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Distribution and Drug Resistance Research of Methicillin-Resistant *Staphylococcus aureus* after Orthopaedic Surgery

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Research purpose of this paper is to comprehend clinical distribution and drug-resistance situation of methicillin-resistant staphylococcus aureus. The method is to use automatic microbe instrument Microscan W /A 96 to do strain identification and drug susceptibility test on separated strains. The research found that 312 strains of MRSA were separated in three years, which account for 58.1% of staphylococcus aureus. MRSA is mainly distributed in wound secretion, purulent sputum and prostatic fluid and less come from blood specimens; Endemic area distribution is mainly in intensive care unit, neurosurgery, respiratory medicine, dermatology, burns orthopaedic and orthopaedics. MRSA show high drug resistance of 82.37%～ 100% to most antibiotics besides vancomycin, cotrimoxazole and rifampicin. And its drug resistance towards ampicillin, amoxicillin/acid, cefalotin, cefazolin, tienam, benzylpencilline, penicillin and tetracycline is 100% and 90% towards clindamycin, cefotaxime, clarithromycin and gentamicin.

Key words: Orthopaedic surgery, methicillin-resistant *Staphylococcus aureus*, drug resistance, clinical distribution

Methicillin-resistant *Staphylococcus aureus* is a main pathogenic bacterium of hospital infection with high drug resistance. It is difficult to control if it spread in hospital and lead to infection prevalence or outbreak. Some scholars hold that MRSA become world top three infection disease along with AIDS and hepatitis B. This research makes a retrospective investigation on MRSA detection result of 2007- 2011 in order to discuss effectiveness of intervention measure of MASA hospital infection. And it aims to provide foundation for prevention and control of MASA hospital infection.

Methicillin-resistant staphylococcus aureus is almost throughout various hospitals at home and broad. Besides methicillin, it shows multi-drug resistance towards various antibiotics that are widely applied in clinic. This paper discusses distribution of MRSA in clinical specimens and departments in our hospital and provides reliable treatment basis or clinic timely and accurately.

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MATERIALS AND METHOD

General Information

312 strains of staphylococcus aureus comes from specimens of sputum, urine, blood, pus, and secretions of inpatients in our hospital dated from January 2004 and December 2006.

Instrument and Susceptibility Paper

Automatic microbial identification and drug susceptibility system was purchased from America Turin Corporation. Blood plate was purchased from Barrett Biotechnology Co. Limited. MH plate was prepared by laboratory and reagent

was purchased from Hangzhou Tianhe Microbial Reagents Co. Limited. Susceptibility paper were 1μg/ slice of oxacillin and 30 μg/ slice of cefoxitin which were purchased by England OXIOD Corporation.

Quality Control Strains

Staphylococcus aureus ATCC25923 and ATCC29213. μg/ slice

Method

Collection and cultivation of specimen: collect specimen by regular method and inoculate them in corresponding medium for 18~ 24 h of Incubation development in 37 °C.

Identification and drug resistance of bacteria: adopt automatic microbe instrument Microscan W /A 96 and manual method on identification of bacteria, 1. identification of staphylococcus aureus: plasma coagulase was positive; catalase test is positive; G+ coccus show grape-like arrangement; reduction of nitrate; VP test is positive; anaerobism decompose glucose acid production. 2. identification of methicillin resistant staphylococcus aureus: drug resistance paper diffusion method. Prepare staphylococcus aureus obtained by separation into suspension of 0.5 McIntosh turbidity by sterile saline solution. Dip bacteria solution by sterile swabs and smear it on surface of MH agar. Then paste drug resistance paper which contains 30μg/ slice of cefoxitin and 1μg/ slice of oxacillin on MH agar. Measure diameter of bacteriostasis circle after 24 hours of 37!thermostatic incubation. And determination standard of result is: diameter of cefoxitin bacteriostasis circle ≥19 mm is drug resistance, ≥20 mm is sensitive; diameter of bacteriostasis circle oxacillind ≤10m is drug resistance, 11~12 mm is mediation, ≤13 mm is sensitive.

Data analysis: make a statistically analysis of WHONET 5.6 software (Analyze antibiotics result of the first strain from the same patient). Outpatient and hospitalization strain; adopt χ^2 to detect comparison of drug resistance rate of MRSA and MSSA and dispose it with SPSS16.0 software. $p < 0.05$ is statistically significant.

RESULTS

Distribution Analysis of MRSA

Among 312 strains of staphylococcus aureus, 312 strains were MRSA and detection rate is 58.1%; 225 strains were MSSA and detection rate is 41.9%. Distribution situation of MRSA and MSSA from 2004 to 2006 is showed in Table 1. Distribution situation of MRSA in clinical specimen and departments is showed in Table 2~3. It can be seen from Table 1 that detection rate of staphylococcus aureus during three years is

Table 1. Change of MRSA and MSSA from 2004 to 2006 strains (%)

Year	SA strain	MRSA	MSSA
2004	146	74(50. 68)	72(49. 32)
2005	174	102(58. 62)	72(41. 38)
2006	217	136(62. 67)	81(37. 33)

Table 2. Distribution of 312 strains MRSA in clinical specimen

Specimen	cases (%)
Wound secretion	156(50.00)
Phlegm	91(29.23)
Prostatic fluid	40(12.71)
Blood	18(5.67)
Other	7(2.39)

Table 3. Distribution of 312 cases of patients in departments

Departments	Cases	Composition ratio (%)	Source of specimen	Age
Intensive care unit	67	21.47	Purulent sputum	43~89
Neurosurgery	55	17.63	Purulent sputum and wound secretion	19~76
Respiration medcine	42	13.46	Purulent sputum	11~82
Dermatology	31	9.94	Wound secretion	15~45
Burn and Plastic Surgery	26	8.33	Wound secretion	2~68
Orthopaedics department	22	7.05	Wound secretion	11~69

Table 4. MRSA department distribution and composition rate (%)

Department	2007	2008	2009	2010	2011	Total	
						Strains	Composition rate
Stomatology department	0	1	0	0	0	1	0.5
ENT department	0	0	0	0	1	1	0.5
Neurosurgery department	10	7	1	8	19	45	20.7
Cardiothoracic surgery department	3	2	0	0	0	5	2.3
Orthopaedics department	6	2	3	2	5	18	8.5
Urinary surgery department	1	2	1	0	1	5	2.3
Hepatobiliary surgery department	0	0	0	1	0	1	0.5
General surgery department	3	5	1	4	7	20	9.2
Oncological surgery department	1	1	0	1	4	7	3.2
Cardiology department	1	0	0	1	0	2	0.9
Nephrology department	0	2	1	1	4	8	3.7
Digestive system department	0	1	1	0	0	2	0.9
Neurology department	5	8	2	2	0	17	7.8
Respiration medicine department	4	3	0	0	1	8	3.7
Medical oncology department	2	2	1	3	5	13	5.9
Pediatrics department	0	3	1	1	4	9	4.1
ICU	20	16	0	2	17	55	25.3
Total	56	55	12	26	68	217	100.0

increasing year by year and constituent ratio of MRSA is also increasing. It can be seen from Table 2 that 312 strains of MRSA specimen mainly come from wound secretion and followed by phlegm and prostate fluid. Blood infection is less. Table 3 shows that 312 cases of MRSA patients are mainly distributed in intensive care unit, neurosurgery, respiratory medicine, dermatology, burns orthopaedic and orthopaedics. Detection rate of intensive care unit is the highest and respiratory tract infection is most common; secondary is neurosurgery and respiratory medicine in which respiratory tract infection is most common; skin infection is most common in dermatologist and burns orthopaedic; operative incision infection is most common in orthopaedics and thoracic surgery. Department distribution: top three department of MRSA strains amount is brain surgery, pediatrics and general surgery, which account for 46.1% (Table 1).

Specimen distribution: sputum and pharyngeal swab are the main resource of MRSA strains, which is 209 strains and accounts for 49.6%. Followed by incision, wound secretion and genitourinary tract specimens.

Drug resistance rate and transition of SAU on common antibiotic: drug resistance of penicillin is 94.0%~ 95.5% which is the highest in three years and followed by erythrocin which is 57.6% ~ 68.7%; 0.5% of nitrofurantoin, 1.2% of rifampicin and 7.9% of moxifloxacin is of low drug resistance; drug resistance rate of vancomycin and linezolid is 0.0%; compared with 2012 and 2010, drug resistance rate of clindamycin show upward trend and drug resistance of oxacillin, gentamicin, levofloxacin and erythrocin are downward.

Result of Drug Resistance

Drug resistance rate of 312 strains of MRSA is lowest towards vancomycin. So far, we have not found MR-SA which is drug resistance towards vancomycin. Followed by cotrimoxazole whose drug resistance is 17.6% and rifampicin whose rate is 40.96%. Drug resistance rate of other antibiotic is more than 801 % (Table 3).

DISCUSSION

It can be seen from clinical specimen distribution of MRSA that MRSA infection site of 312 cases of patients is most common in wound infection. Detection rate of wound secretion is 50.0%, which is related to large doses of antibiotic;

followed by respiratory tract infection and detection rate of sputum specimen is 29.23%; detection rate of prostatic fluid is 12.71%; blood infection is rare and whose detection rate is 5.67%. MASA are mainly distributed in intensive care unit, neurosurgery, respiratory medicine, dermatology, burns orthopaedic and orthopaedics department. Infection rate of intensive care unit is the highest and respiratory tract infections are primary. It is caused by low immunity, difficulty of sputum excretion, reflux and aspiration of gastric content that are induced by protopathy. Invasive procedure such as using breathing machine, statistic or dynamic vein intubation. Indwelling catheter intubation and tracheotomy also increase the risk of spread MRSA. And repeated applications of antibiotics and hormones are also important reason. Approach of MRSA infection of other departments is very widely and respiratory tract infection is most common. Followed by wound secretion, prostatic fluid and so on. In view of age level, patients of <20 and >50 account for 65.0%. Infant and aged have weak immunity and organism resistivity. The aged often have underlying disease such as respiratory disease, cardiovascular disease and endocrine diseases. More serious the underlying disease is, the weaker resistivity is and easier to infect MRSA. Young and middle aged patients aged from 20 to 50 account for 34.98% and most are infected of skin, wound and operative incision, which is related to large doses of antibiotic. And people of this age with underlying disease are uncommon.

External drug resistance experience of 17 kinds of antibacterial agents towards MASA show that MASA is multi-drug resistance. Besides vancomycin, cotrimoxazole and rifampicin, drug resistance rate of MRSA on other antibiotic are all more than 80%, among which drug resistance rate of ampicillin, amoxicillin/ clavulanic acid, cefalotin, cefazolin, tienam, oxacillin, penicillin and tetracycline are 100% and that of clindamycin, cefotaxime, clarithromycin and gentamicin are more than 90%. MRSA not only drug resistent to cephalosporins and other β-lactamsnut also to aminoglycosides, macrolide, lincomycin and tetracycline. Comparison with Gao Junfa's report: drug resistance of cefotaxime, ciprofloxacin, erythrocin, gentamicin is low (drug resistance of these drugs were 100% in Gao Junfa's report) and are approaching drug resistance rate of other drugs. Compared with Zeng Jun's report, besides vancomycin, drug resistance of other drugs are high. Therefore, clinician should pay high attention to drug resistance monitoring of MRSA and avoid utilization of cephalosporins and other ²-lactams for fear of induced drug resistance that leads to cure failure. So far, it was reported that sensitivity of vancomycin towards MRSA is downward because of increase of MRSA infection. VISA has appeared in Japan and America. And China has also reported drug resistance strain. Three years drug resistance monitoring of our hospital found that MRSA is 100% of drug resistance to vancomycin, 17.6% to cotrimoxazole and 40.96% to rifampicin. Vancomycin shows a strong antimicrobial activity to MRSA. Once vancomycin is invalid to MRSA, then MRSA infection may become a pathogenic disease that can not be cured and induce outbreak. Therefore, it should be strictly controlled and use it only when other antibiotic are all drug resistant to prevent MRSA have resistance to drug. Cotrimoxazole ia oral drug which is slow to absorb and only can be applied in moderate infection. Rifampicin has a good antibacterial activity to MRSA and its toxic and side effect is lower than vancomycin. Therefore, take rifampicin to alternate or assist vancomycin treatment can reduce utilization of vancomycin.

According to NCCLS documents, MRSA may show activity to cephalosporins or other β-lactams such as amoxicillin/clavulanic acid, ampicillin/sulbactam, ticarcillin/ clavulanic acid, piperacillin/ tazobactam and imipenem but have no clinical curative effect. Result of this research also hints that MRSA is multi-drug resistant. Therefore, providing drug resistance result of MASA for clinic timely and accurately and monitoring drug resistance situation of MRSA can not only guild clinical rational drug use but also control and slow down drug resistance of bacteria to antibiotic and extend service life of antibiotic.

CONCLUSION

Conclusion of this research is that: MRSA accounts for a high ratio and invasive therapeutic measure should be reduced as possible in clinic. Use antimicrobial agents rationally to prevent and reduce MRSA; strengthen monitoring of MRSA:

Once find MRSA infection cases in carriers and infectors who are detected in early stage, use clear identity and implement standard isolation measure; Hand washing and hygiene is specially emphasized for it can effectively hamper the spread and prevalent of MRSA inpatient area and prevent and control occurrence and outbreak of hospital infection.

REFERENCES

1. Zhang Ruifeng, Wan Huanying. Risk factor analysis of community-acquired MRSA infection and planting. *Chinese J of Nosocomiology*, 2008, **18**(7): 938-940.
2. Gao Yulu, Ma Xiaoling, Fu Guanglin, et al. Risk factor analysis of hospital infection methicillin-resistant staphylococcus aureus. *Chinese J of Nosocomiology*. 2009, **19**(6): 683_685.
3. Shu Ming. Risk factor analysis of hospital MRSA infection. *Chinese J of infection control*, 2010; **9**(3):160-163.
4. Xing Zhiguang, Sun Wenxuan, Zhou Weiqiang, et al. Isolation and identification and drug resistance monitoring of staphylococcus. *Chinese J of Nosocomiology*, 2007; **17**(7):881-884.
5. CLSI.M100-S21.Performance standards for antimicrobial suscep-tibility testing.*Wayne, PA: CLSI*, 2011.
6. Gosbell IB. Epidemiology, clinical features and management of in-fections due to community methicillin resistant Staphylococcus au-reus (cMRSA). *Int Med J*, 2005; **35**(Suppl 2): S120-S135.
7. Gupta V, Datta P, ani H, et al. Inducible clindamycin resistance in Staphylococcus aureus: a study from North India. *J Postgrad Med*, 2009, 55(3): 176 -279.
8. Shinabarger D. Mechanism of action of the oxazolidinone antibacterial agent. *Expert Opin Investig Drugs*, 1999; **8**(8): 1195-1202.
9. Memmi G, Filipe SR, Pinho MG, et al. Staphylococcus aureus PBP4 Is Essential for B_Lactam Resistance in Community Acquired Me-thicillin Resistant Strains. *Antimicrob Agents Chemother*, 2008; **52**(11): 3955- 3966.
10. Schmitz FJ, Krey A, Sadurski R, et al. Resistance to tetracycline and distribution of tetracycline resistance genes in European Staphy-lococcus aureus isolates. *J Antimicrobil Chemother*, 2001, 47(2): 239-240.
11. Skold O.Resistance to trimethoprim and sulfonamides. *Vet Res*, 2001, 32(3-4): 261-273.