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Impact of Interval versus Early Laparoscopic Cholecystectomy in Acute Calculus Cholecystitis: A Retrospective Analysis of Surgical Outcomes

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Abstract: ***Background: The optimal timing for laparoscopic cholecystectomy in the management of acute calculus cholecystitis is debated. This study compares the outcomes of early versus interval laparoscopic cholecystectomy in patients with acute calculus cholecystitis. Methods: This retrospective analysis included 83 patients who underwent laparoscopic cholecystectomy for acute calculus cholecystitis at the Department of General Surgery, MVJMCRH, from December 2021 to November 2023. Patients were divided into two groups: early cholecystectomy (EC, n=51) and interval cholecystectomy (IC, n=32). Data on operative time, blood loss, need for ICU stay, postoperative complications, and hospital stay were collected and analysed. Results: The average duration of surgery was significantly longer in the EC group (129 ± 39.7 minutes) compared to the IC group (82 ± 22.5 minutes, p<0.0001). Mean blood loss was higher in the EC group (55 ± 12.5 ml) than in the IC group (25 ± 6.2 ml, p<0.0001). The need for ICU stay and the incidence of postoperative complications were higher in the EC group, but these differences were not statistically significant (p>0.05). The average of the total hospital stay was significantly shorter for the EC group (4.72 ± 2.57 days) compared to the IC group (index admission and admission for surgery) (8.18 ± 4.63 days, p=0.0001). Conclusions: Early laparoscopic cholecystectomy, despite longer operative times and higher blood loss, is a safe option without increasing postoperative complications resulting in reduced overall duration of hospital stay as well as total cost incurred by the patient. These findings support the recommendation for early surgical intervention in managing acute calculus cholecystitis, aligning with current guidelines and evidence from other studies. Tailoring the timing of surgery to individual patient profiles remains essential to optimize outcomes and ensure patient safety.***

Keywords: Acute calculus cholecystitis, Laparoscopic cholecystectomy, Early surgery, Interval cholecystectomy, Postoperative outcomes

1. Introduction

Acute cholecystitis is a common inflammatory condition of the gallbladder, typically caused by gallstones obstructing the cystic duct. This leads to gallbladder distension, ischemia, and inflammation. It is a significant clinical problem, affecting approximately 10 - 15% of the adult population in developed countries. Globally, the prevalence of gallstone disease varies widely, with higher rates reported in Western countries. In the United States, the prevalence is about 10 - 15%, whereas, in European countries, it ranges from 5 - 22% (1) . In Asia, the prevalence is generally lower, but it has been increasing due to changes in diet and lifestyle. In India, the prevalence of gallstone disease is estimated to be between 4 - 6%, with regional variations influenced by dietary habits, genetic factors, and other socio - economic factors (2) .

Laparoscopic cholecystectomy (LC) has become the gold standard for treating acute cholecystitis due to its minimally invasive nature, which offers benefits such as reduced postoperative pain, shorter hospital stay, faster recovery, and lower incidence of wound infections compared to open cholecystectomy. Since its introduction in the late 1980s, LC has revolutionized the management of gallbladder diseases. The procedure involves the use of a laparoscope and other specialized instruments introduced through small incisions in the abdomen, allowing for the removal of the gallbladder with minimal trauma to the patient (3) .

The Tokyo Guidelines, first introduced in 2007 and updated in 2018 (TG18), provide a comprehensive framework for the diagnosis and management of acute cholecystitis. According to these guidelines, the severity of acute cholecystitis is classified into three grades: (3–5)

- **Grade I (Mild):** Patients with no organ dysfunction and mild local inflammation. These patients are ideal candidates for early laparoscopic cholecystectomy.
- **Grade II (Moderate):** Patients with moderate local inflammation or systemic inflammatory response syndrome (SIRS). Early LC is recommended if the patient is clinically stable and the surgeon has adequate experience.
- **Grade III (Severe):** Patients with organ dysfunction. These patients often require initial stabilization with antibiotics and possibly percutaneous cholecystostomy before considering delayed cholecystectomy.

The Tokyo Guidelines emphasize the importance of early diagnosis and appropriate timing of surgery to improve patient outcomes.

There has been considerable debate regarding the optimal

timing of laparoscopic cholecystectomy in the setting of acute cholecystitis. The two main approaches are: (6)

- **Early Laparoscopic Cholecystectomy (EC):** Performed during the initial hospitalization, usually within 72 hours of symptom onset. Proponents argue that EC can prevent recurrent attacks, reduce the risk of complications, and shorten the overall length of hospital stay.
- **Interval Laparoscopic Cholecystectomy (IC):** Surgery is delayed until the acute inflammation subsides, typically 6 - 8 weeks after the initial episode. This approach is often considered for patients with severe inflammation or comorbidities that contraindicate immediate surgery.

Numerous studies have compared the outcomes of EC and IC, with varying conclusions. Some studies suggest that EC is associated with shorter hospital stays and lower overall healthcare costs without increasing the risk of complications. Others report higher conversion rates to open surgery and increased operative difficulty due to acute inflammation. Despite these findings, clinical practice varies widely, and the decision on timing often depends on the surgeon's experience, hospital resources, and patient factors.

Given the ongoing debate and the need for clear clinical guidance, this study aims to conduct a retrospective analysis comparing the outcomes of EC and IC in patients with acute calculus cholecystitis. The primary endpoints will include operative time, conversion rates to open surgery, postoperative complications, length of hospital stay, and readmission rates.

This analysis will provide valuable insights into the advantages and disadvantages of each approach, ultimately aiding in the development of evidence - based guidelines for the management of acute calculus cholecystitis.

2. Aims and Objectives

The primary aim of this study is to assess the efficacy of early laparoscopic cholecystectomy (EC) in comparison with interval laparoscopic cholecystectomy (IC) for the treatment of acute calculus cholecystitis.

To achieve this aim, the study will focus on the following specific objectives:

1) **Failed Attempts/Inoperability:**
- To compare the rates of failed attempts and inoperability between early laparoscopic cholecystectomy and interval laparoscopic cholecystectomy.

2) **Operating Time:**
- To evaluate and compare the mean operating time required for early laparoscopic cholecystectomy versus interval laparoscopic cholecystectomy.

3) **Postoperative Complications:**
- To analyze and compare the incidence of postoperative complications, such as bile leaks, wound infections, and intra - abdominal abscesses, between the two surgical approaches.

4) **Total Length of Hospital Stay:**
- To compare the total length of hospital stay associated with early laparoscopic cholecystectomy and interval laparoscopic cholecystectomy.

5) **Conversions to Open Cholecystectomy:**
- To assess and compare the rates of conversion from laparoscopic to open cholecystectomy between early and interval approaches.

6) **Patient - Related Outcomes:**
- To evaluate patient - related outcomes, including pain levels, recovery time, and overall satisfaction, for those undergoing early versus interval laparoscopic cholecystectomy.

By addressing these objectives, the study aims to provide comprehensive data on the effectiveness and safety of early laparoscopic cholecystectomy compared to interval laparoscopic cholecystectomy in the management of acute calculus cholecystitis, thereby aiding in the formulation of evidence - based clinical guidelines.

3. Methodology

Study Design: This study is a retrospective analysis conducted at the Department of General Surgery, MVJMCRH, focusing on patients diagnosed with acute cholecystitis and managed with laparoscopic cholecystectomy, either early or interval, during the period from December 2021 to November 2023.

Study Population: The study included a total of 83 patients diagnosed with acute cholecystitis based on clinical, laboratory, and imaging findings, who were treated with laparoscopic cholecystectomy. The inclusion criteria comprised patients aged 18 years and above, who underwent either early or interval laparoscopic cholecystectomy, and who had a follow - up period of at least 3 months post - surgery. Patients with concomitant biliary tract infections, those requiring initial open cholecystectomy due to contraindications for laparoscopy, and those with incomplete medical records or loss to follow - up were excluded from the study.

Surgical Technique: All laparoscopic cholecystectomies were performed using the four - port technique, which is the standard approach in the department. This technique involves the insertion of a 10 - mm port at the umbilicus for the laparoscope, a 10 - mm port in the epigastrium, and two 5 - mm ports in the right upper quadrant. This method allows for adequate visualization and manipulation of the gallbladder and surrounding structures. Bail - out procedures such as fundus - first cholecystectomy, subtotal cholecystectomy, and cholecystostomy were employed as necessary. Conversion to an open procedure was considered in cases where laparoscopic intervention was not feasible or safe.

Data Collection: Data were meticulously extracted from patient medical records. This included demographic information such as age and gender, clinical presentation, and details of the diagnosis. Information regarding the timing of surgery, whether early or interval, operative details including operative time and any conversions to open surgery, intraoperative findings, and complications were also recorded. Postoperative outcomes, including complications, total length of hospital stay, readmissions, and patient follow - up data for at least 3 months post - surgery, were collected to comprehensively assess the surgical outcomes.

Outcome Measures: The primary outcome measures included the rates of failed attempts and inoperability, operating time, postoperative complications, total length of hospital stay, conversions to open cholecystectomy, and patient - related outcomes such as pain levels, recovery time, and overall satisfaction. The data were analysed to compare the efficacy and safety of early laparoscopic cholecystectomy versus interval laparoscopic cholecystectomy, providing valuable insights into the optimal timing for surgery in patients with acute calculus cholecystitis. Bail - out procedures and their indications and outcomes were also analysed to understand their impact on surgical success and patient recovery.

4. Results

The study included a total of 83 patients diagnosed with acute calculus cholecystitis, classified according to the Tokyo Guidelines into three grades of severity. The distribution of cases based on the severity of acute cholecystitis is summarized in Table 1.

Table 1: Incidence of Severity of Acute Calculus Cholecystitis (Tokyo Guidelines)

Grade of cholecystitis	No of cases
Grade 1	27
Grade 2	51
Grade 3	5

The figure1 illustrates the distribution of patients who underwent laparoscopic cholecystectomy for acute calculus cholecystitis, categorized by the timing of the surgery—early versus interval. Out of the 83 cases analysed, 51 patients underwent early laparoscopic cholecystectomy (EC), while 32 patients had interval laparoscopic cholecystectomy (IC). This distribution highlights a preference or necessity for immediate surgical intervention in a majority of the cases. The difference in the number of cases between the two groups may reflect clinical decisions based on patient condition, severity of cholecystitis, and availability of surgical resources at the time of presentation.

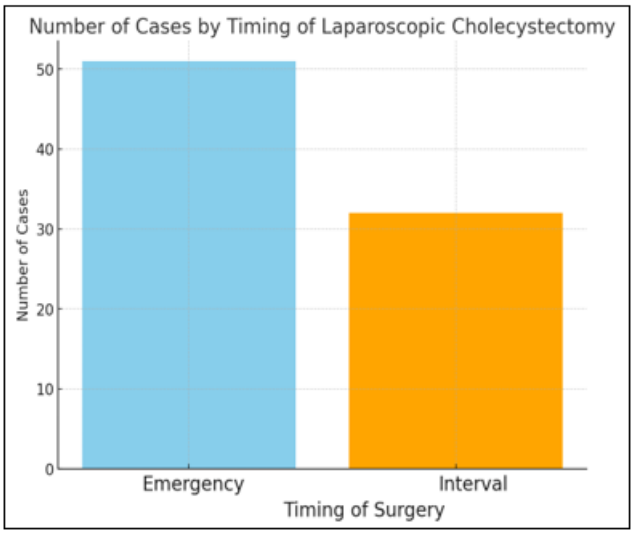

Table 2 presents the demographic and operative data for patients undergoing early versus interval laparoscopic cholecystectomy. The average age of patients in the early group was 42.3 years, significantly younger than the interval group, which had an average age of 51.9 years. Similarly, the body mass index (BMI) was slightly lower in the early group (23.3 kg/m²) compared to the interval group (25.1 kg/m²). Notably, the mean duration of surgery was significantly longer for the early laparoscopic cholecystectomy group, with an average operative time of 129 minutes compared to 82 minutes for the interval group, a difference that was statistically significant ($p < 0.0001$). This data highlights differences in patient demographics and operative complexity between the two approaches.

Among the 83 cases analysed, 2 conversions occurred in the early laparoscopic cholecystectomy (EC) group, while no conversions were recorded in the interval laparoscopic cholecystectomy (IC) group. Although there were more conversions in the EC group, the difference was not statistically significant ($p > 0.05$). This suggests that while conversions may be necessary in early situations due to acute inflammation and other complicating factors, the overall conversion rate remains low, highlighting the feasibility and safety of both surgical approaches.

Table 3 summarizes the postoperative complications observed in the early and interval laparoscopic cholecystectomy groups. The incidence of complications such as bleeding, ICU or ventilation requirements, bile leak/duct injury, intra - abdominal collection, need for interventional radiology, injury to neighbouring structures, re - exploration, and 30 - day readmission were compared between the two groups. While the early group experienced 2 cases of bleeding and 3 patients requiring postoperative ICU or ventilation, the interval group had no cases of bleeding and only 1 patient requiring ICU or ventilation. The differences in bleeding ($p = 0.151$) and other complications were not statistically significant ($p > 0.05$). This indicates that both early and interval laparoscopic cholecystectomy approaches have similar safety profiles, with no significant increase in postoperative complications in either group.

Table 2: Combined Demographic and Operative Data

Demographic Data	Early	Interval	P - value
Avg. age (years)	42.3 +/ - 5.7	51.9 +/ - 6.1	
BMI (kg/m2)	23.3	25.1	
Mean duration of surgery (mins)	129 +/ - 39.7	82 +/ - 22.5	<0.0001

Table 3: Postoperative Complications

Complications	Early	Interval	P - value
Bleeding	2	0	0.15
Post op ICU/ ventilation requirements	3	1	>0.05
Bile leak/ duct injury	0	0	>0.05
Intra - abdominal collection	0	0	>0.05
Need for interventional radiology	0	0	>0.05
Injury to neighbouring structures	0	0	>0.05
Re - exploration	0	0	>0.05
30 - d readmission	2	0	>0.05

The figure 2 shows the distribution of hospital stay duration among patients who underwent early laparoscopic cholecystectomy. Out of the total cases analysed, 11 patients had a hospital stay of less than 3 days, 32 patients had a stay of more than 3 but less than 5 days, and 8 patients had a hospital stay of more than 5 days. The majority of patients (32) fell within the 3 to 5 - day range, indicating that most

patients undergoing early laparoscopic cholecystectomy required a moderate duration of hospitalization. This distribution provides insight into the recovery timeline for patients undergoing early procedures and highlights that while many can be discharged relatively quickly, a significant number still require extended care.

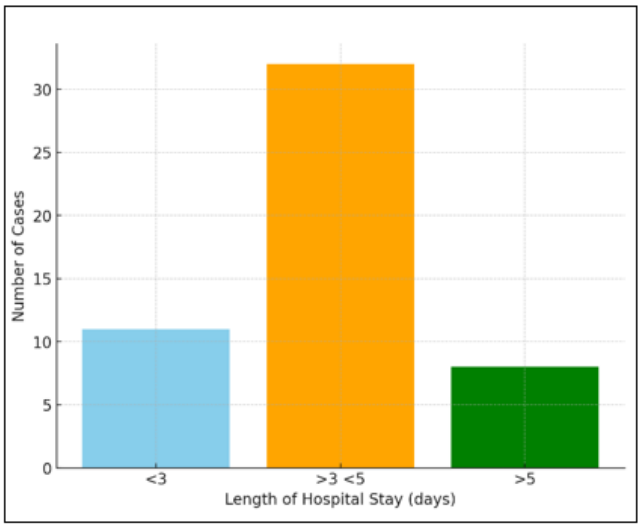

Figure 2: Length of Hospital Stay in Early Laparoscopic Cholecystectomy

Figure 3 illustrates the length of hospital stay for patients undergoing interval laparoscopic cholecystectomy, separated into first and second admissions. For the first admission, 6 patients had a hospital stay of less than 3 days, 24 patients stayed between 3 to 5 days, and 2 patients had a stay of more than 5 days. In the second admission, 18 patients had a hospital stay of less than 3 days, 12 patients stayed between 3 to 5 days, and 2 patients had a stay of more than 5 days. This data indicates that a significant proportion of patients required hospitalization again, with many able to be discharged quickly during the second admission. The interval approach may result in a higher cumulative hospital stay due to the necessity of managing the condition across two separate admissions.

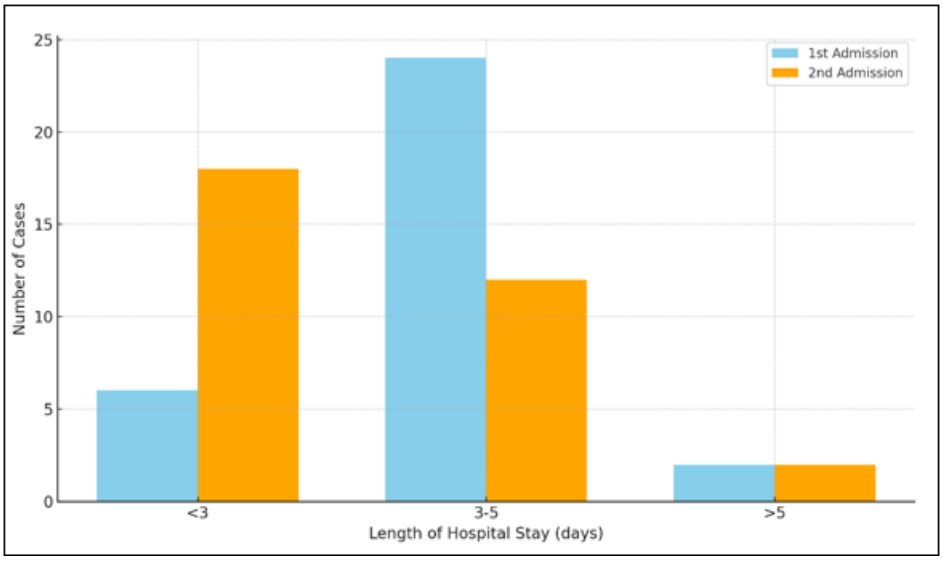

Figure 3: Length of Hospital Stay in Interval Laparoscopic Cholecystectomy

Table 4: Mean Length of Hospital Stay

Mean Length of hospital stay (days)			P - value
Early	Interval		
4.72 +/ - 2.57	1st admission	2nd	<0.001
	4.62 +/ - 3.9	3.56 +/ - 2.5	
	Total		
	8.18 +/ - 4.63		

Table 4 compares the mean length of hospital stay for patients undergoing early versus interval laparoscopic cholecystectomy. For early laparoscopic cholecystectomy, the average hospital stay was 4.72 days. In contrast, patients undergoing interval laparoscopic cholecystectomy had a mean stay of 4.62 days during the first admission and 3.56 days during the second admission, totalling an average of 8.18 days. The combined hospital stay for interval cholecystectomy was significantly longer than that for early cholecystectomy ($p = 0.0001$). This data suggests that while the initial and subsequent hospitalizations for interval surgery are relatively short, the cumulative hospital stay is substantially greater than that for early surgery, highlighting the potential impact on overall healthcare utilization and patient recovery time.

Table 5: Comparative Surgical Parameters

Parameters	Early	Interval	P - value
Avg. Duration of Surgery (mins)	129 +/ - 39.7	82 +/ - 22.5	<0.0001
Avg. Blood Loss (ml) mean	55 +/ - 12.5	25 +/ - 6.2	<0.0001
Need for ICU Stay	3	1	>0.05
Post Op Complications	7	1	>0.05
Avg. Hospital Stay	4.72 +/ - 2.57	8.18 +/ - 4.63	0.0001

Table 5 highlights key surgical parameters comparing early versus interval laparoscopic cholecystectomy. The average duration of surgery was significantly longer for early procedures (129 minutes) compared to interval procedures (82 minutes), with a p - value of <0.0001. Similarly, the mean blood loss was higher in the early group (55 ml) versus the interval group (25 ml), also with a significant p - value of <0.0001. The need for ICU stay and the incidence of postoperative complications were higher in the early group, although these differences were not statistically significant (p > 0.05). The average hospital stay was notably longer for the interval group (8.18 days) compared to the early group (4.72 days), with a significant p - value of 0.0001. These findings suggest that while early surgery may be associated with longer operative times and higher blood loss, it results in a shorter overall hospital stay, highlighting a trade - off between immediate surgical challenges and extended hospitalization in interval procedures.

5. Discussion

This retrospective study aimed to compare the outcomes of early versus interval laparoscopic cholecystectomy in patients with acute calculus cholecystitis. Our findings indicate that early laparoscopic cholecystectomy (EC) is associated with longer operative times and greater blood loss but results in a significantly shorter overall hospital stay compared to interval laparoscopic cholecystectomy (IC).

Operative Time and Blood Loss:
Our study found that the average duration of surgery was significantly longer for the early group (129 minutes) compared to the interval group (82 minutes). Additionally, the mean blood loss was higher in the EC group (55 ml) compared to the IC group (25 ml). These findings are consistent with the study by Jones M et al. (2023), which also reported longer operative times and increased blood loss in early surgeries due to the acute inflammatory process and adhesions present during the initial phase of cholecystitis. The need for meticulous dissection and careful handling of inflamed tissues likely contributes to the increased duration and blood loss in early procedures.

Postoperative Complications:
The incidence of postoperative complications, including the need for ICU stay, was higher in the EC group (7 complications, 3 ICU stays) compared to the IC group (1 complication, 1 ICU stay), though these differences were not statistically significant. This aligns with findings from a meta - analysis by Siddiqui T et al. (2008), which suggested that early cholecystectomy does not significantly increase the risk of postoperative complications (7) . This indicates that, despite the immediate challenges of operating on an inflamed gallbladder, early cholecystectomy can be performed safely without a significant increase in postoperative morbidity.

Hospital Stay:
One of the most significant findings of our study is the difference in the length of hospital stay between the two groups. Patients in the EC group had an average hospital stay of 4.72 days, while those in the IC group had a combined average stay of 8.18 days across two admissions. This difference was statistically significant (p = 0.0001) and underscores the potential benefit of reducing overall hospitalization time by opting for early surgery. Similar results were reported by Menahem B et al. (2015), who found that early cholecystectomy reduced total hospital stay and associated healthcare costs (8) .

Patient Demographics and Surgical Outcomes:
The demographic data indicated that patients undergoing early surgery were younger and had a lower BMI compared to those in the interval group. This could reflect a selection bias where healthier, younger patients are more likely to be chosen for immediate surgery. Despite this, our results suggest that early laparoscopic cholecystectomy is effective and can be safely performed in a wide range of patients.

Our findings are in line with those of other studies that advocate for early laparoscopic cholecystectomy in acute cholecystitis. The Tokyo Guidelines also recommend early surgery, citing benefits such as reduced recurrent symptoms, fewer complications, and shorter hospital stays. However, some studies, like that of Papadakis M et al. (2015), suggest that the decision should be tailored based on the severity of inflammation and patient comorbidities, indicating that interval cholecystectomy might still be preferable in certain cases (9) .

6. Limitations

This study has several limitations. Being retrospective, it is subject to selection bias and relies on the accuracy of medical records. The relatively small sample size and single - centre nature of the study may limit the generalizability of the findings. Further multicentre, prospective studies with larger sample sizes are needed to validate these results.

7. Conclusion

Early laparoscopic cholecystectomy, despite being associated with longer operative times and higher blood loss, offers significant advantages in terms of reducing the total length of hospital stay without increasing postoperative complications. These findings support the recommendation for early surgical intervention in managing acute calculus cholecystitis, aligning with current guidelines and evidence from other studies. Tailoring the timing of surgery to individual patient profiles remains essential to optimize outcomes and ensure patient safety.

8. Recommendations

1) **Adopt Early Laparoscopic Cholecystectomy as Standard Practice for Acute Calculus Cholecystitis:** Based on the findings of this study, early laparoscopic cholecystectomy should be adopted as the standard practice for managing acute calculus cholecystitis. This approach significantly reduces the total length of hospital stay and does not increase postoperative complications, making it a more efficient and patient - friendly option.
2) **Tailor Surgical Timing Based on Patient Profiles:** While early laparoscopic cholecystectomy offers considerable advantages, it is essential to tailor the timing of surgery based on individual patient profiles. Factors such as patient age, BMI, comorbidities, and severity of

inflammation should be considered to optimize outcomes and ensure patient safety. Interval cholecystectomy may still be appropriate for patients with higher surgical risks or severe inflammation.

3) **Implement Protocols for Minimizing Operative Time and Blood Loss in Early Surgeries:** Given that early laparoscopic cholecystectomy is associated with longer operative times and greater blood loss, surgical teams should implement protocols and training to minimize these factors. Techniques such as careful dissection, use of advanced haemostatic tools, and improved perioperative management can help mitigate the challenges associated with early surgeries, enhancing overall patient outcomes.

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