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AN OVERVIEW OF THE ORIGINS, CURRENT SITUATION, AND METHODS OF MANAGING HOSPITAL-ACQUIRED INFECTIONS

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ABSTRACT

Nosocomial infections, often called hospital-acquired infections, refer to new infections that patients acquire while staying in a healthcare facility. These infections are not present or developing at the time of admission but are contracted within the hospital environment during the patient's stay. The transmission of nosocomial infections commonly happens through several pathways, including contact with healthcare personnel, contaminated surfaces or equipment, interactions between patients, or due to invasive medical procedures. These infections can affect various parts of the body, with frequent sites being the bloodstream, respiratory system (such as the lungs), urinary tract, and surgical wounds. Patients undergoing medical treatments or surgeries are particularly vulnerable to these infections due to weakened immune systems or breaks in the skin's natural barriers resulting from surgical incisions or invasive procedures. While numerous types of bacteria can cause nosocomial infections, a major concern is the emergence of multidrug-resistant pathogens (MDR). These bacteria have developed resistance to multiple antimicrobial drugs, making them challenging to treat using standard antibiotics. The rise of MDR organisms in hospitals poses a significant threat to patient health. Treating infections caused by these bacteria becomes more difficult, leading to prolonged illnesses, increased healthcare expenses, and, in severe cases, higher mortality rates. Preventing nosocomial infections involves strict infection control measures within healthcare settings. This includes implementing rigorous hygiene protocols, proper handwashing practices, sterilizing

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medical equipment, following aseptic techniques during invasive procedures, and using antibiotics judiciously to minimize the development of antimicrobial resistance. A nosocomial infection, also termed a "hospital-acquired infection," encompasses infections that develop in a patient within a hospital or healthcare facility, which were not initially present or developing at the time of admission. This definition covers infections acquired during the hospital stay, even if they manifest after the patient has been discharged, and also includes infections contracted by the facility's staff during their work. Moreover, continuous surveillance, monitoring, and ongoing research into effective infection prevention strategies are essential to curb the spread of nosocomial infections and combat the growing threat of multidrug-resistant pathogens in healthcare facilities.

Keywords: Hospital-Acquired Infection, Infection, Control, Challenges.

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INTRODUCTION

Nosocomial infections, commonly referred to as hospital-acquired infections, are new infections that individuals acquire during their stay in a healthcare facility. These infections are contracted within the hospital environment and are not present or incubating at the time of admission. The transmission of nosocomial infections typically occurs through various routes, including contact with healthcare workers, contaminated surfaces or equipment, interactions between patients, or as a result of invasive medical procedures or interventions. These infections can affect various parts of the body, with the most frequent sites being the bloodstream, respiratory system (lungs), urinary tract, and surgical wounds. Patients undergoing medical treatments or surgeries are particularly vulnerable to developing these infections due to weakened immune systems or breaks in the skin's natural barriers from surgical incisions or invasive procedures. While a wide range of bacteria can lead to nosocomial infections, an alarming concern is the rise of multidrug-resistant pathogens (MDR) causing such infections. Multidrug-resistant bacteria have developed resistance to multiple antimicrobial agents, making them challenging to treat with standard antibiotics. This growing incidence of MDR organisms in hospitals poses a significant threat to patient health, as treating infections caused by these bacteria becomes more difficult, leading to prolonged illnesses, increased healthcare costs, and in severe cases, higher mortality rates. Preventing nosocomial infections involves stringent infection control measures within healthcare settings. This includes implementing strict hygiene protocols, proper handwashing practices, sterilization of medical equipment, adhering to aseptic techniques during invasive procedures, and judicious use of antibiotics to reduce the development of antimicrobial resistance. A nosocomial infection, also known as a "hospital-acquired infection," refers to an infection developing in a patient within a hospital or healthcare facility, which was not initially present or developing at the time of admission. This encompasses infections acquired during the hospital stay, even if they emerge after the patient has been discharged, and also includes infections contracted by the facility's staff in the course of their work. Additionally, surveillance, monitoring, and ongoing research into effective infection prevention strategies are crucial in mitigating the spread of nosocomial infections and combating the rise of multidrug-resistant pathogens in healthcare facilities.

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WORLDWIDE PERSPECTIVE OF HOSPITAL-ACQUIRED INFECTION

The healthcare system is predominantly intervention-focused, with minimal emphasis on analyzing or reviewing outcomes. Challenges in maintaining infection control programs stem from various factors including inadequate basic resources (such as gloves and handwashing facilities), insufficient administrative support, limited resources, overcrowding, understaffing, and a lack of comprehensive staff knowledge regarding infection control practices. The future poses an impending challenge with an aging population experiencing higher co-morbidities, notably diabetes, compounded by drug-resistant infections. Over recent years, there has been a notable surge in Healthcare-Associated Infections (HAIs) among patients in India. The rise in these infections is attributed to non-compliance with infection control guidelines, inadequate hand hygiene, outdated technology usage, improper or excessive antibiotic administration, among other reasons. These infections significantly contribute to morbidity, mortality, and create a heightened financial burden on patients and the healthcare system. Implementing and adhering to stringent infection control guidelines, alongside preventive measures aimed at countering bacterial resistance rather than relying solely on antibiotics for treatment, would be pivotal in reducing the disease burden. Research findings, such as those extracted from a meta-analysis sponsored by the World Health Organization in 2010, shed light on the prevalence of healthcare-associated infections in India. The prevalence was notably higher than that reported in Europe and the USA, with adult intensive-care units displaying a significantly elevated density of healthcare-associated infections compared to developed countries. Surgical-site infections were prevalent, surpassing rates in developed nations, particularly among surgical procedures. Gram-negative bacilli were the predominant nosocomial isolates, and reports on antimicrobial resistance were relatively scarce. At a national level, statistics from acute care hospitals indicated a statistically significant reduction (ranging from 4-18%) in rates of certain healthcare-associated infections such as Central Line-Associated Bloodstream Infections (CLABSI), Catheter-Associated Urinary Tract Infections (CAUTI), and Surgical Site Infections (SSI) following colon surgeries and hospital-onset C. difficile infections between 2018 and 2019. However, rates remained relatively stable in other areas like SSI following abdominal hysterectomies or hospital-onset MRSA (Methicillin-resistant Staphylococcus aureus) bacteremia, with a slight increase in Ventilator-Associated Events (VAEs).

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INDIAN PERSPECTIVE OF HOSPITAL-ACQUIRED INFECTION

In India, the prevalence of Healthcare-Associated Infections (HAIs) exceeds that of Western countries, presenting a concerning statistic of one infection per four hospital visits, as compared to one in ten for a European country and one in twenty for the United States, as reported by Daily Rounds. The contributing factors to this higher prevalence are multifaceted and include overcrowded hospitals, inadequate infrastructure, poor adherence to basic hygiene practices, a low ratio of healthcare professionals to patients, improper usage of invasive medical devices, excessive and inappropriate use of antibiotics, and insufficient enforcement of regulations within healthcare facilities. These factors collectively contribute to the incidence of nosocomial infections and associated fatalities in India.

Of particular concern is the significantly elevated rate of vancomycin-resistant enterococcus (VRE) infections in Indian Intensive Care Units (ICUs), reported to be five times higher than the global average. VRE represents a dangerous type of HAI where bacteria have developed resistance, particularly against antibiotics like Vancomycin. Additionally, the rates of methicillin-resistant Staphylococcus aureus (MRSA) are alarmingly high, with studies indicating over 80 percent of S. aureus samples testing positive for resistance against methicillin and closely related antibiotics.

An extensive study highlighted the incidence rates of various healthcare-associated infections within adult ICUs in India. This study reported a rate of 7.92 central line-associated bloodstream infections per 1,000 central line-days, 10.6 catheter-associated urinary tract infections per 1,000 urinary catheter-days, and a rate of 10.4 ventilator-associated pneumonia cases per 1,000 mechanical ventilator-days. These high rates are indicative of the prevailing ICU environment across hospitals in India, suggesting a concerning trend in healthcare settings in the country.
In the HAI Hospital Prevalence Survey, it was found that approximately 1 in 31 hospitalized patients had at least one healthcare-associated infection (HAI) on any given day. Comparatively, patients surveyed in 2015 were approximately 16% less likely to have an HAI compared to patients in the 2011 survey. Specifically, around 3% of hospitalized patients in the 2015 survey were identified to have one or more HAIs. The survey estimated that there were approximately 687,000 HAIs reported in U.S. acute care hospitals in 2015. Tragically, among patients who acquired HAIs during their hospitalizations, about 72,000 succumbed to these infections,

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leading to fatal outcomes during their hospital stays. These figures underscore the significant impact and severity of HAIs within hospital settings, emphasizing the need for continued efforts in infection prevention and control measures to mitigate the occurrence and consequences of such infections.

HEALTHCARE-LINKED INFECTIONS IN ECONOMICALLY DEVELOPING NATIONS

Limited and often substandard data characterize the available information on health care-associated infections (HAIs) in low- and middle-income countries. However, recent analysis conducted by the World Health Organization (WHO) revealed a higher occurrence of HAIs in resource-constrained settings compared to developed nations. In low- and middle-income countries, the prevalence of HAIs fluctuates between 5.7% and 19.1%. The average prevalence is notably elevated in studies of higher quality compared to lower-quality research, indicating rates of 15.5% versus 8.5%, respectively. Within intensive care units (ICUs), the proportion of patients acquiring infections ranges widely from 4.4% to 88.9%. The frequency of overall infections can soar to 42.7 episodes per 1000 patient days, nearly three times higher than that reported in high-income nations. Particularly concerning is the significantly elevated rates of infections linked to the usage of central lines, ventilators, and other invasive devices, reaching up to 19 times higher than those observed in Germany and the USA in some developing countries. Newborns face increased vulnerability in these resource-limited regions, with infection rates ranging 3-20 times higher than those in high-income countries. Disturbingly, among babies born in hospitals in developing countries, HAIs account for 4% to 56% of all neonatal deaths, and as high as 75% in regions like South-East Asia and Sub-Saharan Africa. Surgical site infections (SSIs) emerge as the primary infection affecting the general patient population in countries with limited resources. They impact up to two-thirds of patients who undergo surgery, with frequencies up to nine times higher than observed in developed countries. These findings highlight the significant burden of HAIs in low- and middle-income countries, underscoring the urgent need for enhanced infection prevention and control measures in these healthcare settings.

CATEGORIES OF HOSPITAL-ACQUIRED INFECTIONS

Healthcare-associated infections (HAIs) encompass various types of infections contracted within medical facilities.

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Central line-associated bloodstream infections: This refers to laboratory-confirmed bloodstream infections that occur within 48 hours of the insertion of a central line. It's distinguished from infections originating elsewhere in the body. A central line is a catheter placed into a large vein, often in the neck, chest, or groin, used for administering medications or fluids. Infections related to these lines can lead to severe bloodstream infections if not managed properly.

Catheter-associated urinary tract infection (CAUTI): This occurs as a urinary tract infection in a patient who has had an indwelling catheter in place for at least 48 hours before the onset of the infection. Indwelling catheters are tubes placed into the bladder through the urethra to drain urine. Infections related to these catheters can cause urinary tract infections if proper care is not taken, leading to discomfort and complications.

Ventilator-associated pneumonia: This type of pneumonia develops more than 48 hours after a patient has been intubated and placed on mechanical ventilation. Ventilators assist patients in breathing. Pneumonia in these cases can occur due to bacteria entering the lungs through the breathing tube, posing a significant risk to patients already in critical condition.

Surgical site infections: These infections manifest within 30 days after surgery, affecting the incision or deep tissue at the site of operation. Any surgery carries a risk of infection at the incision site. These infections can vary in severity, ranging from superficial infections to deeper tissue involvement, potentially leading to complications.

Clostridium difficile infections: This bacterium causes gastroenteritis, specifically known as antibiotic-associated diarrhea, affecting the large intestine. Clostridium difficile infections often result from antibiotic use, disrupting the normal balance of gut bacteria and causing severe diarrhea. These infections can be challenging to manage and can lead to serious complications.

Overall, healthcare-associated infections pose a significant risk to patients in medical settings and require stringent preventive measures to minimize their occurrence and subsequent complications. Vigilant hygiene practices, infection control protocols, and proper device management are crucial in reducing the incidence of these infections.

VULNERABILITY INDICATORS OF HOSPITAL-ACQUIRED INFECTIONS

Risk factors contributing to healthcare-associated infections include: Prolonged And Inappropriate Use Of Invasive Devices And Antibiotics: Extended or improper use of invasive medical devices, such as catheters or ventilators, and antibiotics can create opportunities for infections to develop. Invasive devices may introduce pathogens into the body, while

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inappropriate antibiotic use can lead to antibiotic-resistant in Infections. High-Risk And Sophisticated Procedures: Certain medical procedures carry a higher risk of infection due to their complexity or invasiveness. These procedures might involve surgeries, organ transplants, or other intricate medical interventions that increase susceptibility to infections. Immuno-Suppression And Other Severe Underlying Patient Conditions: Patients with compromised immune systems or underlying severe medical conditions are more susceptible to infections. Conditions like HIV/AIDS, cancer, or autoimmune diseases weaken the body's defenses against pathogens. Insufficient Application Of Standard And Isolation Precautions: Failure to consistently apply standard infection control measures, such as hand hygiene, proper use of personal protective equipment, and isolation protocols for contagious patients, increases the risk of spreading infections within healthcare settings. Some Determinants Are More Specific To Settings With Limited Resources: Healthcare facilities with limited resources may face additional challenges in infection control due to inadequate funding, lack of essential medical supplies, or limited access to trained healthcare personnel. Inadequate Environmental Hygienic Conditions and Waste Disposal: Poor sanitation, unclean environments, and improper disposal of medical waste can harbor and spread infections within healthcare settings. Poor Infrastructure; Insufficient Equipment: Inadequate facilities and insufficient medical equipment can hinder infection control efforts, leading to increased risks of contamination and transmission of infections. Understaffing: Shortages in healthcare personnel can impact patient care and infection control measures, potentially leading to lapses in monitoring, treatment, or preventive practices. Overcrowding: Healthcare facilities that operate beyond their capacity might struggle to maintain adequate hygiene and control the spread of infections due to increased patient density. Poor Knowledge And Application Of Basic Infection Control Measures: Lack of awareness or training among healthcare staff regarding infection control protocols and best practices can contribute to the spread of infections. Lack Of Procedure; Lack Of Knowledge Of Injection And Blood Transfusion Safety: Absence or improper implementation of procedures for safe injections and blood transfusions can heighten the risk of transmitting infections through contaminated needles or blood products. Absence Of Local And National Guidelines And Policies: The absence or inadequate implementation of guidelines and policies at local and national levels can hinder standardized infection control practices, leading to variations in healthcare quality and safety standards across different settings. Each of these factors plays a role in exacerbating the risk of healthcare-associated infections, emphasizing the critical importance of comprehensive infection control measures and proper healthcare protocols to

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mitigate these risks and ensure patient safety.

CHALLENGES IN HOSPITAL INFECTION CONTROL

Hospital infection control is pivotal in safeguarding both patients and healthcare workers. However, numerous challenges persist in ensuring effective infection control measures: Passive Surveillance Systems: Many hospitals rely on passive surveillance systems that might not promptly detect emerging infections or outbreaks. These systems often lack real-time monitoring capabilities, delaying response and mitigation efforts. Inadequate Strategies for Outbreaks: Hospitals might lack appropriate strategies to contain and manage outbreaks effectively. This can lead to rapid spread and escalation of infections within healthcare settings. Outdated Control Programs: Infection control programs in some hospitals may be outdated, failing to keep pace with evolving pathogens, technologies, and best practices in infection prevention. Gram-Negative Bacteraemia in Developing Countries: Hospitals in developing nations face specific challenges related to managing fatal gram-negative infections due to resource limitations, infrastructure issues, and limited access to advanced treatments. Weak Microbiology Laboratory Support: The role of microbiology laboratories in identifying and controlling infections is vital. However, inadequacies in these facilities, such as lack of equipment, skilled personnel, or quality control, can hinder effective infection control. Unpreparedness for Unprecedented Crisis: Hospitals often lack preparedness for unexpected crises, such as the emergence of highly resistant pathogens, which can overwhelm existing healthcare systems and infection control protocols. Risks to Healthcare Workers: The inadequate availability or improper use of personal protective equipment (PPE) exposes healthcare workers to various infectious diseases, including tuberculosis, hepatitis, HIV, SARS, and hemorrhagic fevers, leading to occupational hazards. Inconsistent Application of Guidelines: There might be inconsistencies in implementing infection control guidelines due to varying interpretations, resource constraints, or a lack of awareness among healthcare staff.

Addressing these challenges requires a multi-faceted approach: Investment in Surveillance Technologies: Implementing advanced surveillance systems that enable real-time monitoring and data analysis for early detection of outbreaks. Updating Infection Control Programs: Regular review and update of infection control protocols and training healthcare staff accordingly. Enhancing Laboratory Infrastructure: Strengthening microbiology laboratories

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with advanced equipment, trained personnel, and quality assurance measures. Improving Preparedness: Developing and regularly practicing contingency plans for handling unprecedented crises and emerging pathogens. Ensuring Access to PPE: Adequate provision and proper utilization of personal protective equipment for healthcare workers. Promoting Guideline Adherence: Consistent training, monitoring, and reinforcement of infection control guidelines among healthcare staff. By addressing these challenges comprehensively, hospitals can significantly improve their infection control measures and better protect patients and healthcare workers.

NEW CHALLENGES IN INFECTION CONTROL

Increasing Immunocompromised Patients: The rising number of individuals with weakened immune systems poses challenges in implementing fundamental control measures to prevent opportunistic infections. Public Health System Capacity Concerns: There are apprehensions about the capability of public health systems to effectively manage potential disasters and health crises. High-Risk Procedures in Under-Equipped Facilities: Performing high-risk medical procedures in facilities lacking adequately trained staff, efficient laboratories, and necessary protective equipment raises concerns about infection transmission. Gene Therapy and Infectious Complications: The utilization of gene therapy brings forth concerns about potential infectious complications. The uneven development of infection control measures globally amplifies these concerns. Implementing Quality Assurance or Quality Control measures within healthcare sectors is critical in controlling nosocomial infections. Utilizing evidence-based management approaches becomes pivotal in combatting Hospital Acquired Infection Prevention And Control (IPC). This approach aims to prevent avoidable infections, ensuring the safety of both patients and healthcare workers. Effective IPC necessitates continual action across all levels of the healthcare system. This includes policymakers, facility managers, healthcare workers, and individuals accessing healthcare services. IPC holds a universal relevance in patient safety and quality of care. Inadequate IPC practices can cause harm and even fatalities. Achieving quality healthcare delivery becomes implausible without effective IPC measures in place.

CONCLUSION

In conclusion, infection prevention and control are integral to every facet of healthcare, encompassing areas such as hand hygiene, surgical site infections, injection safety,

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antimicrobial resistance, and the operational protocols hospitals adopt both during routine periods and in emergencies. To effectively combat healthcare-associated infections (HCAI), it's crucial to assess and understand the primary factors contributing to these infections. This evaluation serves as the cornerstone for implementing robust and comprehensive Infection Prevention and Control (IPC) policies. These policies are pivotal in halting the spread of preventable infections, serving as the frontline defense in the ongoing battle against healthcare-associated infections. By prioritizing IPC measures and enforcing relevant policies, healthcare facilities can significantly reduce the incidence of infections, thereby ensuring safer environments for both patients and healthcare workers.

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REFERENCES

1. Boev C, Kiss E. Hospital-Acquired Infections: Current Trends and Prevention. Crit Care Nurs Clin North Am. 2017 Mar;29(1):51-65.
2. Habboush Y, Yarrarapu SNS, Guzman N. StatPearls [Internet]. StatPearls Publishing; Treasure Island (FL): Sep 4, 2023. Infection Control.
3. Kalil AC, Metersky ML, Klompas M, Muscedere J, Sweeney DA, Palmer LB, Napolitano LM, O'Grady NP, Bartlett JG, Carratalà J, El Solh AA, Ewig S, Fey PD, File TM, Restrepo MI, Roberts JA, Waterer GW, Cruse P, Knight SL, Brozek JL. Management of Adults With Hospital-acquired and Ventilator-associated Pneumonia: 2016 Clinical Practice Guidelines by the Infectious Diseases Society of America and the American Thoracic Society. Clin Infect Dis. 2016 Sep 01;63(5):e61-e111.
4. Cillóniz C, Dominedò C, Torres A. An overview of guidelines for the management of hospital-acquired and ventilator-associated pneumonia caused by multidrug-resistant Gram-negative bacteria. Curr Opin Infect Dis. 2019 Dec;32(6):656-662.
5. Sydnor ER, Perl TM. Hospital epidemiology and infection control in acute-care settings. Clin Microbiol Rev. 2011 Jan;24(1):141-73.
6. Metersky ML, Kalil AC. New guidelines for nosocomial pneumonia. Curr Opin Pulm Med. 2017 May;23(3):211-217.
7. Stiller A, Schröder C, Gropmann A, Schwab F, Behnke M, Geffers C, Sunder W, Holzhausen J, Gastmeier P. ICU ward design and nosocomial infection rates: a cross-sectional study in Germany. J Hosp Infect. 2017 Jan;95(1):71-75.
8. Novosad SA, Fike L, Dudeck MA, Allen-Bridson K, Edwards JR, Edens C, Sinkowitz-Cochran R, Powell K, Kuhar D. Pathogens causing central-line-associated bloodstream infections in acute-care hospitals-United States, 2011-2017. Infect Control Hosp Epidemiol. 2020 Mar;41(3):313-319.
9. Flores-Mireles A, Hreha TN, Hunstad DA. Pathophysiology, Treatment, and Prevention of Catheter-Associated Urinary Tract Infection. Top Spinal Cord Inj Rehabil. 2019 Summer;25(3):228-240.
10. Young PY, Khadaroo RG. Surgical site infections. Surg Clin North Am. 2014 Dec;94(6):1245-64.
11. Babcock HM, Zack JE, Garrison T, Trovillion E, Kollef MH, Fraser VJ. Ventilator-associated

DOI Link :: https://doi-ds.org/doilink/03.2024-47511779/UIJIR

pneumonia in a multi-hospital system: differences in microbiology by location. Infect Control Hosp Epidemiol. 2003 Nov;24(11):853-8.

12. Magill SS, Edwards JR, Bamberg W, Beldavs ZG, Dumyati G, Kainer MA, Lynfield R, Maloney M, McAllister-Hollod L, Nadle J, Ray SM, Thompson DL, Wilson LE, Fridkin SK., Emerging Infections Program Healthcare-Associated Infections and Antimicrobial Use Prevalence Survey Team. Multistate point-prevalence survey of health care-associated infections. N Engl J Med. 2014 Mar 27;370(13):1198-208. [

13. Hughes JM. Study on the efficacy of nosocomial infection control (SENIC Project): results and implications for the future. Chemotherapy. 1988;34(6):553-61.

14. Eze P, Balsells E, Kyaw MH, Nair H. Risk factors for *Clostridium difficile* infections - an overview of the evidence base and challenges in data synthesis. J Glob Health. 2017 Jun;7(1):010417.

15. Nickel JC, Costerton JW. Bacterial biofilms and catheters: A key to understanding bacterial strategies in catheter-associated urinary tract infection. Can J Infect Dis. 1992 Sep;3(5):261-7.

16. Bell T, O'Grady NP. Prevention of Central Line-Associated Bloodstream Infections. Infect Dis Clin North Am. 2017 Sep;31(3):551-559.

17. Patel AR, Patel AR, Singh S, Singh S, Khawaja I. Central Line Catheters and Associated Complications: A Review. Cureus. 2019 May 22;11(5):e4717.

18. Serra-Burriel M, Keys M, Campillo-Artero C, Agodi A, Barchitta M, Gikas A, Palos C, López-Casasnovas G. Impact of multi-drug resistant bacteria on economic and clinical outcomes of healthcare-associated infections in adults: Systematic review and meta-analysis. PLoS One. 2020;15(1):e0227139

19. Magiorakos AP, Srinivasan A, Carey RB, Carmeli Y, Falagas ME, Giske CG, Harbarth S, Hindler JF, Kahlmeter G, Olsson-Liljequist B, Paterson DL, Rice LB, Stelling J, Struelens MJ, Vatopoulos A, Weber JT, Monnet DL. Multidrug-resistant, extensively drug-resistant and pandrug-resistant bacteria: an international expert proposal for interim standard definitions for acquired resistance. Clin Microbiol Infect. 2012 Mar;18(3):268-81.

20. Kalil AC, Metersky ML, Klompas M, Muscedere J, Sweeney DA, Palmer LB, Napolitano LM, O'Grady NP, Bartlett JG, Carratalà J, El Solh AA, Ewig S, Fey PD, File TM, Restrepo MI, Roberts JA, Waterer GW, Cruse P, Knight SL, Brozek JL. Executive Summary: Management of Adults With Hospital-acquired and Ventilator-associated Pneumonia: 2016 Clinical Practice Guidelines by the Infectious Diseases Society of America and the American Thoracic Society. Clin Infect Dis. 2016 Sep 01;63(5):575-82

DOI Link :: https://doi-ds.org/doilink/03.2024-47511779/UIJIR

21. Miller SE, Maragakis LL. Central line-associated bloodstream infection prevention. Curr Opin Infect Dis. 2012 Aug;25(4):412-22.

22. Mermel LA, Allon M, Bouza E, Craven DE, Flynn P, O'Grady NP, Raad II, Rijnders BJ, Sherertz RJ, Warren DK. Clinical practice guidelines for the diagnosis and management of intravascular catheter-related infection: 2009 Update by the Infectious Diseases Society of America. Clin Infect Dis. 2009 Jul 01;49(1):1-45

23. Al Momani LA, Abughanimeh O, Boonpheng B, Gabriel JG, Young M. Fidaxomicin vs Vancomycin for the Treatment of a First Episode of Clostridium Difficile Infection: A Meta-analysis and Systematic Review. Cureus. 2018 Jun 11;10(6):e2778

24. Furuya EY, Cohen B, Jia H, Larson EL. Long-Term Impact of Universal Contact Precautions on Rates of Multidrug-Resistant Organisms in ICUs: A Comparative Effectiveness Study. Infect Control Hosp Epidemiol. 2018 May;39(5):534-540.

25. Danna DM. Hospital Costs Associated with Sepsis Compared with Other Medical Conditions. Crit Care Nurs Clin North Am. 2018 Sep;30(3):389-398.

DOI Link :: https://doi-ds.org/doilink/03.2024-47511779/UIJIR