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MRSA SCREENING

ESSAY

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Rana Mohamed Nagieb

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List of abbreviations

Agr	:	accessory gene regulator
BORSA	:	borderline-resistant Staphylococcus aureus
CA-MRSA	:	Community-acquired methicillin-resistant Staphylococcus aureus
CDD	:	Cefoxitin disc diffusion test
CFU	:	colony forming units
CLSI	:	Clinical and Laboratory Standards Institute (formerly NCCLS)
CoNS	:	coagulase negative Staphylococcus
EARSS	:	European Antibiotic Resistance Surveillance System
FEM		factors essential for methicillin resistance
GISA	:	Glycopeptide-intermediate S. aureus
HA-MRSA	:	Hospital-acquired MRSA
HCW	:	health-care ward
LTF	:	long-term facility
MDR	:	multi-drug-resistant
mecA	:	gene coding for penicillin-binding protein 2a (PBP2a)
MIC	:	minimum inhibitory concentration
MH	:	Muller-Hinton agar
MODS A	:	Moderately-resistant S. aureus
MRSA	:	Methicillin-resistant Staphylococcus aureus
MRSA-Screen test	:	rapid latex agglutination assay that detect PBP2a
MLST	:	multilocus sequence typing
MSA	:	Mannitol salt agar
MS-Cefox	:	Mannitol salt agar media supplemented with Cefoxitin
MSO	:	Mannitol salt agar media supplemented with Oxacillin

MSSA	:	Methicillin-susceptible Staphylococcus aureus
NaCL	:	sodium chloride
NCCLS	:	National Committee for Clinical Laboratory Standards
NIs	:	Nosocomial Infections
NMDR	:	non-multi-drug-resistant
NNIS	:	National Nosocomial Infection Surveillance System (USA)
Nuc	:	nuclease
OAS	:	. Oxacillin salt agar screen
ODD	:	Oxacillin disk diffusion test.
ORSAB	:	Oxacillin Resistance Screening Agar Base
pgp	:	penicillin-binding protein
PCR	:	polymerase chain reaction
PFGE	:	pulsed-field gel electrophoresis
PVL	:	Panton-Valentine leukocidin
RFLP	:	restriction fragment length polymorphism
Sar	:	Staphylococcal accessory gene regulator
Staph. Aureus	:	Staphylococcus aureus
SCCmec	:	Staphylococcal cassette chromosome mec
ST	:	sequence type
TISA	:	Tiecoplanin-intermediate S. aureus
TSST-1	:	toxic shock syndrome toxin-1
VISA	:	Vancomycin intermediate-resistant Staphylococcus aureus
VRSA	:	Vancomycin-resistant Staphylococcus aureus
CDC	:	Centers of disease control and prevention
SSTIS	:	Skin and soft tissue infections
ICU	:	Intensive care unit

Introduction

Methicillin-resistant Staphylococcus aureus (MRSA) is a bacterium responsible for several difficult-to-treat infections in humans. It is also called multidrug-resistant Staphylococcus aureus and oxacillin-resistant Staphylococcus aureus (ORSA). MRSA is any strain of Staphylococcus aureus that has developed resistance to beta-lactam antibiotics, which include the penicillins (methicillin, dicloxacillin, nafcillin, oxacillin, etc.) and the cephalosporins. Strains unable to resist these antibiotics are classified as methicillin-sensitive Staphylococcus aureus, or MSSA. The development of such resistance does not cause the organism to be more intrinsically virulent than strains of Staphylococcus aureus that have no antibiotic resistance, but resistance does make MRSA infection more difficult to treat with standard types of antibiotics and thus more dangerous***(Gorwitz et al.,2008).***

MRSA was discovered in 1961 in the United Kingdom. It made its first major appearance in the United States in 1981 among intravenous drug users and since then number of MRSA infections in the United States has been increasing significantly. A 2007 report in Emerging Infectious Diseases, a publication of the Centers for Disease Control and Prevention (CDC), estimated the number of MRSA infections in hospitals doubled nationwide, from approximately 127,000 in 1999 to 278,000 in 2005, while at the same time annual deaths increased from 11,000 to more than 17,000***(Klein et al.,2007).***

There are two types of MRSA (hospital acquired and community acquired), the hospital type most common come with nosocomial

infections especialy patients admitted into intensive care units(ICUs) are at great risk for acquiring nosocomial infections due to decrease in their immunity.The most common manifestations of community acquired type(CA_MRSA) are skin infection, pneumonia**.** ***(Raygada and Levine .,2009).***

Diagnostic microbiology laboratories and reference laboratories are key for identifying outbreaks of MRSA by blood,urine,sputum,or other body fluid cultures this for first identification. Another common laboratory test is a rapid latex agglutination test that detect the PBP2a protein. PBP2a is a variant penicillin-binding protein that imparts the ability of S. aureus to be resistant to oxacillin**(** ***Morell et al.,2010***).Also PCR is used for rapid detection and identification of MRSA strains***(Francois and Schrenze.,2008).***

The mecA gene confers resistance to methicillin in S. aureus The gene is located on the staphylococcal chromosome cassette mec and encodes penicillin binding protein 2a (PBP2a). PBP2a is located in the bacterial cell wall and has a low binding affinity for B_ lactams . MRSA strains that possess mecA gene are either heterogeneous or homogeneous in their expression of resistance, mecA gene is the most reliable method of detecting methicillin resistance in staphylococcus isolates but not all laboratories can include molecular biology techniques in their routine clinical practice ***(Velasco et al., 2005).***

Patient screening with nasal culture upon hospital admission,discharge or transport to prevent transfer of organism from patient to patient or from hospital to community or to other hospital is a

mandatory procedure to avoid trans infection between hospitals ***(Tacconelli et al.,2009)***.

Vancomycin and teicoplanin are glycopeptide antibiotics used to treat MRSA infections. Teicoplanin is a structural congener of vancomycin that has a similar activity spectrum but a longer half-life. Because the oral absorption of vancomycin and Teicoplanin is very low, these agents must be administered intravenously to control systemic infections**. *(Siegman et al.,2005).***

Aim of the work

The aim of the work is to:

1- Is to make an overview on MRSA,(definition, type of infection, prevention, diagnosis and treatment)
2- Highlighting new techniques in diagnosis of MRSA
3- Management of MRSA infection in community and hospital wide.

Incidence and prevalence of MRSA infection

MRSA was discovered in 1961 in the United Kingdom. It made its first major appearance in the United States in 1981 among intravenous drug users and since then number of MRSA infections in the United States has been increasing significantly. In the 1980s, reports a new strain of MRSA were first described among healthy children living in the community who did not have a history of traditional MRSA risk factors including recent hospitalization, surgery, dialysis, long-term care, indwelling catheter or percutaneous medical device, or a previous history of MRSA **.** Since that time, the term community-associated MRSA and community-acquired MRSA have been used interchangeably to describe community-onset infections in a patient lacking established HA-MRSA risk factors ***(Gorwitz., 2008).***

The incidence of CA-MRSA varies geographically within the United States, with an annual incidence of 18 to 25.7 per 100,000 population of all documented infections ***(Davis et al., 2007).*** A 2004 study conducted by the CDC in 11 U.S. cities isolated CA-MRSA in 59% (ranging from 15% to 75%) of adult patients who presented to emergency departments with new onset of purulent SSTIs ***(Gorwitz., 2008).***

In 2005, a prospective surveillance study funded by the CDC examined the epidemiologic characteristics of clinical cases of HA-MRSA versus CA-MRSA in 51 rural hospitals in Idaho and Utah, which represented 89% of the total number of rural hospitals in the two states ***(Stevens et al., 2005).*** Of the 724 adult cases that met study criteria for newly documented MRSA infection, 319 patients (44%) tested positive for CA-MRSA. In terms of clinical features, patients in the CA-MRSA group were younger (mean age 41.5 years, N = 178), and those who

presented without co-existing factors experienced the highest proportion of skin and soft tissue infections (156/240, 65%, $p < .0001$) ***(Stevens et al., 2005).***

A retrospective chart review conducted by Olesevich and Kennedy (2006) at East Tennessee Children's Hospital confirmed a 159% increase in positive cultures for CA-MRSA among pediatric patients treated with incision and drainage for soft tissue abscess since 2004. Another study drawing on the National Ambulatory Medical Care Survey and National Hospital Ambulatory Medical Care Survey from 1997 to 2005 found that visits for skin and soft tissue infections increased from 32.1 to 48.1 visits per 1000 population from 1997 to 2005 and increased to 14.2 million by 2005 ***(Hersch et al., 2008).***

In 2006, the Association for Professionals in Infection and Epidemiology (APIC) conducted a national MRSA prevalence study and found that 46 out of every 1000 patients were either infected or colonized with MRSA ***(APIC, 2007).*** In 2007, the first national hospital-based MRSA prevalence was conducted. Results showed that MRSA infection varied nationwide with 39.5% occurring in the Pacific region, 58.3% in the East South Central region, and 47.1% in the Mountain region ***(Brandon et al., 2008).***

Furthermore, New York, Maine, South Carolina, and Delaware had the highest prevalence of patients with MRSA, reporting a combined incidence of greater than 60 per 1000 inpatients ***(Brandon et al.,2008).***

Risk factors for MRSA colonization and infection

Many strategies have been applied to identify both the risk factors that lead to colonization and those that lead to subsequent infection ***(de Irala-Estevez et al., 2001)***. In many cases, identification of a single risk factor is not possible because of patients being simultaneously exposed to several. Intensive care patients have risk factors making them especially prone to nosocomially acquired infection***(Hardy et al., 2004).***

1-previous MRSA colonization:

The risk of MRSA infection in patients is much higher if they are previously colonized with MRSA ***(Asensio et al.,1996).***Between 30 and 60% of critically ill patients colonized with MRSA will develop infection, In a study of patients developing MRSA bacteraemia 83% of patients had been colonized previously **(*Blot et al.,2002).***However, despite colonization rates being perceived to be higher on ICU , there are no comparative studies and along with colonization many risk factors predispose critically ill patients to infection . An example of this is high rates of colonization in nursing homes but the low rates of infection ***(Hardy et al.,2004).***

2-lengh of ICU and hospital stay:

In several studies, the amount of time spent at ICU has been considered the most significant risk factor in acquisition of MRSA infection ***(Hardy et al.,2004*).**The odds ratio for acquiring infection increased more than 2.5 times with a stay of longer than 2 weeks , and more than 4 times after 3 weeks in a study by **(*Ibelings and Bruining,1998).***When compared with MSSA infection, patients infected

with MRSA had a significantly longer length of stay at ICU both before and after infection***(Hardy et al.,2004).***

3-Severity of illness and intensity of care:

An increasing acute physiology and chronic health evaluation (APACHE)II score has been associated with the risk of acquiring MRSA , but once the APACHE II score is greater than 21-25 a reduction is seen in the incidences of infection**.** Patients with the higher APACHE II scores are more likely to die of their underlying disease before acquiring MRSA , whereas less severely ill patients are exposed to a greater number of risk factors ***(Talon. ,1999 and Lipsky et al ., 2010).***

The inensity of care and staff defictis have been associatied with MRSA colonization and infection ; an increasing intensity of work was associated with a greater risk of MRSA acquisition in ICUs ***(Dziekan et al.,2000).*** The effect of staff deficit has been significantly associated with MRSA clusters , whilist in sporadic cases staff deficit did not influence the occurrence of MRSA ***(Grundmann et al.,2002 and Lipsky et al .,2010).***

4-Intravascular devices:

The insertion of intravascular devices has been identified as an independent risk factor associated for MRSA bacteraemia **.**Asensio and colleagues in 1996 , found invasive procedures including the insertion of intravascular devices to be independently associated with MRSA colonization and infection , similar to law and Gill in 1998 , who found a 9- fold increase in MRSA acquisition if a patient had an indwelling catheter. ***(Zinderman et al.,2004) .***