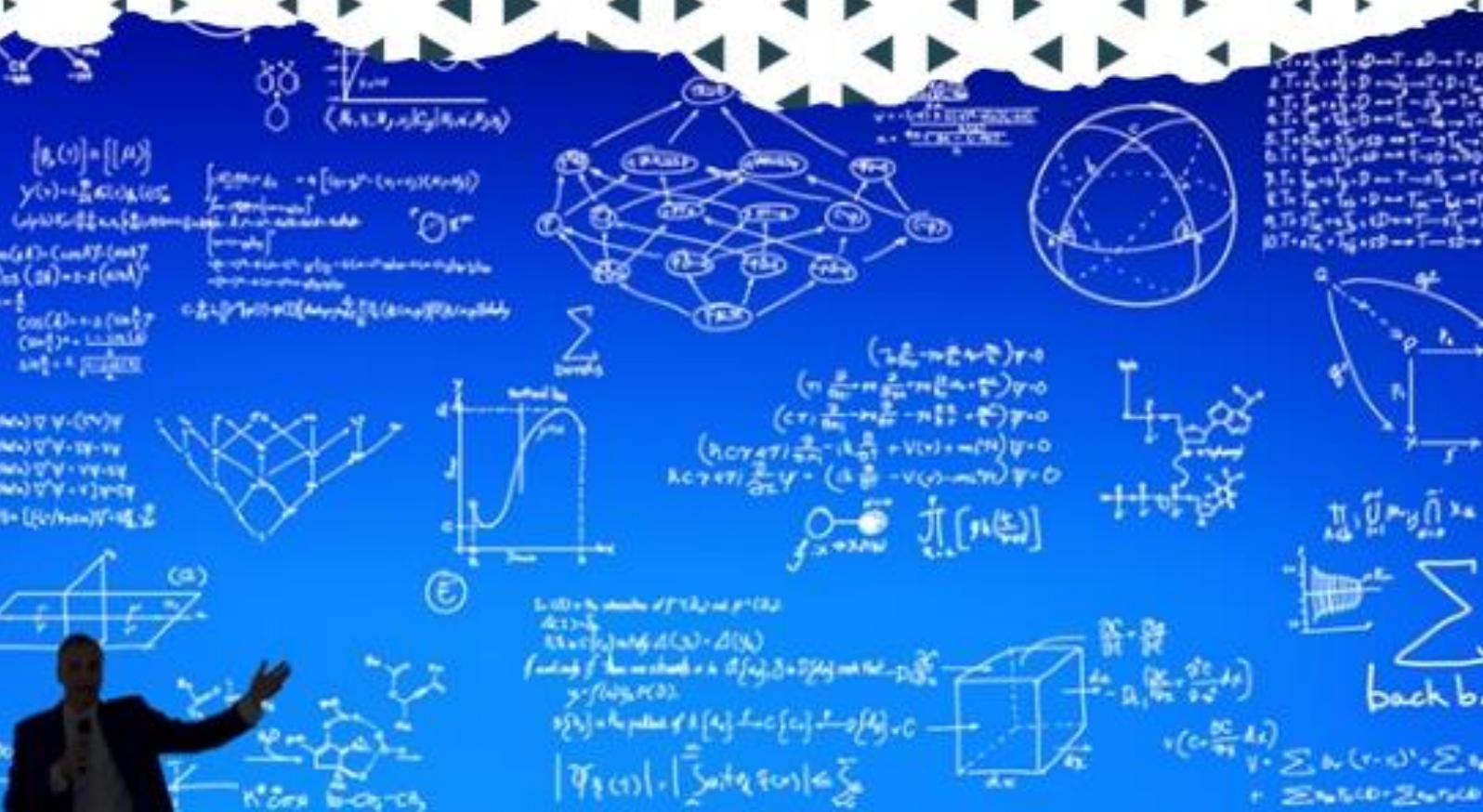




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ONLAYN KONFERENSIYASI**

**ILMIY-ONLAYN KONFERENSIYA TO'PLAMI  
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## Evaluation of Postoperative Outcomes and Rehabilitation Strategies in Pediatric Ileostomy Care

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### Abstract

**Objective.** This study aimed to assess and compare the effectiveness of different management strategies for pediatric patients with ileostomies, focusing particularly on how a comprehensive rehabilitation program influences postoperative complications and recovery outcomes.

**Methods.** Clinical data from 126 children who underwent ileostomy between 2014 and 2024 were retrospectively and prospectively analyzed. The control group (n=71) comprised patients managed from 2014–2019 using conventional care protocols, whereas the main group (n=55) received an optimized rehabilitation-based protocol starting in 2020. The improved approach included structured education for parents and patients, personalized stoma care, the use of combined antiseptics and protective films, absorbent dressings, low-intensity laser therapy, and tailored nutritional support. Early and late stoma complications, systemic morbidity, hospital stay, and reconstructive surgery rates were compared. Statistical significance was defined as  $p < 0.05$ .

**Results.** Early stoma-related complications were reported in 53.5% of the control group and 27.3% of the main group ( $p = 0.003$ ). Systemic complications declined from 46.5% to 25.5% ( $p = 0.016$ ), while severe complications (Clavien–Dindo grades III–V) were notably higher in the control group (49.3% vs. 14.6%,  $p = 0.002$ ). Late complications decreased from 40.0% to 19.2% ( $p = 0.017$ ), and peristomal skin disorders fell from 41.7% to 21.2% ( $p = 0.015$ ). The mean hospital stay was shorter in the main group ( $11.5 \pm 0.35$  vs.  $13.2 \pm 0.5$  days,  $p < 0.001$ ). Additionally, the frequency of timely reconstructive surgery increased, while persistent stoma function was more common in the control group (16.7% vs. 3.8%).

**Conclusion.** Implementing a comprehensive rehabilitation protocol that integrates advanced local and systemic therapeutic measures substantially reduces postoperative morbidity, accelerates recovery, shortens hospitalization, and improves long-term surgical outcomes in pediatric ileostomy patients.

**Keywords:** Children, Ileostomy, Stoma complications, Surgical outcomes, Rehabilitation, Postoperative care, Reconstructive surgery

### 1. Introduction

Ileostomy creation in pediatric surgery remains a crucial life-saving intervention for managing both congenital and acquired intestinal disorders. Despite its essential role, the overall morbidity associated with stoma creation and subsequent closure in children is reported to range from 20% to 38% of cases, reflecting significant clinical challenges [1–4].

In pediatric surgical practice, ileostomies are performed for several primary indications. Among neonates, the most frequent causes include necrotizing enterocolitis, intestinal atresia, anorectal malformations, and Hirschsprung's disease. In older children, severe variants of inflammatory bowel diseases, such as ulcerative colitis and Crohn's disease, may necessitate ileostomy formation [2,5]. The creation of a diverting intestinal stoma allows temporary decompression and diversion of the affected bowel segment, thereby facilitating anastomotic healing and stabilizing the patient's condition prior to definitive reconstructive surgery [1,5,6]. Typically, these stomas are temporary and are reversed once the underlying pathology has resolved and the patient's general condition allows. However, while ileostomy can be a life-preserving measure, it also introduces significant management difficulties. Even short-term stoma function carries a high risk of postoperative complications that require careful multidisciplinary follow-up. Reported complication rates can reach up to 70% or higher in pediatric cohorts [4,6–8]. The most prevalent issues include peristomal skin irritation, high-output stomas resulting in electrolyte disturbances, prolapse, retraction, strictures, infections, and nutritional deficiencies. These complications contribute to longer hospital stays, repeated admissions, and increased emotional and financial strain on families [4,7,8]. Consequently, the development of optimized management and rehabilitation protocols for children with intestinal stomas is a high clinical priority. Despite ongoing research, there remains no universal consensus on the optimal strategies for postoperative care, timing of stoma closure, and complication prevention. In response to this gap, the present study was designed to evaluate and compare different management approaches and to assess the effectiveness of a comprehensive rehabilitation program in improving both early and long-term outcomes for pediatric patients with ileostomies.

### 2. Materials and Methods

This investigation was based on the clinical evaluation and treatment outcomes of 126 pediatric patients who underwent ileostomy at the Republican Scientific Center of Emergency Medical Care in Andijan, Uzbekistan, between 2014 and 2024.



### *2.1. Inclusion and Exclusion Criteria*

Children were included in the study if they had intestinal pathologies causing dynamic obstruction, post-traumatic intestinal disruption, purulent-inflammatory abdominal diseases, adhesive intestinal obstruction, or other indications necessitating stoma formation. Exclusion criteria included malignant neoplasms of the abdominal organs or malignant degeneration of ulcerative lesions.

### *2.2. Demographics and Grouping*

Participants ranged in age from newborns to 18 years, comprising 91 boys (72.2%) and 35 girls (27.8%). The sample was divided into two clinical cohorts:

The comparison group (n=71; 56.4%) included children treated during 2014–2019 using conventional approaches.

The main group (n=55; 43.6%) included patients treated from 2020 onward with a structured and optimized rehabilitation protocol.

Gender distribution was similar between the groups: boys accounted for 67.6% in the comparison group and 78.2% in the main group, while girls represented 32.4% and 21.8%, respectively. Most patients were of school age (8–12 years).

### *2.3. Etiological and Clinical Characteristics*

The most common indication for ileostomy was ulcerative colitis (27.8%), followed by Crohn's disease (16.7%) and small bowel intussusception (14.3%). Less frequent causes included small bowel atresia (7.9%), Hirschsprung's disease (7.1%), anorectal malformations (7.1%), and adhesive intestinal obstruction (3.2%). Emergency and elective operations were almost equally distributed (48.4% and 51.6%, respectively). The most frequent preoperative complication was intestinal obstruction (59.5%), followed by strictures (29.4%), gastrointestinal bleeding (27.8%), perforation (13.5%), and bowel necrosis (4.0%). Comorbidities were identified in 51 children (40.5%), primarily nutritional disorders (13.5%), congenital anomalies and CNS diseases (8.7% each), as well as urinary and bronchopulmonary conditions.

### *2.4. Stoma Characteristics and Localization*

Lesions most frequently involved the colon (47.6%), particularly the sigmoid (16.7%), descending (13.5%), and rectal segments (9.5%). Less often, the cecum (5.6%) and ascending colon (4.0%) were affected. A single-barrel stoma was formed in 44.4% of cases, while double-barrel stomas accounted for 55.6%, with similar distribution across groups (54.9% vs. 56.4%). The comparability of both groups in demographics, pathology type, comorbid conditions, and surgical features allowed a valid outcome comparison.

### 2.5. Postoperative Evaluation and Classification

Surgical data, stoma type, and the frequency and nature of reoperations were analyzed. Complications were categorized as early ( $\leq 30$  days post-surgery) or late ( $> 30$  days), and as local (stoma-related) or systemic. The Clavien–Dindo classification (2004) [9] was used to grade complication severity.

### 2.6. Rehabilitation Program

The optimized rehabilitation protocol combined local and systemic interventions:

**Local management:** individualized education for parents and patients on stoma hygiene and appliance selection; antiseptic and protective care for the peristomal area using specialized creams, films, and pastes; application of low-intensity laser therapy to enhance tissue repair and prevent inflammation. In cases of dermatitis, pyoderma, or ulcerative lesions, combined antiseptics and advanced wound dressings were applied.

**Systemic management:** nutritional optimization, correction of intestinal microbiota with probiotics (bifidobacteria and lactobacilli), specialist consultations, dynamic follow-up of intestinal microbiocenosis, and management of comorbidities.

Patients with severe complications—such as bleeding, necrosis, evisceration, abscess, phlegmon, bowel retraction, prolapse, hernia, or stricture—received inpatient treatment, including surgical correction when necessary.

### 2.7. Statistical Analysis

Statistical evaluation employed descriptive statistics (mean values, standard errors, and relative frequencies). Group comparisons were conducted using the  $\chi^2$  test and Student's t-test, with  $p < 0.05$  considered statistically significant.

## 3. Results

### 3.1. Early Stoma-Related Complications

Early postoperative complications were significantly more common in the comparison group, affecting 53.5% of patients (38 cases), compared to 27.3% (15 cases) in the main group ( $\chi^2=8.762$ ;  $df=1$ ;  $p=0.003$ ). The most frequent complications in both groups included parastomal superficial suppuration, intestinal obstruction, and bowel retraction (Table 1).

Table 1. Structure and incidence of early stoma-related complications

Type of complication	Comparison group (n=71)	Main group (n=55)
Bleeding	2 (2.8%)	1 (1.8%)
Necrosis	3 (4.2%)	1 (1.8%)
Evisceration	3 (4.2%)	2 (3.6%)
Parastomal superficial suppuration	9 (12.7%)	3 (5.5%)
Parastomal abscess	4 (5.6%)	2 (3.6%)

Type of complication	Comparison group (n=71)	Main group (n=55)
Parastomal phlegmon	2 (2.8%)	1 (1.8%)
Bowel retraction	5 (7.0%)	2 (3.6%)
Acute intestinal obstruction	6 (8.5%)	1 (1.8%)
Stomal suture failure	4 (5.6%)	2 (3.6%)
Total with complications	38 (53.5%)	15 (27.3%)

( $\chi^2=8.762$ ;  $df=1$ ;  $p=0.003$ )

### 3.2. Systemic Postoperative Complications

Systemic complications were observed in 46.5% (33 cases) of children in the comparison group versus 25.5% (14 cases) in the main group ( $\chi^2=5.86$ ;  $df=1$ ;  $p=0.016$ ). Bronchopulmonary, septic, and multiple organ failure complications were the most frequent (Table 2).

Table 2. Incidence and structure of systemic postoperative complications

Type of complication	Comparison group (n=71)	Main group (n=55)
Bronchopulmonary	8 (11.3%)	4 (7.3%)
Cardiovascular	5 (7.0%)	3 (5.5%)
Septic	7 (9.9%)	2 (3.6%)
Psychoneurological	6 (8.5%)	3 (5.5%)
Multiple organ failure	7 (9.9%)	2 (3.6%)
Total systemic complications	33 (46.5%)	14 (25.5%)

( $\chi^2=5.86$ ;  $df=1$ ;  $p=0.016$ )

### 3.3. Surgical and Conservative Management

Surgical intervention for stoma-related complications was required in 15.5% of children in the comparison group and 7.3% in the main group. Procedures included debridement and closure for evisceration, abscess drainage, phlegmon resection with vacuum-assisted therapy, bowel revision and re-stoma formation for retraction, and adhesiolysis for obstruction. Conservative therapy—comprising pharmacological treatment, physiotherapy, and targeted local wound management—was sufficient in 9.9% of comparison group cases and 20% of main group patients.

### 3.4. Severity of Complications

According to the Clavien–Dindo classification (2004), severe complications (grades III–V) were substantially more common in the comparison group (49.3%) than in the main group (14.6%) ( $p=0.002$ ). Mortality rates were 15.5% and 5.5%, respectively. In contrast, mild complications (grades I–II) were more prevalent in the main group (21.8% vs. 14.1%), and complication-free recovery was achieved in 63.6% of main group patients versus 36.6% in the comparison group (Table 3).

Table 3. Distribution of complications by Clavien–Dindo grade

Clavien–Dindo grade	Comparison group (n=71)	Main group (n=55)
Grade I–II	10 (14.1%)	12 (21.8%)
Grade III	17 (23.9%)	4 (7.3%)
Grade IV	7 (9.9%)	1 (1.8%)
Grade V (death)	11 (15.5%)	3 (5.5%)
No complications	26 (36.6%)	35 (63.6%)

( $\chi^2=16.87$ ;  $df=4$ ;  $p=0.002$ )

### 3.5. Hospitalization Duration

The mean postoperative hospital stay was  $13.2 \pm 0.5$  days in the comparison group and  $11.5 \pm 0.35$  days in the main group ( $t=3.05$ ;  $p<0.001$ ), indicating significantly faster recovery under the optimized protocol.

### 3.6. Long-Term Outcomes

Long-term follow-up (up to 3 years) was achieved for 60 children from the comparison group and 52 from the main group. Late stoma-related complications occurred in 40.0% of the comparison group and 19.2% of the main group ( $p=0.017$ ). Peristomal skin disorders were found in 41.7% and 21.2%, respectively ( $p=0.015$ ).

The most frequent late complications included prolapse, mucosal hypergranulation, and parastomal fistulas (Table 4).

Table 4. Late postoperative complications

Type of complication	Comparison group (n=60)	Main group (n=52)
Stoma-related:		
Prolapse	5 (8.3%)	2 (3.8%)
Parastomal hernia	3 (5.0%)	1 (1.9%)
Stoma retraction	4 (6.7%)	1 (1.9%)
Stricture	3 (5.0%)	2 (3.8%)
Parastomal fistula	4 (6.7%)	1 (1.9%)
Mucosal hypergranulation	5 (8.3%)	3 (5.8%)
Total stoma-related	24 (40.0%)	10 (19.2%)
Peristomal skin:		
Dermatitis	18 (30.0%)	8 (15.4%)
Skin hypergranulation	3 (5.0%)	1 (1.9%)
Folliculitis/Pyoderma	4 (6.7%)	2 (3.8%)
Total peristomal	25 (41.7%)	11 (21.2%)

### 3.7. Reconstructive Surgery and Stoma Closure

Surgical correction of long-term complications was required in 8 patients (22.2%) from the comparison group and 2 (4.7%) from the main group. The most common indications were strictures and parastomal fistulas. Within the 3-year follow-up, restorative operations were performed primarily in patients with single-barrel stomas (30.0% vs. 32.7%).

Radical reconstruction and stoma closure were achieved more often in the main group (17.3% vs. 11.7%), whereas persistent functioning stomas were significantly more frequent in the comparison group (16.7% vs. 3.8%), indicating a more proactive surgical approach in the optimized program (Table 5).

Table 5. Restorative procedures and stoma closure within 3 years

Type of intervention	Comparison (n=60)	Main (n=52)
Restorative for single-barrel stoma	18 (30.0%)	17 (32.7%)
Resection + single-barrel stoma	2 (3.3%)	1 (1.9%)
Double-barrel stoma closure	14 (23.3%)	6 (11.5%)
Resection + double-barrel stoma	9 (15.0%)	13 (25.0%)
Radical surgery with stoma elimination	7 (11.7%)	9 (17.3%)
Functioning stoma (not operated)	10 (16.7%)	2 (3.8%)

The mean interval before restorative surgery was significantly reduced in the main group ( $3.2 \pm 0.6$  months) compared to the comparison group ( $7.2 \pm 0.7$  months) ( $t=3.32$ ;  $p<0.001$ ). The accelerated timing is attributed to enhanced preoperative rehabilitation, improved nutritional recovery, and lower complication incidence.

#### 4. Discussion

The findings of this study demonstrate that implementing a structured and multidisciplinary rehabilitation program significantly improves outcomes in pediatric patients with ileostomies. Specifically, the approach shortened the time to reconstructive surgery, lowered postoperative complication rates, and enhanced recovery. These benefits were associated with improved preoperative preparation, reduced systemic stress, and accelerated intestinal adaptation—collectively leading to better long-term rehabilitation results. Previous research has shown that overall complication rates among children with intestinal stomas, including mild to severe forms, can exceed 70%, consistent with our observations [10–13]. Children are particularly prone to complications both during the stoma's functional period and at the closure stage. For instance, in a retrospective review of 336 pediatric cases, severe complications classified as Clavien–Dindo grade III or higher occurred in nearly 39% of children under three years of age [14]. Additionally, postoperative complications following planned stoma closure—such as anastomotic leakage, hernias, or adhesive obstruction—were reported in approximately 23% of patients [14]. Importantly, ileostomies are generally associated with a higher risk of adverse outcomes than colostomies, largely due to the more caustic, high-volume effluent of the ileum. Studies have identified ileostomy formation as an independent risk factor, increasing the likelihood of severe complications by roughly 2.5 times [2,4]. The elevated fluid and electrolyte losses typical of ileostomy output predispose young children to dehydration, metabolic imbalances, and peristomal skin injury.

High-output stomas remain one of the most clinically challenging complications, particularly in neonates and infants, as they can lead to malnutrition and intestinal failure. Despite this, no standardized management algorithm currently exists for pediatric high-output enterostomies. A 2024 systematic review highlighted the absence of high-quality evidence to guide management and called for the development of comprehensive, stepwise strategies incorporating dietary modulation, fluid and electrolyte therapy, chyme reinfusion, and pharmacological interventions [15]. Until such evidence-based guidelines are available, clinical management continues to rely heavily on surgical experience and institutional protocols. Current best practices include close monitoring of fluid-electrolyte balance, the use of stool-thickening agents, medications that slow intestinal transit, and the earliest possible initiation of enteral nutrition to promote mucosal adaptation. Another key concern in pediatric ileostomy management is minimizing hospital stay and total treatment duration. The timing of stoma closure directly affects these outcomes. In the present study, earlier closure, achieved through improved preoperative rehabilitation, reduced total hospitalization time without increasing the risk of postoperative complications. Comparable results have been reported internationally. A retrospective analysis of necrotizing enterocolitis cases compared outcomes for early (<8 weeks), intermediate (8–12 weeks), and delayed (>12 weeks) ileostomy closure. Although early closure was associated with slightly longer postoperative hospitalization due to lower body weight and immaturity, the total duration of care from stoma creation to final discharge was not significantly different among groups. Furthermore, the complication rate was unaffected by closure timing, indicating that early closure does not increase the risk of anastomotic leaks or infections [16]. Other studies have suggested that prolonged maintenance of a temporary ileostomy may be detrimental, increasing the risk of stoma-related complications, electrolyte disturbances, and impaired growth. In comparisons between traditional (8–12 weeks) and early (approximately 4 weeks) closure, the early closure group experienced fewer stoma-related complications, though wound infections were slightly more frequent [17].

Our findings are consistent with these trends: when certain clinical prerequisites are met—namely, a stable general condition, adequate weight gain, absence of active infection, and restored distal bowel patency—early restoration of intestinal continuity is both safe and beneficial. Beyond reducing complications, early closure facilitates patient care, improves nutritional absorption, and supports catch-up growth. The criteria for stoma closure in children vary internationally and are typically guided by clinical readiness rather than fixed time intervals. Surveys among pediatric surgeons in the United Kingdom report that most aim for closure within six weeks of stoma creation; however, in practice, the timing often depends on patient-

specific factors such as nutritional status, weight gain, and the absence of stoma-related complications [18,19]. A systematic review of global literature concluded that delayed stoma closure offers no clear advantage and may even increase morbidity [18–20]. Thus, early restoration of intestinal continuity—once patient stability and readiness are achieved—is now considered a standard of modern pediatric surgical practice. The present study supports this paradigm, showing that detailed tactical planning—including comprehensive rehabilitation, individualized timing of closure, and multidisciplinary collaboration—can significantly improve postoperative recovery and long-term outcomes. These findings align with international evidence emphasizing early closure, enhanced perioperative care, and systematic complication prevention as the cornerstones of optimal management for pediatric ileostomy patients. Nevertheless, several limitations must be acknowledged. First, the sample size was relatively modest, limiting subgroup analyses by specific disease type, age, or severity. Second, the retrospective component (2014–2019) may have been affected by incomplete clinical documentation. Third, the single-center design limits generalizability, underscoring the need for larger, multicenter prospective studies to confirm these results.

### 5. Conclusions

The introduction of a comprehensive rehabilitation framework integrating both advanced local and systemic therapeutic measures has demonstrated substantial clinical benefits in pediatric patients with ileostomies. This multidisciplinary approach effectively reduced the frequency and severity of postoperative complications, enhanced intestinal recovery, shortened hospitalization periods, and facilitated earlier restorative surgery. By emphasizing patient and caregiver education, individualized stoma care, optimized nutritional management, and the use of adjunctive technologies such as low-intensity laser therapy, this protocol contributed to improved early and long-term postoperative outcomes. The results of this study confirm that structured rehabilitation should be considered an essential component of postoperative management for children with ileostomies. Future multicenter studies with larger patient cohorts are recommended to validate these findings and further refine evidence-based standards for pediatric stoma care and surgical rehabilitation.

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