



MRSA infections related to Neonatal Surgeries

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ABSTRACT

MRSA (Methicillin resistant *Staphylococcus aureus* strain) which is a resistant and adamant variety of gram positive bacteria affecting large populations. Although there are number of pathogens causing serious life threatening diseases, why MRSA is given a special consideration because the lack of treatments. Currently antibiotics are the major weapon against bacteria, but in case of MRSA they are resistant towards almost all the antibiotics currently available. So researchers themselves have proven that the only solution against this dangerous pathogen is by preventing chances of incidence. Take preventive measures before it attacks us. Here we are exploring the chances of getting MRSA infections. There are lots of studies available on MRSA infections abundantly. So we selected a peculiar population ie neonates and our study is about MRSA infection in neonates, because they are the most vulnerable among all population. Neonates are our next generation and we have some responsibilities to keep them safe. The risk factors also vary from population to population according to their physical as well as biological characteristics. One factor which is common to all kind of population is infections associated with surgeries. So the chances of getting MRSA infection through a surgical wound is higher and it leads to a systemic infection also. In case of neonates these chances get doubled when compared to other population.

INTRODUCTION

Methicillin-resistant *Staphylococcus aureus* (MRSA) is a frequent source of infections affecting premature and critically ill infants in neonatal intensive care units (NICUs). MRSA remains a significant source of morbidity and mortality in the neonatal intensive care unit population. Newborns seem to be particularly vulnerable to colonization and infection with MRSA, and many studies have attempted to ascertain which risk factors might predispose certain infants to these outcomes. The first reported case of methicillin-resistant *Staphylococcus aureus* (MRSA) infection in a neonate was in the 1980s; from there MRSA has become a significant cause of neonatal morbidity. Very immature preterm infants are particularly susceptible to MRSA infections, and neonates with a birth weight (BW) < 1,500 g may account for approximately 80% of all cases of neonatal MRSA infections.¹

Early symptoms of MRSA infection in a newborn can include:

- ◆ a bump that is red, swollen, and hot
- ◆ a bump that is painful, possibly only when touched

- ◆ skin around a sore that is warm or hot
- ◆ a boil full of pus
- ◆ an abscess, which is a larger boil
- ◆ a sore that looks like a spider bite
- ◆ bumps under the skin that are swollen and hard
- ◆ a bump that does not heal
- ◆ and fever also

Complications of MRSA infection

MRSA is spread by contact. So, an infant could get MRSA by touching another person who has it on the skin. Or could get it by touching objects that have bacteria on them. MRSA is carried by about 2% of the population (or 2 in 100 people), although most of them aren't infected. MRSA usually starts as a skin infection that can appear anywhere on a child's body. However, if MRSA bacteria get further into the body, it can cause serious systemic problems. The bacteria can enter through any skin that is broken, such as a cut or scrape. But in depth, MRSA can cause a variety of

serious infections in the pediatric population including blood stream infections, skin and soft tissue infections (SSTIs), conjunctivitis, osteomyelitis, septic arthritis, endocarditis, surgical site infections, meningitis, brain abscesses, pneumonia, and respiratory tract infections etc.^{2,3,4}

Blood stream infections: Presence of bacteria in elsewhere in the body enters the blood stream and causes poisoning of entire body and that condition is called septicemia or blood stream infections. Newborn septicemia is a severe infection in an infant younger than 28 days old. A baby may become infected before birth if your amniotic fluid is infected. During delivery, the newborn may be exposed to an infection in the birth canal.

SSTIs: Skin and soft tissue infections (SSTIs) are clinical condition that involve microbial invasion of the layers of the skin and underlying soft tissues.

Osteomyelitis: It is an infection of the bone, a rare but serious condition.

Conjunctivitis: It is an inflammation or swelling of the conjunctiva.

Septic arthritis: It is an infection in the joint fluid (synovial fluid) and joint tissues.

Endocarditis: Bacterial endocarditis is an infection of the lining of the heart, including the valves.

Surgical site infections : A surgical site infection (SSI) is an infection that occurs after surgery in the part of the body where the surgery took place.

Meningitis : Meningitis is an inflammation of the protective membranes covering the brain and spinal cord.

Brain abscesses : A brain abscess is a collection of pus that develops in response to an infection or trauma.

Pneumonia : Pneumonia is an infection of the lungs with a range of possible causes. It can be a serious and life-threatening disease.

Respiratory tract infection (RTI) : It is defined as any infectious disease of the upper or lower respiratory tract.

So from the above discussed complications it is clear that MRSA infection is a serious clinical situation. Once it is entered in our body no antibiotics can save us. These are not only resistant against antibiotics, they can undergo mutation also. Why this study is relevant because MRSA infections are greatly on an increased mortality rate now days. The prevalence rate of this infection is not accountable because it depends up on various factors like, we should know basically about the endemic and epidemic status of the disease which also varies from time to time. A large outbreak of MRSA has the potential to turn into a pandemic condition, infecting and killing huge numbers of people. MRSA infection is a real concern, especially considering the infection can be fatal. The only thing we can do is to be aware of such conditions and avoid chances to get in to that.^{5,6}

Neonates are the most vulnerable population to nosocomial or HA-MRSA infection because they born in a hospital and these are the category of patients stays in a hospital with the lowest immunity. Neonates are exposed to *Staphylococcus aureus* shortly after birth and can become colonized quickly after contact with adult skin or their environment. Between 3070% of humans are carriers of *Staphylococcus aureus*, so neonates have a very high likelihood of exposure during the immediate period after

birth. Most common sites of colonization with *S. aureus* include the umbilical cord, skin, nasopharynx, and gastrointestinal tract. For MRSA, the nares and umbilicus are the most common sites of initial colonization in newborns.^{4,6}

Ways of transmission

1. Horizontal mode of transmission (from surroundings to individual)

2. Vertical mode of transmission (from parent to progeny)

Both ways are equally important in case of neonates. So let's move on to the details.^{7,8}

Horizontal or healthcare-associated transmission

Studies show that "Even a perfectly cleaned hand may cause MRSA infection". The complex patient care environment of a neonatal intensive care unit (NICU) may lead to MRSA transmission. Researchers have discovered that even if health workers had absolutely perfect hand hygiene, just one in every 100 contacts between a baby and a hospital worker could still result in a MRSA transmission. During the average nine days stay, an infant is likely to have about 250 contacts with NICU workers that carry high risk for MRSA transmission. While each contact is an opportunity for hygiene compliance, it is also potential for hygienic practices to break down.^{3,4}

So let's see how horizontal transmission takes place.

- ◆ One of the major chances of getting MRSA is through surgical infections. An open wound is the most vulnerable way to enter the bacteria systemically in to the body. So improperly sterilized surgical instruments, unhygienic environment in the OT and the unhygienic situations of healthcare professionals who all are performing and assisting the surgery can be a cause for the transmission.

- ◆ The medical supplies used for neonates like stethoscope, thermometers, Blood pressure machine, Fetal stethoscope, Baby scale, Self-inflating bag, oxygen mask, neonatal size Suction apparatus with suction tube, Infant stethoscope, Urinary catheter, Syringes and needles, IV tubing, Suture material for tear or episiotomy repair etc can be a source of MRSA transmission from outside.

- ◆ Negligence of NICU staffs in following good infection control practice like Bringing personal formats like mobile phones, watches, jewellery and other personal belongings inside the NICU, and not taking essential precautions while entering the NICU like wearing gloves, mask and gown Etc can bring a lot of chances for the transmission.

- ◆ Unhygienic hospital environment like bed changing and all (normally the bed unit in the NICU should be cleaned twice daily), so impairment to do so and improper sanitization of materials used, floors and walls in the NICU may cause transmission.

- ◆ Negligence in the regular sterilization of the whole NICU unit may also be a cause. If any central lines are present, then the chances will get doubled.

- ◆ Finally, transmission from the siblings and other relatives who will come and contact with infants can also be considered as a reason for horizontal transmission.

Vertical or Parent related transmission

The researchers, including *Infectious Diseases in Children*

Editorial Board Member C. Buddy Creech, MD, MPH, did a study on vertical transmission by using nasal and vaginal swabs of women at the time of enrollment and nasal swabs for both mother and child at delivery as well as the 2-month and 4-month visits to determine if the infant was colonized with *S. aureus*.^{5,6}

The researchers reported that methicillin-resistant *S. aureus* (MRSA) colonization occurred in 10% to 17% of mothers when they enrolled in the study. At 2 months of age, when infant MRSA colonization peaked, 20.9% of infants were colonized. The researchers concluded that maternal staphylococcal colonization at the time of study enrollment and at delivery did increase the chance of similar colonization of the infant at birth, at discharge, and at 2 and 4 months of age. Of colonized infants, researchers reported that only two infants developed normal staphylococcal disease.^{4,7}

According to the study results, 50 maternal-infant pairs had concurrent MRSA colonization: 70% shared isolates of the same pulsed-field type and 30% shared USA300 isolates. So the possibilities of maternal as well as paternal transmission of MRSA must be considered as a major concern. So let's go through the probabilities

◆ Vaginal carriage is significant in pregnant women. It is quite feasible that vaginal MRSA carriage predisposes newborns to colonization during the birthing process. The vaginal colonization rate of MRSA in pregnant women was 2.8%, which could allow them to act as reservoirs of MRSA with transmission to their offspring during delivery.

◆ Maternal MRSA chorioamnionitis associated with neonatal MRSA sepsis: clinical manifestation of MRSA infections may range from mild focal infections, such as conjunctivitis and skin and soft tissue infections, to more severe forms like toxic shock syndrome, and even invasive infections such as sepsis, necrotizing pneumonia, meningitis, endocarditis, osteomyelitis, liver abscesses, and urinary tract infections. chorioamnionitis is a common cause of maternal and neonatal illness and death.⁸

[Chorioamnionitis also known as intra-amniotic infection (IAI) is an inflammation of the fetal membranes (amion and chorion) due to a bacterial infection. And its adverse maternal and neonatal outcomes may be an early- onset neonatal sepsis and necrotizing enterocolitis]. [Neonatal sepsis is a type of neonatal infection and specifically refers to the presence in a newborn baby of a bacterial blood stream infection (BSI) such as meningitis, pneumonia, pyelonephritis, or gastroenteritis in the setting of fever.]^{5,6}

◆ A mother who had MRSA colonization of her nares and subsequently transmitted MRSA to three of her four quadruplets.

◆ Mothers have also been shown to vertically transmit MRSA to their infants via their breast milk. Breastfed infants had a greater chance of colonization may have been from MRSA colonization of the nipples, because of the fact that breast infections during lactation are typically caused by SA.

◆ Paternal transmission is also a possible chance of spreading MRSA. A father who is a reservoir of MRSA can transmit infection vertically through direct contact with their infants. So that also should consider.⁹

Risk factors regarding transmission of MRSA in new borns

The major reasons for the prevalence of MRSA are due to the poor hospital hygiene and negligence in the hospital infection control practices. Although MSSA infection is the most regularly finding one in hospitals as well as in communities than CA MRSA and HA MRSA, MSSA has a huge difference from these two.

- Prolonged hospital stay
- Presence of dermatitis, skin infections or any other skin lesions or Osteomyelitis
- After paediatric surgical procedures
- Prior use of antibiotics like aminoglycoside and clindamycin in mother
- Prematurity and younger gestational age
- Low birth weight has been shown to be associated with increased risk of MRSA colonization and/or infection
- Feeding methods, including gavage feedings and parenteral feedings, have also been associated with higher risk of MRSA
- Simultaneous MRSA colonization in patients admitted in the same ward or unit
- If the treatment of any bacterial infection with the empirical antibiotics goes wrong, that will also generate MRSA or any other MDR strains.
- Presence of any central lines
- A variety of procedures and devices that neonates in NICUs often require during their hospital stay are also associated with increased risk of MRSA, including endotracheal tube intubation and mechanical ventilation, percutaneous central venous catheterization etc.^{9,10}

However, there are chances of getting MRSA infection in such places also. Because bacteria can enter more easily through a surgical lesion, enter into the body and cause infections systemically which is very serious? Since neonates are the most vulnerable category, treating a systemic infection would be very difficult and it will increase the morbidity and mortality as well. Even in an OT chances of MRSA transmission is present what would be the conditions of other places.^{7,9}

So first let's consider some neonatal surgical conditions that are commonly done and then we can go into details of chances of MRSA transmission and ways to amend such situations.¹¹

Common surgical procedures in Neonates

There are two categories of problems in neonates which require surgical procedures in its early stages

- ◆ Congenital health problems- these are health problems that occur while a baby is developing.
- ◆ Acquired Health Problems - these are health problems that occur in children after they are born.^{10,11}

These are some of the most commonly done surgeries in newborn babies

Hernia Repair, Hydrocele Surgery, Undescended Testes,

Tongue Tie Correction: Appendectomy, Congenital defects, Gallbladder surgery, Reproductive defects, GERD treatment, Abnormal pathways: Imperforate anus: Removal of diseased intestines, Bowed chest, Gallbladder surgery, Biliary atresia, Gastroschisis repair, Circumcision etc.

Orthopedic surgeries are a special category which is also very common in neonates now days, which includes congenital as well as acquired problems. Flail extremity, infection of bone and joints, brachial plexus palsy, fractures, metatarsus adducts, clubfoot, calcaneovalgus foot, congenital vertical talus, dysplasia of hip, congenital muscular torticollis, congenital pseudarthrosis of the clavicle, periosteal new bone are some of the difficult orthopedic conditions found in newborns.^{12,13,14}

Chances of MRSA transmission on or after surgeries

The surgical site infections are of 3 categories,

- It may be a superficial infection affected only the outer layer of skin.
- It may be a deep infection affecting the layers under skin like muscles and soft tissues.
- The infection may go deeper which involves organ or the space on where the surgery was done.

Although there are lots of studies available on MRSA related to surgical site infection in adults, the studies on neonates are very few. But even from the limited number of articles we referred, we could find some of the risk factors that would become reasons for MRSA infection after neonatal surgeries. Since neonates are highly immune compromised population preoperative as well as post-operative surgical procedures might be done with utmost care. But the chances to get infections are not negligible. And the negligence result minimum in prolonged hospital stay, increased hospital cost etc and at maximum death of the patient even.¹⁵

When we consider adult other pediatric age group the risk factors include age, presence of diabetes, malnutrition, co morbidities, risk indices, patient fragility, prior infection, blood lose during surgery etc. In case of neonatal surgeries although there are so many general factors to be considered, but the factors associated with certain disciplines of surgeries are more important. Cardio vascular surgery, gastrointestinal surgery, neuro surgery, orthopedic surgeries are those disciplines showing more rate of transmission. Among them abdominal or gastrointestinal surgeries are more prominent. Because GIT itself is a better space for colonization and it contains normal flora also. Exposure time of surgical part and the total time required for the operation will also affect the infection.¹⁴

For example,

1. Skin and soft tissue infections (SSTIs) are a common complication of MRSA infection. Most of the SSTIs are easily treatable and self-limited but some are life threatening also. Impetigo (both bullous and non-bullous), folliculitis, cellulitis, abscess are some common ones. Life threatening SSTIs are beta haemolytic streptococcus gangrene, myonecrosis and necrotizing fasciitis. So many patients were experienced critical tissue loses and undergone reconstructing cosmetic surgeries to regain their lives. SSTIs can be caused by so many pathogens but MRSA is the most common among them. It is of 3 types uncomplicated, nonnecrotizing complicated, necrotizing fasciitis highly complicated. It involves the microbial invasion of the layers of the skin and under lying soft tissues. There are several means by

which bacteria penetrate into the skin barrier. The common route is through a break in the barrier. Thus Surgical incisions are a best way for the invasion. Patients of post-operative surgery are more prone to SSTIs than others. According to a Canadian Neonatal Surgery Network an overall 15% incidence of SSI related to MRSA was reported in infants with gastroschisis who underwent immediate (<6 h after birth) or delayed closure. For this reason, to reduce time of visceral exposure, the authorities have proposed the gastroschisis sutureless closure, as it is also associated with a reduced risk of SSI

2. Post-operative MRSA infection can lead to considerable morbidity and mortality in orthopedic patients also. Chances are 2 times than that of colonized patients and 9 times higher than that of non-colonized patients. In orthopedic surgeries the implants used for surgical support can be a site for biofilm formation. Then it will be difficult to treat this infection. Orthopedic implants arise resistance towards antibiotic and infection becomes long term morbidity. The occurrence of infection can be reduced by suppressive therapies and elective surgical methods. But that also not effective against MRSA. Once the implant or surgical sites get the bacteria it will prolong the infection and develop a persistent antibiotic resistant. That means patient will suffer long term morbidities.

3. Laparotomy for congenital abdominal wall defects, necrotizing enterocolitis, or congenital bowel obstruction is a rare but needed surgery in neonates with any malformity of abdomen during birth. It is a kind of open surgery which demands large incisions to perform the procedure, unlike laparoscopy which needs only a key hole space in the surgical site. The exposure time of surgical site in an opened condition will increase the chances of infection. Since abdomen is a best location for bacterial colonization the chances will get double. This surgical procedure is known to compromise the integrity of the gastrointestinal tract and to potentially result in bacterial translocation.

So when we spread out the factors based on their riskiness it would be like^{11,15,16}

Surgery related factors

- a. Type of surgery done whether it is open or closed
- b. Site where surgery is done
- c. Time of exposure of surgical site
- d. Total surgery time
- e. Complexity of surgery (requirement of any additional procedures)
- f. Methods of surgery adapted
- g. Sterility of instruments used
- h. Environment of surgical unit
- i. Hygienity of surgeon and people who assist surgery.
- j. Preoperative prophylaxis with antibiotics and patient related factors
- k. Prematurity of baby and gestational age
- l. Low immunity
- m. Low birth weight
- n. Prior infections of mother
- o. Gender of baby

p. Post operative caring of baby

“The awareness about these risk factors will generate actions against their prevention”. So next in our study we are going to discuss about the preventive measures we have to be taken to eradicate MRSA transmission. And these preventive measures are based on some basic guidelines followed by hospitals.

CONCLUSION

The Methicillin resistant staphylococcus infections were common as an endemic disease, gradually it became an epidemic one, and now it's going to be a pandemic explosion. The level of MRSA infected people are increasing day by day around the world. The current active guidelines of our infection control measures have failed in front of this dangerous pathogen. In India the incidence of MRSA varies from 25% in its northern areas and 50% in its southern areas. Indian network for surveillance of antimicrobial resistance (INSAR) in coordination with WHO performs studies and researches based on the progressing of this situation on regular basis. But it is not sufficient to prevent the pathogen from spreading to more and more communities. In our study we are discussing about the MRSA infection in a special population that is in neonates. Since they are the future generation of our world we have some responsibilities towards them and we have to keep our generation safe and healthy. So through our study we are trying to aware people about the various aspects of MRSA infection in neonates.

We hope our study will be an enlightening path towards this goal.

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