Methicillin-resistant Staphylococcus aureus (MRSA) in pregnancy: epidemiology, clinical syndromes, management, prevention, and infection control in the peripartum and post-partum periods.

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1) The Impact of New Strains of MRSA Acquired in the Community on the Care of Pregnant Women and Their Neonates

The spread of strains of MRSA acquired in the community (commonly known as CAMRSA) has been extensively reported in the U.S. and abroad (1). The predominant CAMRSA genotype in the US, known as CDC USA300, is strongly associated with skin and soft tissue infections (2); outbreaks are commonly associated with conditions of crowding, compromised skin, contaminated fomites, close contact, and lack of cleanliness (3). These "5 Cs" are present in many settings and populations such as prisons, football teams, naval ships, military recruits, homeless persons, and men who have sex with men (4). Most purulent skin and soft tissue infections seen in emergency room settings are now caused by MRSA (2). Epidemiologic studies have indicated a national prevalence rate of MRSA nasal carriage of 0.8%, half of which have genetic features consistent with CAMRSA strains (5).

Healthcare-associated MRSA is well described in neonatal intensive care, but community-associated MRSA is emerging in pregnant women and healthy term infants. Labor and delivery is the most second most common discharge diagnosis in the US at just over 4 million births per year (6). In addition, antepartum hospitalizations for pregnancy complications occur at a rate of 15-25 hospital admissions for every 100 deliveries (7). Preliminary data for 2005 show that 12.7 % of infants are born prematurely (8). Implementing appropriate infection control measures in this large hospitalized population

represents a major challenge, as restriction of contact between mothers and infants is neither feasible nor desirable.

a) Infections Caused by CAMRSA in Women During Pregnancy and the Peripartum Period

i) Prevalence of colonization in pregnant women. Exposure to children in daycare (10), and and heterosexual transmission of CAMRSA (11) are additional potential sources of CAMRSA acquisition and infection for women of child-bearing age. Vaginal-rectal colonization rates have been studied in women undergoing culture for Group B streptococcal carriage, with an MRSA colonization rate of 0.43% found among 2,963 vaginal screening cultures (12), similar to reported rates of nasal colonization in general populations.

ii) Skin and soft tissue infections. Case series suggest that the clinical presentation of CAMRSA in pregnancy is similar to that among other patients, with a predominance of skin and soft tissue infections. Sites of infection include the extremities, buttocks, breasts, vulva or groin, abdomen, incision and urine (13). Key features of CAMRSA furunculosis are multiple and recurrent lesions with a necrotic appearance that patients often refer to as “spider bites". In fact, a history of a “spider bite” conferred an almost three-fold increase in the odds ratio of MRSA being isolated from the skin lesion in one study of patients presenting to emergency departments with skin and soft tissue infection (14).

iii) Post-partum infections Infections presenting after delivery include mastitis progressing to breast abscess, furunculosis, cellulitis, and wound infection (15). In one case, an infected episiotomy site appeared to be the source of septic pelvic thrombophlebitis and septic pulmonary emboli, with wound, blood and sputum cultures all positive for MRSA with a community genotype (16).

iv) Other infections: CAMRSA has been reported to cause a number of serious and occasionally fatal infectious syndromes: necrotizing pneumonia, pleural empyema, necrotizing fasciitis, myositis, and severe sepsis with purpura fulminans and the Waterhouse-Friderichsen syndrome. Bacteremia, endocarditis, septic arthritis and osteomyelitis are also seen (11). Although not yet reported specifically in pregnant women, clinicians should be aware of these syndromes caused by MRSA and initiate appropriate testing and treatment. Influenza vaccination should be offered to all women who will be pregnant at any time in the influenza season, especially in view of recent reports of post- influenza necrotizing staphylococcal pneumonia.

b) Infections Caused by MRSA in Neonates:

i) Healthy newborns: Clusters of MRSA infections have been described in healthy newborns before or shortly after discharge from the hospital including pustulosis, especially involving the groin and perineal areas, omphalitis, otitis externa, preseptal cellulitis, and IV site infection (18,19). A more extended series of 61 cases of MRSA

found a preponderance of skin and soft tissue infections, but bacteremia, osteomyelitis, myositis, empyema, urinary tract infection, and one death were also reported. Maternal skin infection was noted in 21% of the records of infants with MRSA (20). Risk factors for neonatal MRSA infection in a study of two outbreaks in a well-infant nursery included longer length of stay and circumcision (21). While this study suspected that poor infection control practices surrounding circumcision were an issue, a meta-analysis of published outbreaks has suggested that the disruption of mucosal and epithelial barriers during circumcision might play a role in the predominance of males and circumcised males in reported outbreaks of CAMRSA among neonates (22).

ii) Neonates in ICUs Multiple outbreaks of MRSA have been reported from neonatal ICUs from the era prior to the emergence of CAMRSA (23) and more recently (24). Neonates are at risk of severe invasive disease from MRSA, including sepsis and death. Infection control recommendations for neonatal ICUs are summarized below (section 5). Optimal infection control management in neonatal ICUs includes the management of visiting parents known to be MRSA-colonized (see below, section 5).

2) Optimal Management of MRSA Infections in Pregnant and Peripartum Women

a) Treatment of Skin and Soft Tissue Infections

i) Surgical drainage, where possible, is the most effective intervention for purulent skin and soft tissue infection (26). A multistate study of outcomes in skin and soft tissue infections showed that almost all patients had complete resolution of lesions two weeks after an emergency room visit, regardless of whether they received antimicrobials to which the organism was susceptible. Incision and drainage was performed in 85% of these cases (15).

ii) Culture of purulent material is essential to identify those patients with MRSA and inform antimicrobial choices (25). Initial drug selection should be informed by local antibiograms, but susceptibilities should always be reviewed, as resistance may emerge in individual patients after multiple courses of therapy. Broader-spectrum resistance is now emerging in some communities (26).

iii) Antibiotic therapy should be reserved for those cases of skin and soft tissue infection where there are systemic signs and symptoms, extensive cellulitis, or underlying disease such as diabetes and immunodeficiency (11). The number of oral antimicrobials available for treatment in pregnancy is limited. Inducible resistance to clindamycin has significant geographic variability. In addition, clinicians should be aware of instances of fulminant, severe Clostridium-difficile-related colitis arising in persons at low risk, including pregnant women, and monitor patients carefully for diarrhea (25).

iv) Vancomycin administered parenterally in adequate doses is the drug of choice for severe infections caused by MRSA. Consultation is advised in cases of severe infection to ensure adequate dosing and duration of therapy, especially if newer agents need to be considered.

b) Behavioral Interventions to Minimize Recurrence of Staphylococcal Skin and Soft Tissue Infections

i) Recurring CAMRSA skin and soft tissue infections are a common problem which requires a comprehensive behavioral approach, as repeated courses of antimicrobials and attempts at staphylococcal decolonization are often not helpful. One study of incarcerated women showed that meticulous hygiene with several showers daily, avoidance of shared personal items and contaminated laundry, and frequent hand hygiene significantly reduced MRSA infections (28). Staphylococcal carriage is increased by the presence of exfoliative skin disorders, obesity, poor hygiene and contact with contaminated fomites, and invasive infection is promoted by skin trauma, including microtrauma induced by shaving and irritation induced by friction.

ii) All pregnant patients with recurrent skin infections should be counseled in the following behavioral interventions to prevent recurrence:

- Avoid all skin trauma such as tattooing and piercing
- Stop any body shaving-clippers could be used if necessary
- Avoid sweating: multiple showers per day are recommended in hot weather
- Obtain treatment of any underlying dermatologic conditions such eczema, psoriasis, or candida intertrigo
- Perform frequent hand hygiene throughout the day
- Avoid of excessive weight gain in pregnancy • Control diabetes adequately
- Wear loose clothing in non-occlusive fabrics to avoid sweating and frictio
- Wash clothes frequently and dry with a hot dryer
- Wash sheets and towels frequently
- Do not share personal items such as towels, razors, makeup or creams

c) The Use and Limitations of Decolonization for MRSA In Pregnant Women

i) Decolonization is most likely to be successful if the following conditions are met:

- The patient’s skin is fully intact with all lesions fully healed and no exfoliative dermatitis present.
- The patient is not returning to an endemic environment such as prison.
- Family members are free of active lesions.
- The patient is able to comply with hygiene and laundry requirements and agrees to cease all body shaving.

ii) Sample decolonization protocol:

- Mupirocin nasal ointment applied according to manufacturer’s instructions twice daily for 5 days (Pregnancy Class B)
- Shower and shampoo with chlorhexidine 4% soap for first three days of decolonization regimen, avoiding contact with mucus

membranes (Pregnancy Class B)
• Wash all bedding, towels and clothes at beginning of decolonization regimen.

iii) Assessing for persistent colonization Repeat nasal swabs should be obtained and screened with a selective medium or polymerase chain reaction-based test one to two weeks after completion of the decolonization protocol. If the patient is persistently colonized, reinfection may have occurred, persistence at other body sites may be present, compliance with the protocol may have been poor, or mupirocin resistance may be present. Consultation should be sought before decolonization is attempted again.

iv) Caveats regarding decolonization. Large scale decolonization programs should not proceed without expert guidance from infection control and laboratory regarding of testing of prevalent strains for mupirocin susceptibility. Rates of mupirocin resistance are not insignificant in some studies (29).

3) Infection Control Procedures for Pregnant and Peripartum Women with MRSA in Ambulatory and Inpatient Settings.

a) The Risk Assessment for MRSA in Peripartum Settings

i) All infection control activities should be informed by an infection control risk assessment which is based on surveillance data and consideration of the populations involved (30). Risk assessment for MRSA in peripartum settings should include the results of infection rates with MRSA in the neonatal ICU, any cases of MRSA infection occurring in healthy newborns, and nosocomial infection rates by organism among peripartum women. Infection rates in women undergoing caesarian section should be followed, with adequate post-discharge surveillance for this and other infections attributable to the hospitalization.

ii) Women with comorbid conditions such as HIV or other serious medical illness may be at higher risk of MRSA colonization due to prior healthcare contact, and this should be included in the risk assessment for institutions providing perinatal care for these populations.

b) Identification of Women with MRSA Colonization

i) Active surveillance screening for MRSA among women admitted to hospital for labor and delivery is not currently recommended by any infection control authorities. Major initiatives to eliminate the transmission of MRSA in healthcare settings have been proposed and are underway in many institutions (31,32,33). These initiatives do not specifically include or exclude women in perinatal care from active screening, but the evidence base from which they derive is not based in perinatal populations. Lengths of stay in labor and delivery are brief. Depending on the screening test used, results of an admission screen might not be available in time to institute contact precautions for most of the patient’s stay (34). If standard measures are failing per ongoing risk assessment,

however, a close examination of practices is recommended, and institution of additional measures such as active screening should be considered (9).

ii) Women with MRSA infections should be identified in the pre and peripartum period by clinical culture. Staff awareness of the manifestations of CAMRSA and need for clinical cultures is essential. Chart flagging methods, whether paper or electronic, should be used to alert the hospital staff and infection control practitioners when patients who have had a positive culture for MRSA are admitted to the hospital for prenatal care or labor and delivery. Although the duration of persistence of CAMRSA strains is not known, data on nosocomial strains indicate that the average persistence of MRSA in patients readmitted to the hospital is 6-8 months (35), making it likely that women identified in the prenatal period will still be positive at the time of readmission for delivery. Systems should be developed to ensure that such patients are hospitalized with contact precautions instituted promptly upon admission.

c) Contact Precautions for Prenatal and Peripartum Inpatients with MRSA

i) Outpatient settings: CDC guidelines for control of multidrug-resistant organisms (MDROs) in outpatient settings state that Standard Precautions (36) should be used for patients known to be infected of colonized with target MDROs, making sure that gowns and gloves are used for contact with uncontrolled secretions and draining wounds (9). Hand hygiene with alcohol gel can also be encouraged for patients entering clinics and procedures developed for cleaning shared equipment and surfaces.

ii) Inpatient settings: when admitted to the hospital, patients with MRSA should be placed in private rooms. Cohorting MRSA-positive patients together in the case of peripartum care is problematic, since many centers now use “rooming in” of healthy newborns with mothers and cross-contamination could occur in this setting.

(1) Hand hygiene before every patient encounter and after each contact or after removing gloves is required. Compliance may be facilitated through liberal placement of alcohol-based disinfectant and observation and feedback of hand hygiene rates to staff (37).

(2) Donning gown and gloves on entry to rooms of patients in contact precautions is mandatory (34). Adequate supplies, waste receptacles and disposal must be provided.

(3) Gowns and gloves should not be worn in public areas.

(4) Meticulous environmental cleaning in the rooms of patients in contact isolation should include wiping of all horizontal surfaces with disinfectant daily.

(5) For patients in the labor and delivery suite, contact precautions should be maintained throughout the pre-op, operating room and recovery areas (38).

4) Infection Control Procedures for Post-Partum Women with MRSA and Their Newborns

a) Healthy Term Neonates in Nnewborn Nursery and "Rooming-In" Settings.

i) Strict adherence to hand hygiene is essential for all staff working in newborn nursery settings. In routine newborn nursery care, contact isolation for infants born to mothers with a history of MRSA colonization is not indicated. If the infant develops active skin infection, however, they should be cared for in contact precautions in a pediatric ward.

ii) Infants in the newborn nursery should be transported to the mother's room in a clean bassinet; the healthcare worker then performs hand hygiene, dons gown and gloves and places the infant in a different bassinet which is left in the mother's room.

iii) Infection control practitioners should help staff develop procedures for care of a mother together with her roomed-in newborn. A sample procedure could be:

• gown and glove on entering the shared room, which is a "contaminated zone",
• move from "clean" to "dirty" in areas of patient care,
• remove gloves and performing hand hygiene between patients
• remove the gown and donning a new one if it becomes soiled in the course of care

b) Neonates in ICUs or Special Care Nurseries

A consensus statement developed in response to multiple outbreaks recommended that the following evidence-based measures be implemented (39):

• Hand hygiene with ready availability of alcohol-based disinfectant and monitoring of compliance.
• Contact precautions with gowns and gloves worn for care of all infants with MRSA, and use of masks for all aerosol-generating procedures.
• Cohorting of MRSA-positive infants and their supplies should be implemented, with dedicated nursing as much as possible.
• Limitation of visitors.
• Periodic screening of infants for MRSA using nasal or nasopharyngeal swabs, weekly during outbreaks and less frequently after transmission has halted.
• Use of molecular analysis with pulsed-field gel electrophoresis or similar tool to assess relatedness of MRSA strains present.
• Cultures of healthcare workers or an environmental source should be undertaken only when epidemiologic analysis implicates them as a possible source

The above should be tailored to the risk assessment; if sporadic cases of MRSA colonization or infection continue occur in the neonatal ICU, weekly screening may be required to prevent outbreaks.

c) Special Considerations in Neonatal ICUs:

i) Multiple births with discordant MRSA status in neonatal ICU Parents visiting multiple infants with discordant MRSA status in the neonatal ICU should visit the non-colonized infant first, while following hand hygiene and gowning procedures per unit policy. In general, visitors to neonatal ICUs are asked to gown, but not glove.

ii) Visitation of parents known to be MRSA-colonized in neonatal ICUs MRSA-colonized parents should not be restricted from visitation. They should be encouraged to perform hand hygiene several times during their visit to prevent hand contamination from nasal contact.

iii) Management of expressed breast milk. MRSA has been isolated from expressed breast milk from a mother with mastitis (40). Breast milk obtained from MRSA-positive mothers with active mastitis should be discarded. Good hand hygiene should be encouraged in communal pumping areas and pumps cleaned routinely.

5) Infection Control in Labor and Delivery and Prevention of Surgical Site Infection in Women Known to be Colonized with MRSA

a) Post-Caesarean section infections in women colonized with MRSA can be minimized by the following:

- Skin preparation with a rapidly-active and fast-drying compound such as chlorhexidine-alcohol (in emergency settings, time may not permit full drying of some skin preps).
- Avoidance of hair removal by shaving
- Maintenance of normothermia during the operation
- Maintenance of glycemic control in the peri- and post-operative period
- Maintenance of good operating room procedures such as limitation of personnel present, closing doors, and effective cleaning procedures between cases
- Administration of a prophylactic antibiotic active against the patient's strain of MRSA, such as clindamycin 600 mg IV may be used (41)
- Surveillance and feedback of infection rates to surgeons and staff

b) Prevention of Other Post-Partum Infections

Good hand hygiene, breastfeeding or adequate pumping should be encouraged to prevent post-partum mastitis.

6) Discharge

Families can be counseled that MRSA colonization may persist for some time and that good hygiene in the household is necessary to prevent intrafamilial spread.

Patient education materials are available on the CDC, Wisconsin and Washington Department of Health websites (42,43,44).

Risks of superficial and invasive infection in infants known to be colonized at discharge or with potential exposure to MRSA should be discussed.

References

1. Grundmann H, Aires-de-Sousa M, Boyce J, Tiemersma E. Emergence and resurgence of meticillin-resistant Staphylococcus aureus as a public health threat. Lancet 2006: 368: 874-85.

2. Fridkin SK, Hageman JC, Morrison M, et al. Methicillin-resistant Staphylococcus aureus disease in three communities. N Engl J Med 2005; 352:1436–44.

3. Borlaug G, Davis JP, Fox BC. Wisconsin Department of Health. Community-associated methicillin-resistant Staphylococcus aureus (CA MRSA). Guidelines for clinical management and control of transmission, October 2005. Accessed on August 30, 2007 at http://dhfs.wisconsin.gov/communicable/resources/pdffiles/CAMRSAGuide_1105.pdf

4. Kazakova SV, Hageman JC, Matava M, Srinivasan A, Phelan L, Garfinkel B, et al. A clone of methicillin-resistant Staphylococcus aureus among professional football players. N Engl J Med 2005; 352:468-75.

5. Centers for Disease Control and Prevention. National Health and Nutrition Survey, accessed August 28, 2007 at http://www.cdc.gov/nchs/data/nhanes/nhanes_01_02/l35_b_doc.pdf]

6. Centers for Disease Control and Prevention, National Center for Health Statistics Table 9. Number and rates of discharges for short-day hospitals and of days of care with average length of stay by selected first-listed diagnostic categories: United States, 2004. Accessed on August 26, 2007. at http://www.cdc.gov/nchs/data/series/sr_13/sr13_162.pdf#table11 [

7. Bennett TA, Kotelchuck M, Cox CE, Tucker MJ, Nadeau DA. Pregnancy-associated hospitalizations in the United States in 1991 and 1992: a comprehensive view of maternal morbidity. Am J Obstet Gynecol 1998; 178: 346-54.

8. Hamilton BE, Martin JA, Ventura SJ. Births: preliminary data for 2005. Centers for Disease Control and Prevention, National Center for Healthcare Statistics, at: http://www.cdc.gov/nchs/products/pubs/pubd/hestats/prelimbirths05/prelimbirths05.htm, accessed August 26, 2007.

9. Siegel JD, Rhinehart E, Jackson M, Chiarello L, Healthcare Infection Control Practices Advisory Committee, Centers for Disease Control and Prevention. Management

of multidrug-resistant organisms in healthcare settings, 2006. Accessed on September 1, 2007 at http://www.cdc.gov/ncidod/dhqp/pdf/ar/mdroGuideline2006.pdf

10. Daum RS. Skin and soft-tissue infections caused by methicillin-resistant Staphylococcus aureus. N Engl J Med 2007; 357; 381-90.

11. Cook HA, Furuya EY, Larson E, Vasquez G, Lowy FD. Heterosexual transmission of community-associated methicillin-resistant Staphylococcus aureus. Clin Infect Dis 2007; 44: 410-13.

12. Chen KT, Huard RC, Della-Latta P, Saiman L. Prevalence of methicillin-sensitive and methicillin-resistant Staphylococcus aureus in pregnant women. Obstet Gynecol 2006; 108: 480-1.

13. Laibl VR, Sheffield JS, Roberts S, McIntire D, Trevino, Wendel GD. Clinical presentation of community-acquired methicillin-resistant Staphylococcus aureus in pregnancy. Obstet Gynecol. 2006;106:461-5.

14. Moran GJ, Krishnadasan A, Gorwitz RJ, Fosheim GE, McDougal LK, Carey RB et al. Methicillin-resistant S. aureus infections among patients in the emergency department. N Engl J Med 2006;355:666-74.

15. Saiman L, O'Keefe M, Graham PL, Wu F, Saod-Salim B, Kreiswirth B, et al. Hospital Transmission of Community-Acquired Methicillin-Resistant Staphylococcus aureus among Postpartum Women. Clin Infect Dis 2003;37:1313-19.

16. Rotas M, McCalla S, Liu Chunhua, Minkoff H. Methicillin-resistant Staphylococcus aureus necrotizing pneumonia arising from an infected episiotomy site. Obstet Gynecol 2007;109:533-6. MMWR report.

17. Centers for Disease Control and Prevention. Severe Methicillin-Resistant Staphylococcus aureus Community-Acquired Pneumonia Associated with Influenza --- Louisiana and Georgia, December 2006--January 2007. Morbid Mortal Wkly Rep 2007; 56 (14): 325-9.

18. Centers for Disease Control and Prevention. Community-associated methicillin-resistant Staphylococcus aureus infection among healthy newgorns-Chicago and Los Angeles County, 2004. Morb Mortal Wkly Rep 2006;55:329-32.

19. Bratu S. Eramo A, Kopec R, Coughlin E, et al. Community-associated methicillin-resistant Staphylococcus aureus in hospital nursery and maternity units. Emerg Infect Dis 2005;11:808-13.

20. Fortunov RM, Hulten KG, Hammerman WA, Mason EO, Kaplan SL. Community-acquired Staphylococcus aureus infections in term and near-term previously healthy neonates. Pediatrics 2006;118:874-81.

21. Nguyen DM, Bancroft E, Mascola L, Guevara R, Yasuda L. Risk factors for neonatal methicillin-resistant Staphylococcus aureus infection in a well-infant nursery. Infect Control Hosp Epidemiol 2007;28:406-11.

22. Van Howe RS, Robson WLM. The possible role of circumcision in newborn outbreaks of community-associated methicillin-resistant Staphylococcus aureus. Clin Pediatrics 2007;46;356-8.

23. Haley RW, Cusion NB, Tenover FC et al. Eradication of endemic methicillin-resistant Staphylococcus aureus infections from a neonatal intensive care unit. J Infect Dis 1995;171:614-624.

24. Saiman L, Cronquist A, Wu F, et al. An outbreak of methicillin-resistant Staphylococcus aureus in a neonatal intensive care unit. Infect Control Hosp Epidemiol 2003; 24: 317-21.

25. Grayson LM. The treatment triangle for Staphylococcal infections. N Engl J Med 2006: 355: 724-7.

26. Graber, Wong MK, Carleton, Perdreasu-Reminton, Haller BL, Chambers HR. Intermediate vancomycin susceptibility in a community-associated MRSA clone. Emerg Infect Dis 2007; 13 (3); 491-3.

27. Centers for Disease Control and Prevention. Severe Clostridium difficile--Associated Disease in Populations Previously at Low Risk --- Four States, 2005. Morbid Mortal Wkly Rep 2005; 54(47):1201-5

28. Turabelidze G, Lin M, Wolkoff B, Dodson D, Gladbach S, Zhu B. Personal hygiene and methicillin-resistant Staphylococcus aureus infection. Emerg Infect Dis 2006; 12(3): 422-7.

29. Jones JC, Rogers TJ, Brookmeyer P, Dunne WM, Storch GA, Coopersmith CA, et al. Mupirocin resistance in patients colonized with methicillin-resistant Staphylococcus aureus in a surgical intensive care unit. Clin Infect Dis 2007; 45: 541-7.

30. The Joint Commission. 2007 Comprehensive Accreditation Manual for Hospitals. Available from www.jrinc.com.

31. Association of Professionals in Infection Control. Guide to the elimination of methicillin-resistant Staphylococcus aureus (MRSA) transmission in healthcare settings, 2007. Accessed on September 1,2007 at http://www.apic.org/Content/NavigationMenu/GovernmentAdvocacy/MethicillinResistantStaphylococcusAureusMRSA/Resources/MRSAguide.pdf

32. Institute for Healthcare Improvement. Reduce methicillin-resistant Staphylococcus aureus infections; getting started kit, 2007. Accessed September 1, 2007, at

http://www.ihi.org/IHI/Programs/Campaign/Campaign.htm?TabId=2#ReduceMethicillin-ResistantStaphylococcusAureus(MRSA)Infection

33. VHA Directive 2007-002 Methicillin-resistant Staphylococcus aureus (MRSA) Initiative . Accessed on September 1, 2007 at www1.va.gov/vhapublications/ViewPublication.asp?pub_ID=1525

34. Diekema DJ, Edmond MB. Look before you leap: active surveillance for multidrug-resistant organisms. Clin Infect Dis 2007: 44: 1101-7.

35. Scanvic A, Denic L, Gaillon S, Giry P, Andremont A, Lucet JC. Duration of colonization for methicillin-resistant Staphylococcus aureus after hospital discharge and risk factors for prolonged carriage. Clin Infect Dis 2001;32:1393-8.

36. Siegel JD, Rhinehard E, Jackson M, Chiarello L and the Healthcare Infection Control Practices Advisory Committee. Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings 2007. Accessed on September 3, 2007 at http://www.cdc.gov/ncidod/dhqp/gl_isolation.html

37. Institute for Healthcare Improvement. How to Guide: Improving Hand Hygiene. Accessed on September 2, 2007, at http://www.ihi.org/IHI/Topics/CriticalCare/IntensiveCare/Tools/HowtoGuideImprovingHandHygiene.htm

38. Conner Always, Blanchard J, Burlingame B, Kleiner C, Pashley HS, Peterson C et al , Eds. Recommended practices for prevention of transmissible infections in the perioperative practice setting. In: Standards, Recommended Practices, and Guidelines. AORN Publications, Denver, Colorado, 2007.

39. Gerber SL, Jones RC, Scott MV, Price JS, Dworkin MS, Filippell MB et al. Management of outbreaks of methicillin-resistant Staphylococcus aureus infection in the neonatal intensive care unit: a consensus statement. Infect Control Hosp Epidemiol 2006: 27: 139-45.

40. Gastelum DT, Dassey D, Mascola L, Yasuda L. Transmission of community-associated methicillin-resistant Staphylococcus aureus from breast milk in the neonatal intensive care unit. Ped Infect Dis J 2005; 24: 1122-4.

41. Bratzler DW, Houck PM. Antimicrobial prophylaxis for surgery: a advisory statement from the national Surgical Infection Prevention project. Clin Infect Dis 2004; 38: 1706-13.

42. Centers for Disease Control and Prevention. Methicillin-resistant Staphylococcus aureus. Accessed September 3, 2007 at http://www.cdc.gov/ncidod/dhqp/ar_mrsa.html

43. Department of Health, Wisconsin. Patient information pamphlet. Accessed on August 30, 2007 at http://dhfs.wisconsin.gov/communicable/resources/pdffiles/CAMRSAPatientPamphlet.pdf

44. Dellit T, Duchin J, Hofmann J, Olson EG. Washington State Department of Health. Interim guidance for evaluation and management of community-associated methicillin-resistant Staphylococcus aureus skin and soft tissue infections in outpatient setting . Accessed on August 30, 2007 at http://www.doh.wa.gov/Topics/Antibiotics/MRSAInterim.htm