by the study by Pittet, Hugonnet, Harbarth, Mourouga, Sauvan, Touveneau and Perneger (2000), who believed that primary mechanisms of MRSA spread throughout hospitals due to direct contact between patients and healthcare workers. The study evaluates a hand hygiene programme which improved hand washing techniques significantly among nurses and nursing assistants, but remained poor among doctors. During the same period of the hand hygiene programme, overall nosocomial infection decreased (prevalence of 16.9% in 1994 to 9.9% in 1998; $p=0.04$), MRSA transmission rates decreased (2.16 to 0.93 episodes per 10,000 patient-days; $p<0.001$), and the consumption of alcohol-based hand rub solution increased from 3.5 to 15.4 L per 1,000 patient-days between 1993 and 1998 ($p<0.001$).

From a previous study I restate the importance of hand washing techniques as the first line of defence mechanism against the spread of infection in hospitals. In addition, it is a basic practice in effective infection control management. Hand washing with soap and water remains a sensible strategy for hand hygiene in healthcare settings and is recommended by CDC and other experts.

B) Gloves

Wearing gloves is considered a universal precaution in healthcare settings to prevent cross infection between patients and healthcare workers as shown in a study by McBryde, Bradley Whitby and McElwain (2004). This was carried out at a large teaching hospital to estimate how often the gloves of a healthcare worker are contaminated with MRSA after contact with a colonized patient and the effectiveness of hand washing procedures to decontaminate the healthcare professionals' hands and how well different healthcare professional groups complied with hand washing procedures. The results of this study report that about 17% (9–25%) of contacts between a healthcare worker and an MRSA-colonized patient leads to transmission of MRSA from a patient to the gloves of a healthcare worker. In addition, different healthcare workers exhibited different behaviour with adherence to infection control measures. Non-contact staff (cleaners, food services) had the shortest hand washing times. In this study, glove use compliance rates were above 75% in all healthcare worker groups except doctors whose compliance was only 27% (see Table (4)).

Table (4): Compliance of glove use amongst different healthcare worker groups

Type of healthcare worker	Compliance with gloves us (%)
Nurse	76
Doctor	27
Physiotherapist	83
Ward assistant	91
Food services	75
Cleaner	75

The study suggests that single-use disposable sterile gloves should be used during aseptic procedures to prevent patients acquiring infection from healthcare workers. Non-sterile gloves should be used for all procedures involving contact with blood, body fluid, excretions and secretions where there is a risk of infection to the healthcare worker. The use of gloves does not eliminate the need for hand hygiene. Likewise, the use of hand hygiene does not eliminate the need for gloves.

C) Isolation policy

All Infection control measures for reducing the transmission of meticillin-resistant *Staphylococcus aureus* (MRSA) infection in hospitals carried out the importance of isolation policy (Forceville, Faibis, Lahilaire, Gantier, Philippot, Leporcq, Paulet, Broche and Combes, 2002). On the other hand, it is important to emphasise that isolation precautions can protect only if they use consistently and appropriately precautions of the infection control policy. As shown in one study (Cepeda, Whitehouse, Cooper, Hails, Jones, Kwaku, Taylor, Hayman, Cookson and Shaw, 2005), moving MRSA-positive patients into single rooms or cohorted bays does not reduce cross infection. That result is shown from a prospective one-year study in the intensive-care units of two teaching hospitals. Admission and weekly screens were used to ascertain the incidence of MRSA colonisation. In the middle six months, MRSA-positive patients were not moved to a single room or cohort nursed unless they were carrying other multi-resistant or notifiable pathogens. Standard precautions were practised throughout. Hand hygiene was encouraged and compliance audited. The result concludes that transfer and isolation of critically ill patients in single rooms carries potential risks. They explained that single room or cohort isolation of infected or colonised patients is used to reduce spread, but its benefit over and above other contact precautions is not known. From a previous study all healthcare workers who are in direct contact with the patients in isolation have a responsibility to observe the precautions outlined in the policy. Hospitals are directed to develop a system to ensure that patients, personnel, and visitors are

educated about the use of precautions and their responsibility to adhere to them.

D) Educational programme for infection control

An educational programme for infection control can consider effective measures that can be used to reduce an outbreak of MRSA, which is to encourage staff to assume responsibility for infection control. The study by Nettleman (1991) highlights the importance of ongoing education and feedback, and that both these methods are effective and should be used to their full advantage in the decreased rate spread of MRSA nosocomial infection in the hospital. Presumably the cumulative effect of the education programme was the application of better hand washing techniques when caring for patients. Therefore patients with community acquired MRSA were less likely to serve as sources for nosocomial. Lectures on hand washing implementing programmes that provide education on the effect of MRSA, how it is transmitted and on the importance of infection control practices will provide staff with the necessary background knowledge to make informed decisions. Basing decisions on sound evidence is more likely to result in good infection control practices. Other advantages of educational programmes are that staff are made aware of the implications of MRSA in their work environment, and that every individual must take responsibility for his/her actions to prevent the spread of MRSA.

This suggestion is also supported by Hardy, Hawkey, Gao and Oppenheim (2004), who demonstrate hand washing techniques as an effective role in the control of MRSA transmission. In addition, the study argues the need for team effort involving all healthcare professionals with the implementation of hand washing techniques, strict infection control programmes and rational antibiotic prescribing (see Table (5)).

E. Conclusion

In conclusion, diabetic foot infection is a common problem in Saudi Arabia due to complications of diabetic disease, which is at a high rate in my home country. The role of foot infection in diabetic foot ulceration is well documented and increased mortality associated with diabetic foot ulcers has been reported. The frequency of healthcare-associated MRSA infection has increased inexorably in recent years in Saudi Arabia where most clinical isolates from diabetic infection *S. aureus* are now meticillin-resistant. Since MRSA spreads primarily on the hands of healthcare workers, rates of infection are a function of infection control activities within institutions. Moreover, infections with MRSA are serious and often life-threatening. The literatures also

encourage the infection control measures to prevent the spread of MRSA in hospitals with reinforcement of hygienic precautions and development of policies to restrict the use of antibiotics. In addition, effective infection control policy has always involved universal precaution such as hand washing techniques, which is

the most important measure in prevention MRSA cross infection and maintaining an isolation policy, with implementation of precaution procedure being helpful too.

Table (5): Routes of transmission and control measures for the reduction of MRSA colonization in hospital

Transmission	Control	Measures
Hands	Hand washing	Hand washing campaigns
		Alcohol-based hand rubs
Environment	Cleaning	Intensive cleaning
		Removal of dust
Colonized patients	Screening of patients	Isolation of colonized/infected patients
	Eradication	Use of bactraban and mupirocin

Corresponding Authors:

2. Dr. Samira Alsenany, BSc (Hons), RN, MSc,
PGCert ANP, Mphil,
PhD Assistant Professor in Gerontology, Nursing
Department

College of Applied Medical Sciences
King Abdulaziz University
Salsenany@kau.edu.sa

2. Dr. Amer A. Al-Saif, PT, MPT, DPT, PhD
Assistant Professor, Physical Therapy Department
Neuro Rehab Track; Balance and Dizziness Therapy
Faculty of Applied Medical Sciences
Aalsaiif@kau.edu.sa
King Abdulaziz University

References:

1. Fatani, H., Mira, S. J., EL-Zubier, A. G. (1987) Prevalence of diabetes mellitus in rural Saudi Arabia. **Diabetic Care**, 1987; 10: 180-183.
2. Candel, González, Alramadan, Matesanz, Diaz, González-Romo, Candel, Calle and Picazo (2003) Infections in diabetic foot ulcers. **European Journal of Internal Medicine**, Volume 14, Issue 5, August 2003, Pages 341-343.
3. William, Jeffcoate and Harding (2003) Diabetic foot ulcers. **The Lancet**, Volume 361, Issue 9368, 3 May 2003, Pages 1545-1551.
4. Lewin, K. (1958) Group decision and social change. In: E. Maccoby (Eds.) Reading in social psychology (3rd). New York: Holt, Rinehart and Winston.
5. Zaman, R., Dibb, W. L. (1994) Methicillin resistant *Staphylococcus aureus* (MRSA) isolated in Saudi Arabia: epidemiology and antimicrobial resistance patterns. **The Journal of Hospital Infection**, 26(4):297-300.
6. Bilal, Gedebo and Al-Ghamdi (2002) Endemic nosocomial infections and misuse of antibiotics in a maternity hospital in Saudi Arabia. **Apmis**, February 2002, vol. 110, no. 2, pp. 140-147(8).
7. Madani, T. (2002) Epidemiology and clinical features of methicillin-resistant *Staphylococcus aureus* in the University Hospital, Jeddah, Saudi Arabia. **The Canadian journal of infectious disease and medical microbiology**, July/August 2002, Volume 13, Number 4: 245-250.
8. *El-Tahawy*, T. (2000) Bacteriology of diabetic foot Infections. **Saudi Medical Journal** 2000; Vol. 21 (4): 344-347.
9. Qari, D. and Akbar, F. (2000) Diabetic foot *Presentation and treatment*. **Saudi Medical Journal**, 2000; Vol. 21 (5).
10. The medical sector in the kingdom of Saudi Arabia report (2004) Available at: www.us-saudi-business.org/pub.htm.
11. Stanley, Stephanie (2004) A collaborative care approach to complex diabetic foot ulceration. **British Journal of Nursing**; 13 (13) 8 Jul 2004-21 Jul 2004, pp.788, 790-793.
12. McConville, D., Buchanan, J. and Lee, B. (2003) Infection control in diabetic foot disease. **Diabetic Foot**, 6(2):74, 76, 78.

13. Eneroth (2004) The challenge of multicenter studies in diabetic patients with foot infections. **The Foot: International Journal of Clinical Foot Science**, 14(4):198-203, 2004 Dec.
14. Armstrong (2004) Advances in the treatment of diabetic foot infections. **Diabetes Technology & Therapeutics**, 6(2):167-77, 2004 Apr.
15. Yetzer (2002) Causes and prevention of diabetic foot skin breakdown. **Rehabilitation Nursing**, 27(2):52-8, 79, 2002 Mar-Apr.
16. Akbar, D. (2003) Blood stream infections are common in admitted diabetics. **Endocrine Abstracts**, (2003) 5 P109.
17. Karim, Ogbeide, Siddiqui (2000) Prevalence of diabetes mellitus in a Saudi community. **Saudi Medical Journal**, 2000; Vol. 21 (5).
18. Tarin and Khan (2004) Pattern of diabetic admissions in medical ward. **Pakistan Journal Med. Res.** Vol. 43 No.4, 2004.
19. Kucan and Robson (1989) Diabetic foot infections: Fate of the contralateral foot. **PLAST. RECONSTR. SURG.** Volume 77, Issue 3, 1986, Pages 439-441.
20. Reiber, G. E., Lipsky, B. A. and Gibbons, G. W. (1998) The burden of diabetic foot ulcers. **Am. J. Surgery**, 176 suppl. 2A (1998), pp. 5S-10S.
21. Reiber, G. E., Vileikyte, L., Boyko, E. J. *et al.* (1999) Causal pathways for incident lower-extremity ulcers in patients with diabetes from two settings. **Diabetes Care** 22 (1999), pp. 157-162.
22. Tentolouris, Jude, E. B., Smirnof, I., Knowles, E. A. and Boulton, A. J. M. (1999) Methicillin-resistant *Staphylococcus aureus*: an increasing problem in a diabetic foot clinic. **Diabet. Med.** 16 (1999), pp. 767-771.
23. Mantey, Hill, R. L. R, Foster, A. V. M., Wilson, S., Wade, J. J. and Edmonds, M. E. (2000) Infection of foot ulcers with *Staphylococcus aureus* associated with increased mortality in diabetic patients. **Commun. Dis. Public Health** 3 (2000), pp. 288-290.
24. Stijn, Blot, Koenraad, Vandewoude, Eric, Hoste, Francis and Colardyn (2002) Outcome and Attributable Mortality in Critically Ill Patients With Bacteremia Involving Methicillin-Susceptible and Methicilli Resistant *Staphylococcus aureus*. **Arch. Intern. Med.** 2002;162: 2229-2235.
25. Abdulrazak, A., Bitar, Z.I., Al-Shamali, A. A. and Mobasher, L. A. (2005) Bacteriological study of diabetic foot infections. **Journal of Diabetes and its Complications.** Volume 19, Issue 3 , May-June 2005, Pages 138-141.
26. Lawrence, A., Lavery, R., Wunderlich P. and Tredwell, J. L. (2005) Disease management for the diabetic foot: Effectiveness of a diabetic foot prevention program to reduce amputations and hospitalizations. **Diabetes Research and Clinical Practice**, In Press, Corrected Proof, Available online 31 March 2005.
27. Malone, J.M., Snyder, M., Anderson, G., Bernhard, V.M., Holloway, Jr., G. A. and Bunt, T. J. (1989) Prevention of amputation by diabetic education. **The American Journal of Surgery**, Volume 158, Issue 6, December 1989, Pages 520-524.
28. Mehtar, S. (1995) Infection control programmes—are they cost-effective? **Journal of Hospital Infection**, Volume 30, Supplement 1, June 1995, Pages 26-34.
29. Huskins, C. and Goldmann, D. (2005) Controlling methicillin-resistant *Staphylococcus aureus*, aka “Superbug”, **The Lancet**, Volume 365, Issue 9456, 22 January 2005, Pages 273-275.
30. Hardy, K. J. Hawkey, P. M, Gao, F. and Oppenheim, B. A. (2004) Methicillin resistant *Staphylococcus aureus* in the critically ill. **British Journal of Anaesthesia**, 2004, Vol. 92, No. 121-130.
31. Cepeda, J. A., Whitehouse, T., Cooper, B., Hails, J., Jones, K., Kwaku, F., Taylor, L., Hayman, S., Cookson, B., Shaw, S. *et al.* (2005) Isolation of patients in single rooms or cohorts to reduce spread of MRSA in intensive-care units: prospective two centre study. **The Lancet**, Volume 365, Issue 9456, 22 January 2005, Pages 295-304.
32. McBryde, E. S., Bradley, L. C., Whitby, M. and McElwain, D. L. S. (2004) An investigation of contact transmission of methicillin-resistant *Staphylococcus aureus*. **Journal of Hospital Infection**, Volume 58, Issue 2 , October 2004, Pages 104-108.
33. Pittet, D., Hugonnet, S., Harbarth, S., Mourouga, P. H., Sauvan, V., Touveneau, S., Perneger, T. V. *et al.* (2000) Effectiveness of a hospital-wide programme to improve compliance with hand hygiene. Infection control programme. **Lancet**. Volume 356, Issue 9238, 14 October 2000, Pages 1307-13.
34. Stein, A. D., Makarawo, T. P. and Ahmad, M. F. R. (2003) A survey of doctors' and nurses' knowledge, attitudes and compliance with infection control guidelines in Birmingham teaching hospitals. **Journal of Hospital Infection**, Volume 54, Issue 1, May 2003, Pages 68-73.
35. Potts, A. (2004) Reduction in Rates of Nosocomial Infections Attributed to Methicillin-

- Resistant *Staphylococcus aureus*. **American Journal of Infection Control**, Volume 32, Issue 3, May 2004, Page E115.
36. Wenzel, Nettleman, M. D., Jones, R. N. *et al.* (1991) Methicillin-resistant *Staphylococcus aureus*: implications for the 1990s and effective control measures. **Am. J. Med.**, 91 suppl. 3B (1991), pp. 221S–227S.
 37. Bradley, S. F. (1999) Methicillin-resistant *Staphylococcus aureus*: Long-term care concerns. **The American Journal of Medicine**. Volume 106, Issue 5, Supplement 1, 3 May 1999, Pages 2–10.
 38. Herwaldt, L. A. (1999) Control of methicillin-resistant *Staphylococcus aureus* in the hospital setting. **The American Journal of Medicine**, Volume 106, Issue 5, Supplement 1, 3 May 1999, Pages 11–18.
 39. Strohal, R., Schelling, M., Takacs, M., Jurecka, W., Gruber, U. and Offner, F. (2005) Nanocrystalline silver dressings as an efficient anti-MRSA barrier: a new solution to an increasing problem. **Journal of Hospital Infection**, Volume 60, Issue 3, July 2005, Pages 226–230.
 40. Nettleman, M. D., Trilla, A., Fredrickson, M. and Pfaller, M. (1991) Assigning responsibility: using feedback to achieve sustained control of methicillin-resistant *Staphylococcus aureus*. **American Journal of Medicine**, 91 (suppl. 3B): Am. J. Med. 1991 Sep 16; 91(3B): 228S–232S.
 41. Haddad, Q., Sobayo, E. I., Basit, O. B. and Rotimi, V. O. (1993) Outbreak of methicillin-resistant *Staphylococcus aureus* in a neonatal intensive care unit. **J Hosp Infect**. 1993 Mar; 23(3):211–22.
 42. Vicca, A. F. (1999) Nursing staff workload as a determinant of methicillin-resistant *Staphylococcus aureus* spread in an adult intensive therapy unit. **Journal of Hospital Infection** 43: 109–11.
 43. Eveillard, M., Eb, F., Tramier, B., Schmit, J. L., Lescure, F. X., Biendo, M., Canarelli, B., Daoudi, F., Laurans, G., Rousseau, F. and Thomas, D. (2001) Evaluation of the contribution of isolation precautions in prevention and control of multi-resistant bacteria in a teaching hospital. **Journal of Hospital Infection**, Volume 47, Issue 2, February 2001, Pages 116–124
 44. Webster, J. and Faoagali, J. L. (1989) An in-use comparison of chlorhexidine gluconate 4% w/v, glycol-poly-siloxane plus methylcellulose and a liquid soap in a special care baby unit. **Journal of Hospital Infection**, Volume 14, Issue 2, August 1989, Pages 141–151.

6/6/2012