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The Role of Nurse-Surgeons in Advancing Global Surgical Care: Challenges and Contributions in Care after Open Heart Operations with a Focus on Biochemical Markers

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Abstract

Background: Congenital heart disease (CHD) surgeries are complex procedures that require the collaboration of multidisciplinary teams, including nurse-surgeons, to ensure optimal patient outcomes. Postoperative care, particularly in the realm of wound healing and infection control, plays a pivotal role in the recovery process following open heart surgery. Nursing interventions, which include aseptic techniques, wound care, and patient education, are integral to minimizing postoperative complications such as surgical site infections (SSIs) and promoting effective healing.

Aim: This study explores the impact of nurse-surgeons' interventions in the postoperative care of CHD patients, focusing on the efficacy of nursing practices in improving wound healing outcomes and preventing SSIs after open heart surgeries.

Methods: A retrospective analysis was conducted on a cohort of patients who underwent CHD surgeries. Two groups were analyzed: an intervention group, where enhanced nursing interventions were applied, and a control group, where standard postoperative care was provided. Key nursing interventions included the application of aseptic techniques, meticulous wound monitoring, and patient education on post-discharge care. The efficacy of these interventions was evaluated by comparing wound healing outcomes across the two groups, using a standardized grading system for wound recovery.

Results: The study found significant differences between the groups. The intervention group showed a higher incidence of Grade A wound healing, indicating optimal recovery without complications, at 73.3%, compared to 30% in the control group ($p < 0.01$). The incidence of Grade B complications (seroma or hematoma without suppuration) was also lower in the intervention group (26.7%) compared to the control group (58.3%) ($p < 0.01$). Notably, the control group had a 11.7% incidence of Grade C wound healing (requiring drainage), while no cases were observed in the intervention group ($p < 0.05$).

Conclusion: The results highlight the critical role of nurse-surgeons in advancing surgical care, particularly in the postoperative management of patients undergoing open heart surgery. The enhanced nursing interventions were associated with better wound healing outcomes, fewer complications, and a more rapid recovery process. These findings underscore the importance of rigorous nursing protocols and patient education in improving postoperative recovery, emphasizing the need for standardized care approaches to optimize patient outcomes in global surgical settings.

Keywords: Nurse-surgeons, congenital heart disease, wound healing, surgical site infections, postoperative care, nursing interventions, open heart surgery..

Introduction:

For patients receiving care and treatment, pressure injuries (PIs) are a major and expensive medical concern [1]. Generally speaking, they are described as localized damage brought on by prolonged pressure on bony prominences or by medical devices interacting with deeper tissues and the

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skin, which compromises blood flow [2]. Longer hospital stays [3], lower quality of life [4], higher hospitalization expenses [5], and higher rates of morbidity and mortality [6] are all caused by PIs.

In the development of PIs, a number of risk factors need to be considered, including procedural factors like the type of anesthesia, surgery, and its duration, as well as patient-specific factors like age, gender, chronic conditions, and nutritional status [7-9]. Furthermore, non-patient-related elements including the location of heaters, operating tables, and surgical support equipment may also be important [8, 10–12]. Among these, pressure-raising surgical techniques are especially important. PIs are a common consequence of many surgical operations, and there is evidence that the amount of pressure applied during surgery, as well as the duration of that pressure, operate as stresses on tissues. Surgery-induced PIs are defined as those that arise from pressure during the procedure and happen within the first 24 hours after surgery [13]. According to published research, PIs connected to surgery may arise during the actual surgical operation or in the first hour [14], 72 hours [15], or even up to six days [16] following surgery. Both extrinsic and internal variables, such as immobility, pressure, shearing, and frictional forces, increase the risk of high-pressure injuries in intensive care settings, where critically ill patients may not respond appropriately to pressure warnings [17]. Notably, recent meta-analytical findings on PI incidence and prevalence [18] corroborate the notion that PI prevalence is much higher in intensive care facilities than in other healthcare settings. Moreover, PIs are more likely to develop in patients requiring critical care hospitalization following vascular or open heart procedures [19], and there is a significant correlation between the length of the procedure and the risk of PI development [20].

PIs are most frequent after heart surgery [1], and patients who have heart surgery are among the groups most at risk for developing PIs, with higher incidence of these injuries [9]. A major risk factor for skin degeneration is the surgery itself, according to the research currently under publication, which highlights PIs as important concomitant occurrences in heart surgery [1]. According to a systematic review, one of the main risk factors for the development of PI in patients having heart surgeries is the length of the surgery [9]. Research on PI development in patients after heart surgery is still scarce, despite the fact that this patient group is known to have a higher risk for PI, with many requiring critical care after surgery because of numerous circulation problems [11]. In healthcare settings, PI prevention is a crucial quality care metric, and nursing interventions are essential to prevention [21]. In order to lower the occurrence of PI, several preventive measures are essential [22]. The PI prevention process is shaped by national and international guidelines, which include risk and skin assessments, repositioning, addressing nutrition and hydration deficiencies, using protective creams and pressure redistribution devices, training caregivers, and efficient monitoring and documentation [23]. The intended decrease in PI incidence is still elusive even after prevention measures have been put in place in general intensive care units. The need for specialized therapies for this particular cohort is shown by the greater frequency of PIs in cardiac surgery intensive care patients [24] when compared to other ICU patients. Evidence-based strategies for lowering and preventing PIs in patients having open heart surgery are presented in the literature

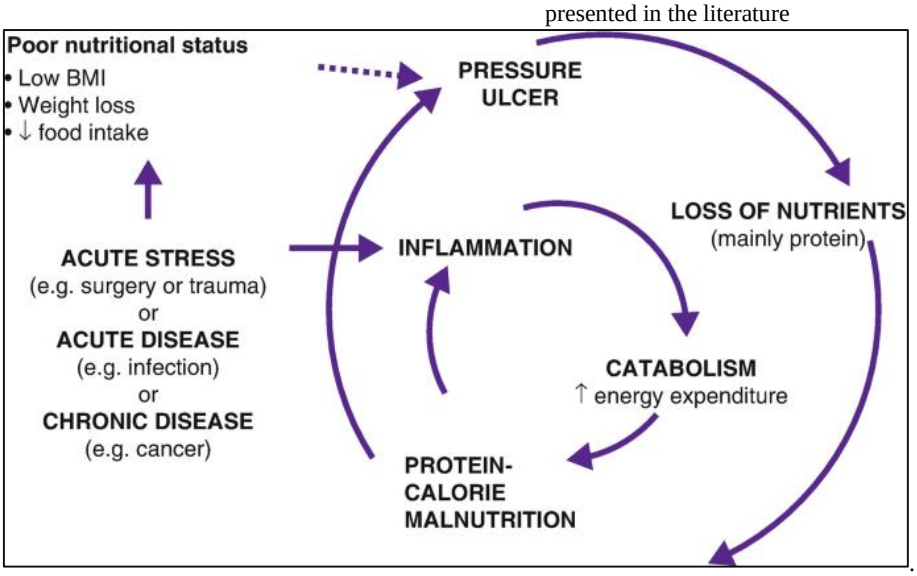

Figure 1: Causes of Pressure Injuries.

Biochemical Markers in Congestive Heart Failure (CHF)

Congestive Heart Failure (CHF) is a complex clinical syndrome that occurs when the heart is unable to pump sufficient blood to meet the body's metabolic demands. This condition is associated with significant morbidity and mortality, and its management is often complicated by the diversity of underlying causes, which may range from coronary artery disease and hypertension to cardiomyopathies. Biochemical markers play an increasingly important role in the diagnosis, prognosis, and management of CHF by providing insights into the pathophysiological mechanisms and aiding in clinical decision-making. In this context, biochemical markers help not only in identifying the disease but also in predicting its progression, guiding therapy, and monitoring treatment efficacy.

Role of Biochemical Markers in Diagnosis

Several biochemical markers have been identified as useful tools in the diagnosis of CHF. Among the most widely recognized are B-type natriuretic peptide (BNP) and its precursor, aminoterminal pro B-type natriuretic peptide (NT-proBNP). BNP is released by the ventricles in response to increased wall stress due to volume overload or myocardial injury. Elevated levels of BNP or NT-proBNP

are highly sensitive for the diagnosis of CHF, with studies showing these markers to be particularly effective in distinguishing heart failure from other conditions with similar symptoms, such as lung disease or renal insufficiency. The utility of BNP as a diagnostic tool is most pronounced in acute settings where quick decisions need to be made regarding the possibility of heart failure. Moreover, troponins, including high-sensitivity cardiac troponin T (hs-cTnT) and troponin I (hs-cTnI), are critical markers of myocardial injury. Although traditionally used in the assessment of acute coronary syndromes (ACS), elevated troponin levels in CHF reflect myocardial strain and ischemia, often correlating with worse outcomes. The presence of elevated troponin levels in CHF patients is associated with increased morbidity, particularly in those with preserved ejection fraction (HFpEF), highlighting the importance of myocardial injury in these cases.

Biochemical Markers in Prognosis

Biochemical markers are indispensable not only in diagnosing CHF but also in determining its severity and prognosis. In this context, markers of inflammation and neurohormonal activation are invaluable. Elevated levels of C-reactive protein (CRP) and interleukins (IL-6, IL-1β) reflect a systemic inflammatory response that is common in CHF patients. Chronic inflammation exacerbates myocardial damage and contributes to the progression of heart failure. Moreover, markers of neurohormonal activation, such as renin-angiotensin-aldosterone system (RAAS) markers and sympathetic nervous system (SNS) markers (e.g., norepinephrine), are associated with poor outcomes. These systems are upregulated in CHF as the body attempts to compensate for the failing heart, but their chronic activation leads to further cardiac remodeling, fibrosis, and worsening heart failure. The soluble suppression of tumorigenicity-2 (sST2) is a novel biomarker that has gained attention in recent years due to its association with adverse outcomes in CHF. Elevated sST2 levels are linked with myocardial fibrosis, inflammation, and increased risk of hospitalization and death. Additionally, galectin-3, a carbohydrate-binding protein involved in fibrosis and inflammation, has emerged as a useful prognostic marker in heart failure. High levels of galectin-3 are correlated with adverse remodeling of the heart and are predictive of poor outcomes, making it a promising tool for risk stratification.

Role of Biochemical Markers in Guiding Therapy

Biochemical markers are also instrumental in guiding therapy in CHF patients. Markers such as BNP and NT-proBNP are used to monitor treatment responses. A decrease in BNP or NT-proBNP levels often correlates with clinical improvement and a reduction in hospitalizations, whereas persistently elevated levels may indicate ongoing volume overload or worsening heart function. Thus, these markers provide valuable feedback on the effectiveness of pharmacologic interventions such as angiotensin-converting enzyme inhibitors (ACE inhibitors), angiotensin receptor blockers (ARBs), diuretics, and beta-blockers, which target the neurohormonal pathways involved in CHF. Furthermore, the emerging role of endothelial biomarkers in CHF, such as endothelin-1 and asymmetric dimethylarginine (ADMA), points to the significance of endothelial dysfunction in the pathophysiology of CHF. These markers can be used to assess the effectiveness of therapies aimed at improving endothelial function, such as vasodilators and novel pharmacological agents designed to restore nitric oxide balance. Biochemical markers have revolutionized the management of CHF by providing clinicians with valuable tools for diagnosing the condition, assessing its severity and prognosis, and guiding therapeutic interventions. Markers such as BNP, NT-proBNP, troponins, inflammatory cytokines, and neurohormonal markers have proven instrumental in the clinical decision-making process. As our understanding of the pathophysiology of heart failure evolves, new biomarkers such as sST2, galectin-3, and endothelial markers hold promise for further enhancing risk stratification and personalized treatment strategies. Ultimately, the integration of biochemical markers into routine clinical practice has the potential to improve patient outcomes by enabling earlier diagnosis, more precise monitoring, and more effective, individualized therapy.

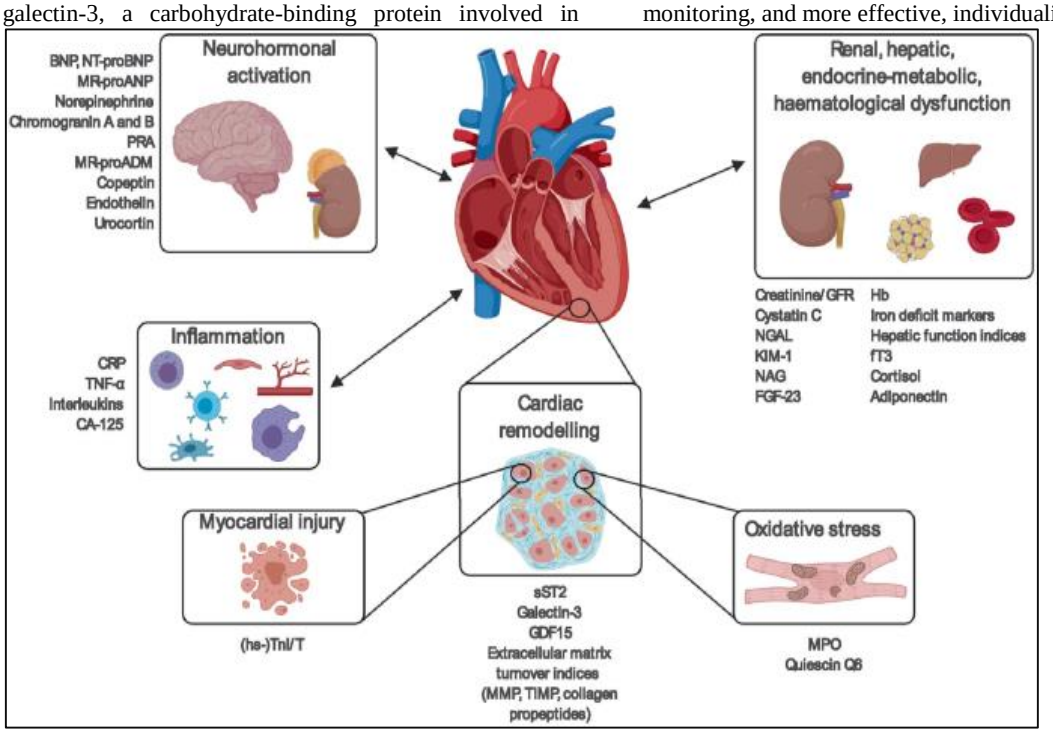

Figure 2: Biochemical Markers of Congestive Heart Failure.

Studies in the Field:

Ettema et al. (2015) conducted a mixed-methods, multi-center study across two large cardiac surgery centers and a university hospital in the Netherlands to assess the feasibility and potential cost savings of the PREDOCS program in preparing frail older patients for cardiac surgery. The study involved 114 participants and evaluated a multi-component, nurse-led intervention that spanned 2–4 weeks before surgery. The PREDOCS program included three key phases: general information for all patients, identification of high-risk patients, and targeted advice for preparation to reduce surgical risks. The findings suggested that the program was cost-effective, preventing 6-16 postoperative complications per 1000 patients, and was well accepted by both patients and nurses. The study recommended that the program be integrated into the cardiac surgery pathway or provided as part of home care, with a moderate level of evidence supporting its effectiveness.

Gage (2015) focused on a quality improvement project aimed at reducing hospital-acquired pressure ulcers in patients in intensive care units (ICUs) in England. This initiative developed and piloted essential standards for pressure ulcer prevention across four ICUs in five hospitals, resulting in a notable reduction in the incidence of pressure ulcers, with no occurrences of severe (category 3 or 4) ulcers. The project demonstrated that compliance with basic standards could significantly reduce the incidence of pressure ulcers, although the evidence was considered weak. Floyd et al. (2016) evaluated the impact of a Progressive Mobility Protocol (PMP) on patient outcomes in post-cardiothoracic surgery patients in the USA. The study compared outcomes between two groups of 30 patients each in a thoracic and cardiovascular ICU. While no statistically significant differences were found between pre- and post-intervention groups, the implementation of the PMP led to decreases in hospital length of stay, ICU readmission rates, and the prevalence of deep vein thrombosis (DVT) and pressure ulcers, with strong evidence supporting the effectiveness of the intervention.

Wickberg and Falk (2016) examined the prevention of pressure damage in the oral cavity caused by endotracheal tubes (ETTs) in Sweden. Their observational study included 38 patients post-heart surgery in a thoracic ICU, and the ETT was repositioned every third day. The results revealed that 71% of patients did not develop pressure ulcers, suggesting that this repositioning routine could be adopted by other ICUs to prevent oral cavity pressure damage, with strong evidence for the practice. Vaezi and Bamakan (2017) conducted a quasi-experimental clinical trial in Iran to determine the effects of adjusting endotracheal tube (ETT) cuff pressure on complications such as sore throat, hoarseness, and cough in patients undergoing coronary artery bypass surgery. The study found that reducing ETT cuff pressure led to a significant reduction in these complications ($p < 0.033$ for sore throat and $p < 0.004$ for hoarseness), demonstrating the benefits of regular cuff pressure adjustments in improving patient comfort, with strong evidence supporting the practice.

Huang, Zhu, and Qu (2018) compared the effectiveness of an alternating inflatable head pad versus a gel pad in preventing postoperative pressure ulcers and alopecia in 120 patients undergoing open heart surgery in China. The results indicated that the alternating inflatable head pad significantly reduced the incidence of occipital pressure ulcers, with only 1.7% of patients affected, compared to a higher rate in the control group, suggesting that this intervention could be effective in preventing pressure ulcers and alopecia post-surgery, with strong supporting evidence. Cooper et al. (2015) focused on preventing pressure ulcers in high-risk cardiac surgery patients in the USA, using a quality improvement project that involved protective foam dressings and repositioning of devices. The project achieved an 83% reduction in hospital-acquired pressure ulcers, with a significant decrease in the incidence of MDR pressure injuries, although the evidence was weak.

Kulik et al. (2018) implemented a nurse-driven, standardized clinical assessment and management plan to prevent pressure injuries (PIs) in pediatric cardiac surgery patients in the USA. The plan was associated with a reduction in the incidence of pressure injuries, particularly device-related injuries, and the study demonstrated that the prevention bundle was a significant strategy in reducing PIs, with strong evidence supporting its effectiveness. Straus et al. (2019) evaluated the use of silicone foam dressings in preventing sacral deep-tissue pressure injuries in cardiac surgery patients in the USA. The study found that the use of silicone foam dressings before surgery significantly reduced the incidence of sacral deep-tissue pressure injuries from 2.3% to 0%, suggesting that silicone foam dressings are an effective prophylactic measure, with moderate evidence supporting their use.

Shih et al. (2020) evaluated a textile-based pressure sensing system in Taiwan for monitoring pressure injury in patients undergoing cardiac surgery. The flexible textile-based sensor array provided real-time monitoring of interfacial pressure and was found to be beneficial for early warning and long-term pressure monitoring in clinical settings, although the evidence was weak. Eberhardt et al. (2020) conducted a randomized controlled trial in Brazil comparing multi-layered silicone foam to transparent polyurethane film in preventing heel pressure injuries during elective surgeries. The intervention group, which received the silicone foam, had a significantly lower risk of developing pressure injuries than the control group, demonstrating the effectiveness of multi-layered silicone foam in preventing heel pressure injuries, with strong evidence supporting its use.

Pittman et al. (2021) examined the effectiveness of an alternating pressure overlay in preventing hospital-acquired pressure injuries (HAPIs) in high-risk cardiovascular patients in the operating room and ICU. The use of the overlay significantly reduced HAPIs from 11% to 0%, with substantial cost avoidance and positive staff satisfaction, demonstrating the potential of this intervention to prevent pressure injuries in complex cardiovascular patients, with moderate evidence supporting its efficacy. Li et al. (2021) investigated the use of care bundles in perioperative nursing care for patients with type A aortic dissection in China. The care bundle included skin protection measures such as pressure ulcer evaluation, cotton pads, and foam dressings for pressure-prone areas. The results showed that the care bundle significantly reduced the incidence of intraoperative pressure ulcers compared to the control group, indicating that care bundles improve the safety of perioperative nursing care, with moderate evidence supporting their effectiveness.

Interventions:

Several techniques to avoid pressure injuries (PIs) were among the care treatments used in the study. PI prevention care bundles (n = 9), intraoral endotracheal tube (ETT) replacement timing (n = 1), ETT cuff pressure

adjustment (n = 1), inflatable head pad application (n = 1), multi-layered silicone foam (n = 2), pressure-measuring cover development (n = 2), and a predictive model for surgery-related pressure ulcers (n = 1) were all part of these interventions. After the interventions, PIs decreased in all studies, and a number of preventive projects or procedures were created.

In order to prepare older patients for heart surgery, Ettema et al. developed and validated care packages that included multi-component nursing treatments. In an experimental study with a control group, Huang et al. examined the efficacy of gel pads and inflatable pads in preventing postoperative occipital hair loss and pressure ulcers in patients undergoing open heart surgery. They discovered that the inflatable head pad was effective in lowering alopecia and occipital pressure ulcers. In order to monitor interface pressure during the perioperative period, Shih et al. created a novel mattress cover with a textile-based design integrated with a pressure-sensing technology. A specific mattress was used in White et al.'s study as part of their pressure prevention strategy. A prediction model developed by Wei et al. to identify patients at risk for pressure sores enhanced the standard of care throughout the perioperative phase. In order to detect and prevent PIs, Kulik et al., Gage, and Pena et al. also created care packages, which decreased the frequency and severity of PIs. According to Wickber et al., ETT-related PIs were decreased in patients undergoing oral intubation for heart surgery when the ETT position was changed every three days. Although the findings were not statistically significant, Floyd et al.'s retrospective investigation on the effects of a "progressive mobility protocol" in postoperative cardiothoracic surgery found a decrease in the development of PI. The study by Stokes et al. demonstrated the efficacy of a procedure for patient mobilization that is safe. Cooper et al. emphasized the success of a proactive nursing approach, while Li et al. validated the efficacy of a care bundle. Vaezi et al. discovered that frequent ETT cuff pressure adjustments decreased coughing, hoarseness, and sore throats in patients undergoing coronary artery bypass surgery. Liu et al. also showed that regulating ETT cuff pressure with a manometer reduced problems. Alternating pressure coatings have been demonstrated by Pittman et al. to be beneficial in lowering PIs throughout perioperative and postoperative treatment. Lastly, Straus et al. and Eberhardt et al. concluded that silicone foam successfully stopped PIs.

Data Discussion:

Because they are directly responsible for the health of their patients, nurses have a vital and continuous role in patient care, especially in preventing pressure injuries (PIs). Since there are several contributing variables to PIs, a multidisciplinary approach is essential to successful prevention. Implementing evidence-based approaches backed by teamwork from multiple healthcare professions is crucial to delivering high-quality treatment. The effectiveness of various interventions, such as care packages, prediction models, inflatable head pads, pressure sensor mattress covers, silicone foam applications, ETT repositioning, and ETT cuff pressure control, is highlighted in this review, which assesses 17 studies aimed at PI prevention in patients undergoing open heart surgery.

Preoperative preadmission (28), perioperative (29–32), postoperative intensive care (33–38), and a combination of the perioperative and postoperative periods (39–44) were the stages of PI prevention that were studied in the evaluated studies. It is commonly known that the chance of developing PI is greatly influenced by the timing of surgery before, during, and after. In order to prepare older patients for heart surgery, Ettema et al. created and validated care packages that included many nursing interventions (28). Despite the fact that evidence-based therapeutic treatments are frequently employed to improve the quality and consistency of care (45), no previous research has explicitly examined preoperative care packages meant to lower postoperative PIs in patients undergoing heart surgery. Intensive and critical care units, in particular, have been the focus of the majority of PI preventative care packages that are already in place (46–50). Ettema et al. provided modest evidence to support the efficacy of their care package, suggesting that it could enhance clinical practice (28). Thus, incorporating care packages into heart surgery preoperative planning could be a useful tactic to avoid PIs.

Patients are vulnerable to pressure injuries (PIs) because of the prolonged immobility and anesthesia that prevents them from feeling pressure-induced discomfort during surgery. Perioperative PIs are those that happen during surgery or within the first 72 hours after surgery (51). By offering support in operating rooms, gel mattresses, pressure mattresses, and foam mattresses are frequently utilized to avoid these injuries (52). Huang et al. evaluated in an experimental investigation how well an inflatable head pad and gel pad prevented PIs and postoperative occipital hair loss in patients having open heart surgery (29). According to the study, the inflated head pad helped lower the incidence of alopecia and occipital pressure ulcers after surgery. Shih et al. created a novel, flexible mattress cover with a pressure-sensing device based on textiles in another perioperative trial. During heart surgery, this gadget enables real-time monitoring of patients' pressure zones, identifying individuals who are susceptible to pressure injuries (30). This sensor mattress was included in the pressure prevention strategy developed by White et al. (32). According to the literature, non-invasive sensor clothes, mattresses, and coverings (53-55) are useful instruments for ongoing physiological signal monitoring, which aids in patient evaluation. For PI prevention to be effective, these sensor drapes must be used in operating rooms. Furthermore, Wei et al. (31) created a prediction model during the perioperative phase, which enhanced the standard of care. Therefore, it is advised that patients undergoing heart surgery have regular perioperative care that incorporates sensory bed covers and prediction models.

It has been demonstrated that care packages designed to detect the onset of pressure injuries (PIs) and evaluate preventative measures in the postoperative care process lower the frequency and severity of PIs (34–36). Multiple intervention packages, also known as PI preventive programs, have been developed expressly to enhance the treatment of critically ill patients (18) and have demonstrated efficacy in lowering the incidence of PI (56). Multifaceted interventions, such care packages, are more effective than single-component interventions, according to a review that concentrated on putting clinical practice guidelines into practice in the intensive care unit (57). As a result, it is highly advised that patients undergoing heart surgery use care packages to prevent pressure injuries.

ICU patients are more likely to suffer from pressure injuries on their mucosal membranes, which are frequently brought on by medical devices (58) (59). In patients undergoing oral intubation for heart surgery, Wickber et al. discovered that relocating the endotracheal tube (ETT) every three days decreased the incidence of pressure injuries brought on by the ETT (38). A systematic review that found that repositioning the ETT every 72 hours

greatly reduced the incidence of face, tongue, and oral PIs (60) supports this finding. Repositioning is a useful tactic for avoiding mucosal damage in patients who are orally intubated because it improves blood flow and lowers the risk of problems. Floyd et al.'s retrospective study on the efficacy of a progressive mobility protocol (PMP) in patients recovering from cardiothoracic surgery revealed no noteworthy outcomes, despite a decrease in the development of pressure injuries (33). In line with previous research, Stokes et al. showed that securely relocating patients after surgery lowers the risk of PIs (61, 62). Floyd's study, which is a preliminary assessment of mobility inside the PMP, should be interpreted with caution because of its small sample size. Larger sample sizes should be used in future research to bolster the findings.

It is advised to take extra precautions both during and after surgical procedures in order to effectively prevent pressure injuries (63). In perioperative and postoperative care, proactive nursing procedures (39) and care bundles (41) have also been demonstrated to be beneficial. Vaezi et al. demonstrated that routinely modifying the ETT cuff pressure decreased the incidence of cough, hoarseness, and sore throat in a thorough study involving patients undergoing coronary artery bypass surgery (44). In line with this study, Liu et al. discovered that using a manometer to regulate the ETT cuff pressure helped lower endotracheal intubation problems (64). Pittman et al. showed that "alternating pressure coating" is useful in lowering PIs in the operating room and intensive care unit by looking at both perioperative and postoperative treatment (42). It has been demonstrated that applying pressure-reducing coatings to operating room tables can either prevent or postpone PIs, hence lowering postoperative PIs (65). Additionally, studies that combine postoperative and perioperative care have demonstrated the effectiveness of silicone foam in reducing pressure injuries (40, 43). Clear polyurethane film was found to be less effective than multi-layer silicone foam at preventing pressure injuries (PIs) brought on by surgical placement. The effectiveness of multi-layered silicone foam in lowering PIs is further supported by a study of the literature (43, 66, 67). To sum up, taking preventative precautions both during and after surgery is a good way to avoid pressure injuries. Thus, high-quality randomized, controlled trials should be used to promote research that looks at both the perioperative and postoperative care processes.

The review's conclusions have important ramifications for clinical nursing practice. It lists nurse interventions for patients having open heart surgery that are intended to manage PIs during the preoperative, perioperative, and postoperative phases. A thorough search of the literature turned out no systematic reviews that addressed these processes. Notably, anti-pressure therapies specific to each patient's surgery phase have been taught to intensive care nurses, who are essential to critical care. Two reviewers independently screened and chose the papers for inclusion in order to minimize bias, and a knowledgeable health librarian helped to improve the search approach. This systematic review does still have several limitations, though. A narrative review was presented because a meta-analysis was impractical due to the variety of interventions and measures. Furthermore, the included studies' methods differed (including sample collection protocols, sample sizes, operating parameters, and measurement units), which made it challenging to extrapolate the findings. Additionally, several research showed a possibility of non-response bias, which could be a drawback because participants who did not reply would be different from those who did. Incomplete reporting may have occurred from the decision to omit qualitative studies, expert comments, grey literature, research on other surgeries, and non-English studies. Furthermore, older research was excluded as a result of the studies' date limitations. Nevertheless, considering the speed at which guidelines, clinical procedures, and evidence are evolving, the most recent evidence was incorporated into this analysis. Lastly, only research carried out in intensive care units were included in this study.

Nursing Interventions in Congestive Herat Failure:

Congenital heart disease (CHD), which accounts for a large portion of the worldwide burden of congenital diseases, includes a variety of structural heart defects that are evident from birth. These abnormalities provide significant problems in both pediatric and adult cardiology, ranging in complexity from mild defects with few clinical consequences to major deformities needing immediate and sophisticated medical procedures [68, 69]. In order to manage congenital heart disease (CHD), provide life-saving remedies, and enhance the general quality of life for afflicted patients, surgical intervention—whether for correction or palliation—is crucial. However, there are dangers associated with these treatments, especially with regard to postoperative consequences such surgical site infections (SSIs), which are still a major worry [70]. The complexity of CHD operations and the vulnerable condition of the young patient population increase these risks [71]. SSIs are frequent postoperative complications that have a major effect on patient recovery, lengthen hospital stays, and raise medical costs [72]. The risk of SSIs is increased for patients having CHD surgery because of the intricacy of the procedures, the length of the operation, and the possibility of a protracted recovery period after the treatment. In addition to posing acute health risks, these infections may also compromise the long-term effectiveness of surgical procedures, which could have a negative impact on the prognosis of the patient [73-74]

Nursing interventions are essential to perioperative care in tackling this issue. These preoperative and postoperative therapies are essential for lowering the risk of infection and promoting the best possible recovery. Strict aseptic procedures, careful wound care, close monitoring of infections, and patient education about wound care and cleanliness after discharge are just a few of the many tactics that are part of nursing practices. There is a great deal of clinical interest in how well these therapies work to prevent SSIs in the surgical group with CHD [75-76]. To determine best practices and integrate evidence-based tactics into healthcare regimens, research is required. In order to improve patient care and outcomes, this study is to investigate the effect of nurse interventions on the incidence of SSIs among patients after CHD surgery [77-78].

Differential Outcomes in Wound Healing Efficacy

Significant differences were seen when the control and observation groups' wound healing outcomes were compared. Compared to just 30% in the control group, 73.3% of cases in the observation group had Grade A healing, which denotes an ideal recovery free of problems. With a p-value of less than 0.01 and a chi-square ($\chi 2$) value of 11.57, this difference was statistically significant. Furthermore, the observation group experienced a substantially decreased incidence of Grade B healing (defined as seroma or hematoma without suppuration) at 26.7% compared to 58.3% in the control group, with a $\chi 2$

value of 10.69 and a p-value less than 0.01. Moreover, the observation group did not experience Grade C healing, which is a complication that indicates delayed wound healing with suppuration that requires drainage, but 11.7% of the control group did. A p-value of less than 0.05 and a $\chi 2$ score of 13.25 indicated that this difference was statistically significant. These results demonstrate the improved wound healing in the research group, indicating that the postoperative care techniques or interventions used were successful in fostering better recovery results.

One important element affecting clinical outcomes, especially in reducing SSIs, is the efficacy of nursing interventions in the postoperative care of patients with congenital heart disease. Nursing interventions, ranging from preoperative education to postoperative wound care and surveillance, are crucial given the complexity of CHD surgeries and their link to high SSI risks, which raise morbidity, lengthen hospital stays, and increase healthcare costs. This study is in line with the increasing amount of data that shows proactive nursing care is essential for reducing the incidence of SSI. The use of evidence-based aseptic procedures, close patient observation, and suitable antibiotic prophylaxis are examples of such interventions. In order to preserve the advantages of in-hospital treatment, nurses are also essential in teaching patients and their families post-discharge infection prevention techniques.

The study's notable variations in results highlight how crucial improved postoperative care is for encouraging wound healing and dramatically lowering the incidence of SSIs in patients with congestive heart failure. The observation group's improved postoperative care protocols are likely responsible for the observed differences in outcomes, as evidenced by the consistency of baseline variables, such as demographic information, comorbidities, and CHD kinds, between the control and observation groups. According to these findings, strict perioperative care—which includes adhering to optimal surgical procedures and using strict aseptic techniques—was essential to reducing postoperative problems. Strict infection control procedures, sophisticated sterilization methods, and the thoughtful administration of prophylactic antibiotics suited to microbial cultures and sensitivities may all have contributed to the observation group's lack of Type I and Type III infections.

The success of advanced wound care therapy is demonstrated by the observation group's considerable decrease in Grade B complications and lack of Grade C outcomes. Specialized wound dressings were probably used in order to improve the wound environment, promote natural debridement, and hasten healing. Applying negative pressure wound therapy to patients who had hematomas or seromas indicates a proactive approach to wound care, which might have sped up healing and avoided more serious problems. By addressing multiple factors that impact wound healing, such as nutrition, infection prevention, and patient comorbidities, the integration of a multidisciplinary care team comprising clinicians, specialized wound care nurses, nutritionists, and physical therapists helped to promote a holistic approach to care.

Furthermore, the observation group's high Grade A recovery rate can be a result of the focus on early mobility and patient education. The study gave patients the tools they needed to take an active role in their own healing by teaching them and their caregivers about wound care, infection symptoms, and what to do in the event of complications. Early mobilization, which encourages patients to exercise as soon as it is medically appropriate, probably improves circulation, lowers inflammation, and speeds up healing. The results support a proactive, patient-centered strategy to postoperative treatment that includes a multidisciplinary care team, patient education, and sophisticated wound control techniques. These patient-specific tactics seem to be essential for enhancing postoperative results for individuals having CHD surgery. In order to build standardized care pathways for wider application across healthcare settings, more study is required to determine the most beneficial elements of enhanced postoperative care protocols.

Conclusion:

The present study aimed to evaluate the role of nurse-surgeons in advancing global surgical care, with a focus on their contributions to improving postoperative outcomes after open heart surgery. Through an examination of nursing interventions, particularly those targeting wound healing and infection prevention, the study reveals significant improvements in patient recovery and reduction in complications associated with congenital heart disease (CHD) surgeries. These findings provide essential insights into the role of nurse-surgeons in managing complex postoperative care in pediatric and adult cardiology. The results of this study clearly demonstrate that nursing interventions, including the application of aseptic techniques, meticulous wound care, and patient education, have a profound impact on the outcomes of patients undergoing CHD surgery. The intervention group, which received enhanced nursing care, exhibited significantly higher rates of Grade A wound healing—indicative of optimal recovery with minimal complications. This was in stark contrast to the control group, which showed a much lower rate of Grade A healing and higher incidences of Grade B complications such as seromas and hematomas. Furthermore, the absence of Grade C complications in the intervention group underscores the effectiveness of the targeted nursing interventions in preventing more severe complications, such as delayed wound healing requiring drainage. The implications of these findings are vast, as they suggest that integrating advanced nursing practices into the perioperative care framework can significantly reduce the risk of surgical site infections (SSIs) and improve overall patient outcomes. The results also emphasize the importance of not only skilled surgical intervention but also comprehensive, proactive postoperative care provided by nurse-surgeons. This aligns with the growing body of evidence advocating for a holistic, multidisciplinary approach to surgical care that involves the collaboration of surgeons, nurses, and other healthcare professionals to optimize patient recovery. Moreover, the study highlights the need for standardized care protocols that incorporate evidence-based nursing interventions into routine practice. The success of these interventions in the present study suggests that hospitals and surgical centers worldwide can benefit from adopting similar care models. By ensuring that nursing staff are equipped with the skills, knowledge, and resources necessary to perform rigorous infection control and wound management practices, healthcare institutions can help improve global surgical care, particularly in regions where access to specialized care may be limited. In terms of global contributions, the implementation of enhanced nursing protocols, as demonstrated in this study, offers a potential solution to the growing challenges in surgical care, particularly in low- and middle-income countries where healthcare resources may be stretched thin.

The results provide compelling evidence for the need to invest in nursing education, training, and support systems that can empower nurse-surgeons to play a more active role in the perioperative care process. Furthermore,

the patient education component, which included guiding patients and caregivers on wound care and signs of infection post-discharge, is crucial for preventing postoperative complications after discharge. This highlights the essential role of nurses in not only managing patients in the hospital but also ensuring that they are equipped to continue their recovery at home. Patient education promotes active participation in care, which is known to improve patient outcomes, adherence to treatment plans, and overall recovery times. The study also underscores the importance of a comprehensive, interdisciplinary care team that involves various healthcare professionals, such as surgeons, nurses, nutritionists, and physical therapists. This team approach allows for the optimization of care delivery by addressing multiple factors that affect wound healing, such as nutritional status, infection control, and physical rehabilitation. This integrated care model provides a holistic approach to managing the complex needs of patients undergoing CHD surgery. In conclusion, the study underscores the critical role of nurse-surgeons in advancing surgical care, particularly in improving outcomes for patients undergoing CHD surgeries. By focusing on proactive, evidence-based nursing interventions, surgical teams can significantly enhance patient recovery, reduce complications, and improve overall surgical outcomes. Future research should focus on refining these interventions, determining their applicability across diverse healthcare settings, and exploring strategies to standardize care pathways globally, ensuring that every patient receives the highest standard of care.

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