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QUESTION 2: Does placement of patients with an infection in private hospital rooms decrease the risk of subsequent surgical site infection/periprosthetic joint infection (SSI/PJI) for patients undergoing orthopaedic procedures?

RECOMMENDATION: There is some evidence to suggest that isolation of patients who are carriers of or are infected with methicillin-resistant *Staphylococcus aureus* (MRSA) in private rooms, as well as observing isolation protocols, reduces the rate of hospital-acquired infections. Patient isolation and contact precaution measures also play a key role in controlling outbreaks due to other multi-drug resistant organisms such as vancomycin-resistant enterococci (VRE), *E. coli*, *Klebsiella*, *Acinetobacter*, *Pseudomonas* and others. The issue of whether placing orthopaedic patients with an active infection in private rooms has any effect on the rate of PJI for other patients has not been examined.

LEVEL OF EVIDENCE: Limited

DELEGATE VOTE: Agree: 88%, Disagree: 5%, Abstain: 7% (Super Majority, Strong Consensus)

RATIONALE

SSIs are a disastrous complication in orthopaedic surgery, which overburden the healthcare systems by adding to patient morbidity, mortality and cost of treatment. Approximately 50% of SSIs can be prevented by following evidence-based strategies recommended for their prevention [1]. *Staphylococcus aureus* is the most common organism isolated in orthopaedic SSI, accounting for approximately 30 to 40% of the cases in various series [2–4]. More importantly, the rising incidence of MRSA, which is reported to be present in 10 to 35% among orthopaedic SSIs in some series, is a matter of concern [2,5,6]. Multiple strategies have been recommended for prevention of SSIs including surgical hand preparation, surgical site preparation, perioperative antibiotic prophylaxis and multi-modal interventions for certain highly-resistant organisms, especially MRSA [7,8]. These multi-modal interventions, also called “bundles,” include preoperative screening of patients, isolation of carriers, contact precautions, decolonization and the judicial use of antibiotics. Bundles have been proven to be very effective in reducing rates of transmission from carriers and SSI caused by resistant organisms, especially MRSA [9], and prevention of outbreaks of other multi-drug resistant organisms (MDROs) such as VRE and extended spectrum beta lactamase (ESBL) producing organisms like *E. Coli*, *Klebsiella*, *Acenitobacter,* etc. [10]. In a study conducted over a period of 18 months involving multi-specialty surgical units of a Swiss teaching hospital, implementation of such infection control measures for MRSA led to extremely low levels of overall nosocomial MRSA infection rate at 0.77% (169 out of 21,754) [11].

Transmission of infection in a hospital occurs from patient to patient, through transiently-colonized healthcare workers, contact with contaminated surfaces and airborne dispersal. Isolation measures are fundamental to interrupt this transmission. The role of isolation of patients with active infection and those who are carriers for highly-resistant organisms in private rooms and its effect on the risk of subsequent SSI/PJI has been discussed in this review.

At the outset, it is important to understand whether colonization with these high-risk organisms increases the chances of subsequent SSI/PJIs. Several studies [12–14] have concluded that colonization with *S. aureus* and MRSA is an important risk factor for SSIs following orthopaedic surgeries. In a recent study involving 4,148 patients who underwent orthopaedic surgical interventions, Nakamura et al. [2] found that patients with nasal carriage of *S. aureus* had a significantly higher incidence of SSI (1.16%) as compared to non-carriers (0.39%). In a systematic review by Levy et al. [14] including five studies, they established that nasal carriage of *S. aureus* (including MRSA) is a major risk factor for orthopaedic SSIs. While this is true for infection with *S. aureus* and MRSA, a cause-effect relationship for SSI has not been established for colonization by other MDROs. This may be explained by the fact that the colonizing strains of these later organisms and those causing outbreak differ in their pathogenicity in causing SSIs and other hospital-acquired infections (HAIs) [15].

The second aspect is to determine the effectiveness of patient isolation in single rooms in reducing the risk of subsequent SSI/PJI. Since isolation strategies concomitantly include implementation of screening/surveillance techniques with or without decolonization, along with hand hygiene and contact precautions (such as use of separate gowns, gloves, etc.), it is difficult to determine the singular role of isolation separately.

We conducted a comprehensive literature search for studies evaluating the role of isolation of infected/colonized patients and the rates of SSI in patients undergoing orthopaedic surgeries. Most of these studies were pertaining to MRSA and involved multiple interventions (including surveillance, contact isolation, decolonization and antibiotic prophylaxis) for MRSA control. Out of 24 studies reviewed, 15 evaluating the efficacy of *S. aureus*/MRSA screening and decolonization were excluded because “patient isolation” was not specifically performed or mentioned. After reading the selected articles, nine studies [9,16–23] were chosen for this review, all of which provided conclusive evidence that multi-modal interventions were effective in decreasing SSI caused by MRSA. Analysis of combined data from these studies showed that MRSA control measures (including isolation) led to reduction in the rate of SSI from 1.14% (199 out of 17,457) to 0.38% (128 out of 33,328). In another prospective interventional study by Sankar et al. [24], patients undergoing hip or knee arthroplasty were subjected to pre-admission MRSA screening. Positive patients received topical decolonization therapy and their admission was postponed until three consecutive swabs from three body sites were negative. After application of this protocol, they found a significant reduction in the overall incidence of healthcare-associated infections (HAIs) (from 8.5% to 3.5%) and mean length of hospital stay (from 10.43 days to 9.47 days).

In the latest World Health Organization (WHO) guidelines for prevention of SSI, it has strongly recommended that patients undergoing orthopaedic surgery who are nasal carriers of *S. aureus* should be decolonized with intranasal mupirocin 2% ointment, with or without chlorhexidine gluconate body wash [7]. Similarly, in a systematic review of preventive measures for healthcare-associated infections by MRSA, Kock et al. [25] concluded that mupirocin-based decolonization therapy should be considered for *S. aureus* carriers who are undergoing orthopaedic surgery.

To achieve optimal impact, these isolation measures should be implemented along with hand hygiene, education of healthcare workers and rational use of antibiotics. In fact, in a prospective study by Spence at al. [26] where all patients were housed in single rooms and good hand hygiene

practices were followed, it was found that following additional “contact precautions” for asymptomatic MRSA carriers had no effect on rate of hospital-acquired MRSA infections and was relatively expensive.

Many countries have introduced strict guidelines as part of nationwide policies in order to reduce the rates of HAIs, especially those caused by resistant organisms such as MRSA. The “search and destroy” policy, which has been implemented in countries like the Netherlands, Belgium, Germany and Sweden to control and maintain low endemic levels of MRSA, includes screening of patients on admission for MRSA, contact isolation of MRSA-positive patients in single rooms, pre-emptive isolation and screening of high-risk patients, decolonization and follow-up screening, healthcare worker screening and suspension from work until decontamination is achieved [27]. Likewise, implementation of a “search and isolate” strategy in a region hyper-endemic for MRSA has been reported to cause significant reduction in MRSA bacteremia from 0.64 to 0.30 per 1,000 admissions [28].

Active surveillance cultures (ASC), which involves the universal screening of all patients whether or not they exhibit signs or symptoms of infection in order to detect infected as well as colonized patients, have proven to be effective in controlling the spread of MRSA and VRE [29]. However, the Association for Professionals in Infection Control and Epidemiology (APIC) and Society for Healthcare Epidemiology of America (SHEA) do not support legislative mandates for use of ASC [30]. “Targeted surveillance” based on patients’ risk factors is almost equally as effective and more cost-efficient as compared to universal screening [31]. Various risk factors for MRSA colonization include previous hospitalization or surgery, previous therapy with quinolones or cephalosporins, advanced age, dialysis, underlying chronic illness, residency in long-term-care facility, eczema or psoriasis, history of promiscuity or prison, pressure sores and intravenous drug abuse [32].

Although adequate literature has been published on MRSA, very few studies have evaluated the role of isolating patients infected with other MDROs like VRE, ESBLs (*E. coli* and *Klebsiella*), multi-drug resistant *Acenitobacter* and *Pseudomonas*, etc. in preventing SSI. These organisms become increasingly significant in the intensive care unit (ICU) setting rather than the ward setting. Contact precautions and patient isolation have proven to be the cornerstones of the control measures to be undertaken during an outbreak [33], but the role of routine isolation of patients who are carriers of these MDROs in preventing SSIs and other HAIs is unknown. It has been suggested that the outbreak strains of these MDROs may be different from the colonising strains in terms of transmissibility and capacity to survive on epithelial surfaces [15]. *Acenitobacter* species is an increasingly important source of nosocomial infection in recent years accounting for up to 20% of SSIs following orthopaedic surgeries [3] and is capable of causing other HAIs such as pneumonia, meningitis and bacteremia [34]. Gogou et al. [35] reported an outbreak of MDR (carbapenem-resistant*) Acenitobacter baumanii* in the orthopaedic ward with 29 cases reported within 2 years despite strict control measures, eventually requiring relocation of the department. The ability of the organism to contaminate and survive in the environment such as traction table, wash basins, suction drains, catheters, etc. has been highlighted in the study as causing difficulty in eradication. Such reports serve as a reminder for implementation of immediate control measures on identification of such MDROs. As per the guidelines of the US Healthcare Infection Control Practices Advisory Committee, full contact precautions (including admission to a single patient room, wearing a gown and gloves for all interactions involving contact with patient and discarding them before exiting the patient room) should be followed to prevent the transmission of these MDROs during outbreaks [10]. Avoidance of overcrowding and understaffing and routine environmental cleaning has shown to reduce transmission of MDROs [36–38]. While isolation strategies appear to have a definite role in preventing the outbreak of these organisms, the effect of their routine application on reducing orthopaedic SSI/PJI is not clearly defined.

In a recent study involving 2,255 arthroplasty patients, Navalkele et al. [39] concluded that recent respiratory tract infections (within 30 days prior to surgery) increased the risk of SSI. In another systematic review and meta-analysis of risk factors for PJI, Zhu et al. [40] found no significant association between urinary tract infection (UTI) and risk of PJI. Although the role of contact isolation in cases of infections other than those caused by MDROs such as UTI, respiratory tract infections, skin infections etc. has not been studied, it is a general protocol at many centers to keep such patients isolated from other patients undergoing elective orthopaedic procedures.

Another strategy that has given beneficial results by advocating isolation of patients is the concept of a “ring-fenced” orthopaedic center. This has been followed in the United Kingdom (UK), and involves the creation of separate wards where only patients undergoing clean, elective orthopaedic surgeries are admitted. It excludes admission of patients with known or suspected infection, patients colonized with MDROs, patients with chronic wounds or abscess, patients with active chest infection, patients undergoing bowel surgery and patients with long-term indwelling devices who are requiring antibiotic treatment at the time of admission. We found three studies (two prospective and one combined prospective and retrospective) in which ring-fencing of elective orthopaedic wards was implemented [21–23] . Combined analysis of data from these 3 studies show that ring-fencing was effective in decreasing the rate of SSI from 1.31% (57 out of 4,347) to 0.35% (32 out of 9,230). In a study in the UK, Barlow et al. [21] found that creation of a dedicated arthroplasty ward resulted in a decrease in the incidence of SSI and reduction in mean length of hospital stay amongst patients undergoing primary lower limb arthroplasty.

Although placement of patients in single rooms provides infection control benefits, it has not been proven by studies conducted either in the ICU setting or outbreak situation [41–45]. In a review article by van de Glind et al. [46], the authors could not find an association between single patient rooms and reduced infection rates. Various studies have cited negative effects of isolation including anxiety, depression and negative impacts on patient care, safety and satisfaction [47–49]. However, in a recent prospective survey by Chittick et al. [50], the majority of patients in contact isolation were happy with the privacy, felt safe and were satisfied with the quality of care. Adequate education of patient and care-giver at the time of isolation plays an important role in minimizing these adverse effects.

In a systematic review analyzing the cost-benefit of infection control interventions targeting MRSA, Farbman et al. [51] found a median save/cost ratio of 7.16 with 15 out of 18 studies showing a favorable cost/benefit ratio. Higher benefits were observed in intermediate to highly-endemic settings.

Due to lack of well-designed studies which precisely define the exclusive role of isolation of infected patients in preventing surgical site infection and heterogeneity of data in the available studies, a systematic meta-analysis on this question was not possible. Nonetheless, there is definitive evidence of the beneficial role of isolation (along with other interventions) in preventing MRSA SSI.

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