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Diagnostic Approach for the Detection of Methicillin Resistant *Staphylococcus Aureus* Infections

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Abstract – Methicillin-resistant Staphylococcus aureus (MRSA) infections comprise an overall pandemic. The test to the clinical microbiology research facility is the manner by which to react to the MRSA issue. This incorporates the execution of conventions for commanded enactment that will require a functioning screening program. While increasingly costly atomic methods have the capability of offering very delicate and quick outcomes, they may not be the most fitting fit for some symptomatic settings. MRSA disease likewise adds to expanded patient grimness and mortality. Immediate, fast location of MRSA from blood societies, just as skin and soft tissue infections (SSTIs), offers guarantee of lessening dreariness. Like any outcome, these are helpful just whenever used in a suitable way. The effective utilization of MRSA diagnostics requires a synergistic exertion between the research center, drug store, and a functioning anti-microbial stewardship program. An analytic methodology for MRSA identification is required to decide the best fit for their setting based on their patient populace and assets. This review is designed to give the overview of diagnostics tools required for detection of Methicillin-resistant Staphylococcus aureus.

Keywords: Methicillin-Resistant, Staphylococcus Aureus, Skin and Soft Tissue Infections, Lab Diagnostic

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INTRODUCTION

Staphylococcus aureus is a flexible pathogen equipped for causing a wide scope of human infections (Gordon RJ, 2008; Brown E L, 2009). It is in charge of a developing weight of sickness in both network and emergency clinics causing a wide assortment of contaminations, going from shallow skin diseases to extreme, frequently deadly, foundational contaminations (Moore CE, 2004). Skin and delicate tissue diseases (SSTIs) are a typical reason for grimness in both the network and the Hospital (Weigelt J, 2005).

Folliculitis, furuncles, and impetigo are instances of essential S. aureus diseases. Furuncles are related with S. aureus strains that produce the Panton-Valentine leucocidin, while bullous impetigo is related with strains that produce exfoliative poisons. Auxiliary skin diseases can happen in patients with skin injury, careful cuts, skin ulcers, or dermatitis (Issartel B, 2005) . Disease with CA-MRSA is most normally connected with skin and delicate tissue contamination (SSTI) (Issartel B, 2005).

Community Associated - MRSA

First Methicillin-resistant *Staphylococcus aureus (MRSA)* were described as hospital- acquired MRSA (HA-MRSA), but in recent years community-acquired MRSA (CA-MRSA) strains have been reported worldwide (Verdier I, 2007 ; Borer A, 2002).

In 1963, the principal major nosocomial scourge of a methicillin-safe strain of S. aureus was depicted . First in Europe during the 1960s and after that in the United States during the 1970s, have revealed flare-ups of nosocomial contaminations brought about by methicillin-safe S. aureus (MRSA) (Chambers HF, 1988) .

The principal MRSA case was accounted for in the United Kingdom in 1961. The primary instance of MRSA in the United States was portrayed in 1968. The principal instance of CA-MRSA disease in the United States was accounted for in 1980 (Al-Rawahi GN, 2008) .

In 2007, Daum announced that over 10% of Staphylococcus aureus strains found in the network were MRSA. A meta-examination by Salgado et al. in 2003 demonstrated a network gained MRSA disease rate among hospitalized patients of 30.2% in 27 review investigations and 37.3% in 5 forthcoming examinations, and a network wide MRSA contamination rate among non-hospitalized patients of 1.3%. USA 300, a clone of MRSA has been recognized as the most widely recognized type of network gained MRSA in United State. (Barkin JA, 2007) .

CA-MRSA first rose among kids during the 1990s (Adam LH, 2009). In Europe, CA-MRSA contaminations seem, by all accounts, to be less normal than in the United States (Tinelli M, 2009 ; Mc Donald M, 2006) .

PVL-containing MRSA is a developing pathogen in the region of Saskatchewan and somewhere else in Canada (Mc Donald R, 2005). PVL has been related with furunculosis; serious SSTIs, including necrotizing fasciitis ;and necrotizing pneumonia. (Darker EL , 2009).

Community-Associated Clones of MRSA

Five CA-MRSA strains represent by far most of CA-MRSA infection around the world.

- The primary generally perceived CA-MRSA strain is normally known as the Midwest Clone. As per multi-locus arrangement composing investigation, the Midwest Clone has a place with the succession type ST1 clonal genealogy.
- The second CA-MRSA strain—ST30 clonal heredity—is known as the Southwest Pacific/Oceania Clone, as it was ensnared in confined network episodes in Australia, Greece, Mexico and United States.
- The third CA-MRSA strain—ST80 clonal heredity—is known as the European Clone for causing endemic malady in numerous European people group.

The fourth CA-MRSA strain—ST59 clonal genealogy—is referred to as the Pacific Clone as it is endemic in the United States, Taiwan, and Vietnam

- The fifth CA-MRSA strain—ST8 clonal genealogy—is otherwise called USA300, USA300 is currently pandemic in networks crosswise over 38 U.S. states, Canada, and 9 European nations (Binh AD, 2008).

Correlation of clinical, epidemiological and microbiological qualities of community – associated MRSA (CA-MRSA) (Loughrey A, 2007)

Characteristics	*Staph.aureus*	HA-MRSA	CA-MRSA
Population affected	Immunocompetent & immunocompromised Individuals in the community	Hospital/healthcare ,preterm neonate immunocompromised neonates	Usually young healthy individual in the community.
Site of infection	Predominantly wound, bactermia, entrotoxin-mediated food poisoning .	Bacterium & wound infection	Skin infection {abscesses & cellulites, furunculosis, sSSTIs & may be bacteraemia .
Risk factors	Colonization with s.aureus, trauma, body puncturing, medicate misuse.	Inhabiting gadget, catheters, lines, delayed hospitalization	Close physical contact, scraped spot wounds, poor mutual cleanliness.
Transmission	Patients own skin flora	Person to person spread, environmental to patient ,animal to patient	Person to person shared facilities {sports equipment,towels,pools etc},environment.
Microbiological Characteristics	Yes	No	No
Susceptibility to methicillin	Yes	No	Yes
Susceptibility to other antibiotics (Erythromycin, Clindamycine)	Variable {usually limited}	Low{<5%}	High{>95%}
Presence Pvl gene locus	Not present	Predominantly subclasses I,II or III	Mainly IV {subtypes a-h} & V
SCC mecA type			
Treatment	Oral or IV Flucloxacillin	Oral: doxycyline IV: Vancomycin/ teichoplanin	Clindamycine or co-trimethoxazole

MECHANISM OF METHICILLIN RESISTANCE

Hetero-resistance

Identifying oxacillin or methicillin obstruction in clinical separates that possesss the mec A quality might be troublesome under the standard test conditions, since staphylococcus now and then show hetroresistance in their reaction to oxacillin. In heteroresistant strain, all cells in the test

populace have the hereditary components (mecA quality) for oxacillin opposition ,however not all cells express this obstruction. Thus, in the weakness test, a few cells seem safe subterranean insect other seem powerless. On the off chance that too couple of cells express opposition , an oxacillin-safe strain may go undetected.

Other Factors of resistance

In view of the powerlessness to relate PBP2a generation with the dimension of opposition communicated, Hartman and Tomasz have proposed the presence of a second factor, which they named factor X, that intervenes methicillin obstruction in conjugation with PBP2a. This pathway controls debasement of cell divider and may intercede beta-lactam-invigorated cell lysis; along these lines, it might assume a job in the marvel of resistance.

Mupirocin Resistant MRSA

Mupirocin is a topical antimicrobial specialist that meddles with protein combination by aggressive hindrance of bacterial isoleucyl-tRNA synthetase. It has been utilized to treat skin and delicate tissue contaminations and to annihilate staphylococcal carriage in social insurance laborers and patients. In any case, the predominance of mupirocin opposition in MRSA has expanded in settings with broad utilization of this specialist, and it has likewise been accounted for in network related MRSA strains.

In Canada, abnormal state mupirocin opposition has as of late been accounted for in over half of network related strains recognized in a flare-up in northern Saskatchewan. Mupirocin opposition in staphylococci is normally characterized as low-level obstruction (MICs, 8 to 256 _g/ml) or abnormal state opposition (MICs, _512 _g/ml) . Low-level opposition is typically connected with point transformations in the chromosomally encoded ileS quality , though abnormal state obstruction is commonly because of a plasmid-intervened quality, mupA (likewise alluded to as ileS2), which encodes an extra altered isoleucyl-tRNA synthetase (Simor AE, 2007) . In 1993 in Ireland ,a study of 1152 staphyloccal separates from emergency clinic and network source observed just 2% to be mupirocin safe. In a 1997 European investigation 3.9% of S.aureus strains were impervious to mupirocin . In the United States somewhere in the range of 1990 and 1995 ,mupirocin obstruction was observed to be high (24%) among MRSA endure a veterans emergency clinic ,where MRSA colonization was endemic and mupirocin was as often as possible utilized. In one investigation of Brazilian medical clinic (1994-1995), where utilization of mupirocin was visit, protection from mupiocin was observed to be > half (Orrett Fitzroy A, 2008).

Laboratory Diagnosis of SSTIs secondary to CA-MRSA

An oxacillin minimum inhibitory concentration (MIC) more noteworthy than or equivalent to 4 µg/mL is symptomatic of MRSA; notwithstanding, it might require 2–4 days to totally affirm a life form as oxacillin safe.

Disc Diffusion Method

The circle dispersion technique is a dependable strategy for discovery of methicillin opposition, Oxacillin is favored on the grounds that it is the best institutionalized for the plate dissemination method. Although a 48-h brooding period, expansion of 4% NaCl to the agar, or hatching at 30'C has been accounted for to improve identification of obstruction, up to 40% of safe strains still might be missed if cephalosporin circles are utilized. McDougal and Thornsberry demonstrated that a few strains of S. aureus creating a lot of betalactamase gradually hydrolyze penicillinase-safe penicillins. The standard plate dispersion test with a 1-,ug oxacillin circle after a 24-h brooding at 35C will identify 95% of coagulase negative safe strains . Expansion of 4% NaCl to the Mueller-Hinton agar, in any case, may permit identification of up to 96% of safe strains inside 18 h (McDougal and Thornsberry;2006).

Broth Microdilution Method

In many investigations, 95% of safe strains can be distinguished by this technique. The explicitness of this test strategy approaches 100%. Methicillin-safe coagulase-negative staphylococci are more hard to identify by microdilution strategies than strains of S. aureus. Soup microdilution tests for oxacillin in Mueller-Hinton stock enhanced with 2% NaCl when hatched for 24 h at 35 C will recognize 60 to 90% of safe coagulase-negative strains.

Agar screen method

An agar screen technique was one of the soonest reference strategies used to characterize methicillin obstruction in staphylococci (Rolinson, Letter, Br. Drug. J. 1:125-126, 1961). In this technique, a bacterial suspension is vaccinated onto agar containing a beta-lactam anti-toxin. Development of any provinces on this medication containing agar is characteristic of opposition. The agar screen technique can distinguish 95% of safe coagulase-negative strains after a 24-h brooding . The agar screen technique is most likely the best single test and ought to be utilized as the last referee for marginal strains or those that give divergent outcomes by different strategies.

Agar breakpoint method

Break point procedures are essentially MIC methodology that test only the breakpoint obsessions. In this way the conditions and breakpoint obsessions depicted for agar debilitating tests may be used in breakpoint tests.

E test Method

E test is a quantitative procedure for deciding the antimicrobial helplessness of microbes. The framework include in a predefined anti-microbial angle which is utilized to decide the Minimum Inhibitory Concentration (MIC) of oxacillin ,in ug/ml ,of various antimicrobial specialists against microorganism as tried on agar media utilizing medium-term hatching. E test depends on a blend of the idea of both weakening and dispersion tests. Like a full range MIC technique .E test legitimately measures antimicrobial defenselessness in term of discrete MIC values.

Rapid culture-based detection

Direct distinguishing proof of MRSA is conceivable utilizing chromogenic media, forestalling the requirement for subcultures and corroborative biochemical testing accordingly, MRSA can typically be recognized inside 24 hours of essential vaccination of these culture plates; a portion of these media permit MRSA identification in as right on time as 16 to 18 hours.

Automated Systems

Mechanized frameworks dependent on stock microdilution strategies and adjusted to upgrade location of methicillin opposition may accomplish worthy dimensions of affectability. Research facilities that utilization robotized frameworks for weakness testing of staphylococci ought to either utilize a corroborative reference test (e.g., circle dissemination, soup microdilution, or agar screen) or direct a preliminary contrasting the mechanized framework and a reference technique to record exactness for the strains present inside a specific clinic or network setting (Chambers HF, 1988).

Molecular detection methods

Polymerase chain reaction (PCR) based atomic tests intensify and recognize different hereditary components of MRSA. These examines permit MRSA location in two to six hours (normal about 2.5 hours). The affectability and particularity of these strategies (contrasted with customary societies) by and large surpass 90 percent despite the fact that outcomes shift contingent upon the inspecting site. Sub-atomic strategies are more costly than fast culture-based identification techniques and require significant interests in lab hardware, reagents, and prepared research center staff (Malhotra Kumar S, 2008).

MRSA Screening (mec A Latex Agglutination) Test

MRSA - Screen is a subjective slide latex agglutination test for the discovery of PBP2a present in secludes of Staphylococcus aureus and is accordingly valuable as a guide in recognizing MRSA.

MRSA – Screen contains a latex reagent honed with monoclonal antibodies against PBP 2a together with reagents to rapidly remove PBP 2a from the bacterial movies of MRSA. Concentrate are set up by warming up a suspension of Staph. Aureus cells under essential conditions, trailed by an equalization and a centrifugation step. The supernatant is then mixed with the latex reagent on a test card and detectable bundling or agglutination inside three minutes shows the conceivable of PBP2a.

Therapy for Methicillin –Resistant S. aureus Infections

There is proof that anti-microbials may not be essential for treatment of uncomplicated SSTIs, for example, abscesses, including those brought about by MRSA. At the point when MRSA segregates were refined from SSTI patients, diseases settled notwithstanding when beta-lactam anti-toxins, which are probably idle against MRSA, were utilized. It is standard practice to treat patients with SSTIs with an anti-toxin. Abuse of anti-toxins has antagonistic outcomes, including untoward symptoms and monetary expenses, and may add to the spread of anti-infection safe life forms. The disturbing increment in the commonness of network related MRSA might be an outcome of long stretches of anti-microbial abuse (Rajendran PM, 2007).

The cephalosporins, specifically, cephalothin and cefamandole and penems, imipenem and CGP-31608, are among the most dynamic beta-lactam anti-infection agents in vitro against methicillin-safe staphylococci. Strains may seem powerless to these medications in vitro, regardless of whether measures to upgrade obstruction (e.g., hatching at 30°C, expansion of NaCl to the medium) are utilized. Since utilization of beta-lactam anti-infection agents conveys a critical shot for disappointment and in light of the fact that involvement with different medications is constrained, vancomycin remains the medication of decision for methicillin-safe staphylococci. Absence of clinical reaction and harmfulness are issues that may warrant thought of different treatments. The principal decision is include rifampin or gentamicin or both. On the off chance that the issue is not kidding drug lethality or absence of reaction

regardless of various anti-infection agents (Chambers HF, 1988) Ceftobiprole is another cephalosporin with great action against methicillin (meticillin)- safe Staphylococcus aureus (MRSA). Since this pathogen is a noteworthy issue in clinic and ventilator-related pneumonia and is a developing issue in network gained pneumonia (Rodvold KA, 2009). Strains regularly are impervious to at least one aminoglycosides, however many have stayed helpless to gentamicin. Obstruction can rise when aminoglycosides are utilized as single operators. So these ought to be utilized in blend with another medication, ideally vancomycin, to which the strain additionally is defenseless. Blends of gentamicin and rifampin, quinolones, clindamycin, or trimethoprim-sulfamethoxazole are of problematic adequacy. Blends of aminoglycosides and beta-lactam anti-infection agents are synergistic and bactericidal for some safe strains.

Vancomycin is the medication of decision for treatment of contaminations brought about by methicillin-safe staphylococci, both S. aureus and coagulase-negative strains. Vancomycin has demonstrated viability against methicillin-safe staphylococci for treatment of genuine contaminations. Teicoplanin is another glycopeptide anti-infection basically identified with vancomycin and ristocetin. Like vancomycin, it is very dynamic in vitro against a wide range of gram positive living beings, including enterococci and both methicillin-defenseless and methicillin-safe staphylococci. In contrast to vancomycin, be that as it may, teicoplanin has a long disposal half-life allowing organization once per day, and it is very much endured when given intramuscularly, with a bioavailability of 90%. These pharmacokinetic properties propose that teicoplanin may give an antimicrobial option in contrast to treatment of genuine gram-positive diseases in patients who have constrained venous access or touchiness to, B-lactam anti-toxins (Bibler MR,1987).

Linezolid has been utilized for the treatment of nosocomial and network obtained pneumonia, just as convoluted skin and delicate tissue contamination brought about by MRSA, including vancomycin middle of the road S. aureus. Since the primary report of a VISA strain in 1997, VISA sickness has been represented in various countries. Since VISA will when all is said in done show cross-security from some adversary of MRSA administrators, for instance, teicoplanin and daptomycin. (Watanabe Y , 2008).

Fusidic corrosive, an operator accessible in Australia and Europe yet not in the United States, is dynamic in vitro against methicillin-safe Staphylococci .Like rifampin, opposition can develop if this medication is utilized alone, so it must be utilized in mix with a second medication, for example, rifampin, to which the strain is helpless. It tends to be utilized as a topical operator just as intravenously. Mupirocin is a protein combination inhibitor that demonstrations by restricting irreversibly to isoleucyl t-RNA synthetase. It is mostly utilized as a treatment (2% in paraffin base) and is successful in taking out MRSA. It is topical specialist was viewed as sheltered, successful and less expensive and came up short on the un towards impacts on typical body vegetation related with oral antimicrobial operators.

Prevention and control of MRSA Infections

- Avoidance of wrong or unnecessary anti-infection treatment and prophylaxis in all human services settings .Ensuring that anti-microbials are given at the right dose and for a proper term.
- Limiting the utilization of glycopeptides anti-toxins to circumstances where their utilization has been demonstrated to be proper. On the off chance that conceivable, delayed courses of glycopeptide treatment ought to be maintained a strategic distance from.
- Reducing the utilization of expansive range anti-toxins, especially third-age cephalosporin's and floroquinolones.
- Instituting anti-infection stewardship software engineers in social insurance offices, key parts of which incorporate the recognizable proof of key work force who are in charge of this, reconnaissance of anti-toxin obstruction and anti-toxin utilization, and prescriber instruction (Coia J.E, 2006).

CONCLUSION

A demonstrative methodology for MRSA identification is required to decide the best fit for their setting based on their patient populace and assets. Continuous shared endeavors with contamination control, drug store, and an anti-toxin stewardship program should be set up. These endeavors will guarantee that outcomes are followed up in a sorted out, opportune way and that great quality markers are checked. Regardless of whether it is MRSA or other rising multidrug-safe life forms, the clinical microbiology network has dependably reacted to these difficulties. More proof put together examinations that concentration with respect to persistent results, cost-adequacy and technique exactness after some time are required. This methodology will bolster sound logical and money related choices for the lab and diagnostic.

REFERENCES

Bibler M. R., Frame P. T., Hagler D. N., Bode R. B., Staneck J. L., Thamlikitkul V., Harris J. E., Haregewoin A., Bullock W. E., J.R. (1987). Clinical Evaluation of Efficacy, Pharmacokinetics, and Safety of Teicoplanin for Serious Gram-Positive Infections. Antimicrobial agents and chemotherapy; 31 : pp. 207-12.

Brown E. L., Bowden M. G., Bryson R. S., Hulten K. G., Bordt A. S., Forbes A., Kaplan S. L. (2009). Pediatric Antibody Response to Community-Acquired *Staphylococcus aureus* Infection Is Directed to Panton-Valentine Leukocidin. Clinical and vaccine immunology; 16: pp. 139–41.

Coia J.E., Duckworth G.J., Edwards D.I., Farrington M., Fry C., Humphreys H., Mallaghan C., Tucker D. R. (2006). Guidelines for the control and prevention of meticillin-resistant Staphylococcus aureus (MRSA) in healthcare facilities. Journal of Hospital Infection; 63: pp. 1-44.

Gordon R. J., Lowy F. D. (2008). Pathogenesis of Methicillin-Resistant Staphylococcus aureus Infection . Clin Infect Dis. 2008 June; 46: pp. 1-16.

Moore C. E., Segal S., Berendt A. R., Hill A. V. S., Day N. P. J. (2004). Lack of Association between Toll-Like Receptor 2 Polymorphisms and Susceptibility to Severe Disease Caused by Staphylococcus aureus. Clinical and diagnostic laboratory immunology; 11: pp. 1194–97.

Weigelt J., Itani K., Stevens D., Lau W., Dryden M., Knirsch C. (2005). Linezolid versus Vancomycin in Treatment of Complicated Skin and Soft Tissue Infections. Antimicrobial agents and chemotherapy; 49: pp. 2260–66.

Issartel B., Tristan A., Lechevallier S., Bruyere F., Lina G., Garin B., Lacassin F., Bes M., Vandenesch F., Etienne J. (2005). Frequent Carriage of Panton-Valentine Leucocidin Genes by Staphylococcus aureus Isolates from Surgically Drained Abscesses. Journal of clinical microbiology; 43: pp. 3203–3207.

Verdier I., Durand G., Bes M., Taylor K. L., Lina G., Vandenesch F., Fattom A. I., Etienne J. (2007). Identification of the Capsular Polysaccharides in Staphylococcus aureus Clinical Isolates by PCR and Agglutination Tests. Journal of clinical microbiology; 45: pp. 725–29.

Borer A., Gilad J., Yagupsky P., Peled N., Porat N., Trefler R., Shprecher-Levy H., Riesenberg K., Shipman M., Schlaeffer F. (2002). Community-Acquired Methicillin- Resistant Staphylococcus aureus in Institutionalized Adults with Developmental Disabilities. Emerging Infectious Diseases; 8 : pp. 966-70.

Chambers H. F. (1988). Methicillin-Resistant Staphylococci. Clinical microbiology reviews; 1: pp. 173-86.

Al-Rawahi G. N., Schreader A. G., Porter S. D., Roscoe D. L., Gustafson R., Bryce E. A. (2008). Methicillin-Resistant Staphylococcus aureus Nasal Carriage among Injection Drug Users: Six Years Later. Journal of clinical microbiology; 46: pp. 477–79.

Barkin J. A., Miki R. A., Mahmood Z., Landy D. C., Owens P. (2007). Prevalence of methicillin resistant staphylococcus aureus in upper extremity soft tissue infection at Jackson memorial hospital ,Miami- dade county , florida. The Iowa Orthopaedic Journal; 29: pp. 67-73.

Adam L. H., Michael D. C., Ralph G., Budd N. S., Christine S. C. (2009). Pediatricians perspectives on the impact of MRSA in primary care: a qualitative study. BMC Pediatrics: 9: pp. 1-9.

Tinelli M., Monaco M, Vimercati M, Ceraminiello A, Pantosti A. Methicillin- Susceptible Staphylococcus aureus in Skin and Soft Tissue Infections, Northern Italy. Emerging Infectious Diseases; 15 : 250-7.

McDonald M., Dougall A., Holt D., Huygens F., Oppedisano F., Giffard P. M., Bamber J. I., Stephens A. J., Towers R., Carapetis J. R., Currie B. J. (2006). Use of a Single-Nucleotide Polymorphism Genotyping System To Demonstrate the Unique Epidemiology of Methicillin-Resistant Staphylococcus aureus in Remote Aboriginal Communities. Journal of clinical microbiology; 44: pp. 3720–27.

McDonald R. R., Antonishyn N. A., Hansen T., Snook L. A., Nagle E., Mulvey M. R., Levett P. N., Horsman G. B. (2005). Development of a Triplex Real-Time PCR Assay for Detection of Panton-Valentine Leukocidin Toxin Genes in Clinical Isolates of Methicillin-Resistant Staphylococcus aureus. Journal of clinical microbiology; 43: pp. 6147–49.

Loughrey A., Millar B.C., Goldsmith C. E., Rooney P. J., Moore J.E. (2007). Emergence of CA-MRSA in Northern Ireland. Ulster Med J; 76(2) : pp. 68-71.

Rajendran P. M., Young D., Maurer T., Chambers H., Perdreau-Remington F., Ro P., Harris H. (2007). Randomized, Double-Blind, Placebo-Controlled Trial of Cephalexin for Treatment of Uncomplicated Skin Abscesses in a Population at Risk for Community-Acquired Methicillin-Resistant Staphylococcus aureus Infection. Antimicrobial agents and chemotherapy; 51 : pp. 4044–48.

Simor A. E., Stuart T. L., Louie L., Watt C., Ofner-Agostini M., Gravel D., Mulvey M., Loeb M., McGeer A., Bryce E., Matlow A. (2007).Mupirocin-Resistant, Methicillin-Resistant *Staphylococcus aureus* Strains in Canadian Hospitals. Antimicrobial Agents and chemotherapy; 51: pp. 3880-86.

Orrett Fitzroy A. (2008). The emergence of mupirocin resistance among clinical isolates of methicillin resistant staphyloccus aureus in Trinidad: a first report.Jpn.J.Infect.Dis.; 61: pp. 107-10.

Malhotra Kumar S., Haccuria K., Michiels M. et. al. (2008). Current trends in rapid diagnostics for methicillin resistance staphylococcus aureus and glycopeptide –resistance enterococcus species. J. Clin. Microbio; 46: pp. 1577.

Rodvold K. A., Nicolau D. P., Lodise T. P., Khashab M., Noel G. J., Kahn J. B., Gotfried M., Murray S. A., Nicholson S., Laohavaleeson S., Tessier P. R., Drusano G. L. (2009). Identifying Exposure Targets for Treatment of Staphylococcal Pneumonia with Ceftobiprole. Antimicrobial agents and chemotherapy; 53: pp. 3294–3301.

Rossney A., Connell S. O. (2008). Emerging high level mupirocin resistance among MRSA isolates in Ireland. Euro surveillance; 13: pp. 4-6.

Watanabe Y., Neoh H. M., Cui L., Hiramatsu K. (2008). Improved Antimicrobial Activity of Linezolid against Vancomycin-Intermediate Staphylococcus aureus. Antimicrobial agents and chemotherapy; 52: pp. 4207–08.

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