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Incidence of bloodstream infections in small bowel transplant recipients receiving selective decontamination of the digestive tract: A single-center experience

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Abstract

Pediatric patients undergoing small bowel transplantation are susceptible to postoperative CLABSI. SDD directed against enteric microbes is a strategy for reducing CLABSI. We hypothesized that SDD reduces the frequency of CLABSI, infections outside the bloodstream, and allograft rejection during the first 30 days following transplant. A retrospective chart review of 38 pediatric small bowel transplant recipients at CCHMC from 2003 to 2011 was conducted. SDD antimicrobials were oral colistin, tobramycin, and amphotericin B. The incidence of CLABSI, infections outside the bloodstream, and rejection episodes were compared between study periods. The incidence of CLABSI did not differ between study periods (6.9 CLABSI vs. 4.6 CLABSI per 1000 catheter days; $p = 0.727$), but gram positives and *Candida* predominated in the first 30 days. Incidence of bacterial infections outside the bloodstream did not differ ($p = 0.227$). Rejection occurred more frequently during the first month following transplant ($p = 0.302$). SDD does not alter the incidence of CLABSI, bacterial infections outside the bloodstream, or allograft rejection

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Authors' contributions

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Conflict of interest

All authors have no conflict of interest.

in the immediate 30 days post-transplantation. However, SDD does influence CLABSI organism types (favoring gram positives and *Candida*) and *Candidal* infections outside the bloodstream.

Keywords

pediatric transplantation; intestinal transplantation; infectious risk

Patients undergoing small bowel or combined liver/small bowel transplantation are at risk for a variety of significant complications that occur prior to and following transplantation. Among the most serious and life-threatening challenges encountered following transplantation are CLABSIs with fungal and bacterial species, particularly within the first postoperative month (1–5). The incidence of these infections is substantial (6–9), and reduction in risk for CLABSIs has been a main focus of pretransplant, perioperative, and post-transplant care.

A strategy to reduce the incidence of infection following transplant is SDD directed at gram-negative aerobes and fungal species (i.e., *Candida*) that most commonly elicit CLABSI. Established in 1984 among adult trauma patients admitted to intensive care units (10), SDD employs the use of both systemic and oral antibiotics in an attempt to eradicate offending organisms and thus reduce the incidence of CLABSI. SDD was first applied in adults following liver transplantation in 1988 (11). Since that time, studies have attempted to analyze the various effects of SDD regimens on infection rates, resistance patterns, and mortality (1). Although some of the data include pediatric subjects (12), the vast majority of studies regarding the use of SDD following liver and/or small bowel transplant have been in adults and animal models (3–5). Human data regarding the utility of SDD following pediatric small bowel transplantation are conspicuously absent.

This study investigates the efficacy of an SDD regimen on the rate of CLABSI and type of infection (bacterial species) during the first 30 days following small bowel transplantation in pediatric subjects, compared to the subsequent 30 days following SDD discontinuation. Furthermore, we review the potential influence of an SDD regimen on the incidence of infections outside the bloodstream (lung, peritoneum, and wound), incidence of allograft rejection, and composition of small bowel bacterial flora during these two time periods.

Materials and methods

In this retrospective observational study, charts of pediatric small bowel transplant recipients at CCHMC from 2003 to 2011 were reviewed. Subjects who met the following inclusion criteria were enrolled: (i) use of an SDD regimen following transplantation and (ii) post-transplant care provided at CCHMC during the study period (60 days). Subjects who met the following exclusion criteria were removed from chart review: death or transfer of care within 60 days following transplantation. Multiple data points were recorded from each subject via electronic chart review. Incidence of CLABSI, susceptibility testing of organisms from positive blood cultures, incidence of other types of infection (lung, peritoneum, and wound), organism identification from all positive cultures obtained in the blood and other sites (lung, peritoneum, and wound), incidence and type of rejection episodes, and antibiotics

administered with the duration of each were reviewed for each of the two time periods following transplantation. A “CLABSI” was defined using the criteria established by the National Nosocomial Infections Surveillance System (13), which states, “a CLABSI is a primary BSI in a patient that had a central line within the 48-h period before the development of the BSI and is not bloodstream related to an infection at another site.” “Other infections” were defined as follows:

Lung infections: ventilator-associated pneumonias as defined by the NHSN (14) (two or more days of mechanical ventilation, worsening oxygenation, and positive culture from endotracheal tube).

Peritoneal infections: positive culture from fluid samples obtained incidentally from abdominal fascial closure surgery or reoperation for intestinal perforation or leak.

Wound infections: positive culture from the surgical incision site accompanied by cellulitis, abscess, or drainage.

The diagnosis of acute cellular rejection of the small bowel allograft is determined histologically at our institution using graded criteria (indeterminate – 1, mild – 2, moderate – 3, severe – 4) adopted from Wu et al. (15), established in 2003. For this study, only those tissue samples whose histological grade of rejection was mild (grade 2) or higher were included. Mild rejection (grade 2) is defined as “mild localized inflammatory infiltrate with activated lymphocytes, mild crypt epithelial injury, increased crypt epithelial apoptosis (usually with >6 apoptotic bodies/10 crypts), mild architectural distortion, and no mucosal ulceration” (15). As per the protocol following small bowel transplantation, transplant recipients at CCHMC undergo weekly ileoscopy for rejection surveillance during the first 10 wk following transplant (twice weekly for the first four wk, once weekly during weeks 5–10). Intestinal aspirates from these surveillance ileoscopies with bacterial counts above 100 000 (10^5) cfu/mL of intestinal fluid were included for comparison according to microbial composition (GPB, GNB, mixed [GPB and GNB], or yeast). These observations were then compared between the two time periods: first 30 days following transplant vs. day 31–60 following transplant. Data were entered into an IRB-approved database for evaluation and statistical analysis. A central venous catheter was in place for all subjects included in this study during the entire study period of 60 days. All patients received the following oral agents for SDD as per the CCHMC intestinal transplant protocol during the initial 30 days following transplantation: colistin, tobramycin, and amphotericin B. Four subjects were transitioned off amphotericin B to nystatin due to intolerance. The rationale for employing SDD for 30 days was because the new allograft is most vulnerable to translocation during the first few weeks following transplantation, but an excessively long regimen will theoretically promote colonization of polymicrobial-resistant organisms.

All small bowel transplant recipients received a single dose of intraoperative thymoglobulin and again one day postoperatively as preconditioning. Additionally, all transplant recipients received a combination of oral tacrolimus and intravenous methylprednisolone for immunosuppression as per the CCHMC intestinal transplant protocol.

Bacterial, viral, and fungal prophylaxis with piperacillin–tazobactam, ganciclovir, fluconazole, and trimethoprim–sulfamethoxazole was also provided for various intervals to all transplant recipients as per the institutional protocol.

Data analysis

Statistical analysis was performed using SAS[®] software (V9.13, SAS Institute Inc., Cary, NC, USA). McNemar's exact test comparing marginal proportions was used to compare incidence of CLABSI, incidence of infections outside the bloodstream, and incidence of rejection among study subjects between the study time periods (days 0–30 and days 31–60 following transplant). Further analysis using McNemar's exact test was performed to assess the rate of CLABSI by bacterial type (gram positive vs. gram negative), the rate of infections outside the bloodstream by location (lung, peritoneum, and wound), and bacterial gram type (positive vs. negative) from intestinal aspirates between the study time periods (day 0–30 and days 31–60 following transplant). For statistical purposes, if multiple observations (i.e., more than one CLABSI) were noted to occur for the same subject in a study period (30 days), only one overall observation (i.e., one CLABSI) was counted for that particular subject in that study period. Statistical significance was based on a 5% significance level. *Post hoc* sample size calculation was performed using online software (https://www.statstodo.com/SSizMcNemar_Pgm.php).

Results

In total, 38 patients who underwent small bowel transplantation at CCHMC between January transplantation at CCHMC between January 2003 and December 2011 were identified for chart review. Of these patients, nine died before reaching the 60-day post-transplant period of observation, resulting in exclusion from the study. Causes of death include multi-organ failure (3), sepsis (1), intra-abdominal hemorrhage (1), cardiac arrest (1), graft removal (1), cardiopulmonary failure (1), and other (1). The median age of the 29 subjects included for review was 12 months (Table 1) with a range of five months to 17 yr. Among transplant recipients, short bowel syndrome secondary to various etiologies was the most common primary diagnosis (76%; 22 of 29). Causes of short bowel syndrome included necrotizing enterocolitis (36%, eight of 22); gastroschisis with associated atresia (32%, seven of 22); midgut volvulus (18%, four of 22); and one subject each with a history of meconium peritonitis, congenital short bowel, and mesenteric ischemia. Intestinal failure was the primary disease listed in the remaining seven transplant recipients and was attributed to several causes including pseudo-obstruction (28%, two of seven), megacystis microcolon intestinal hypoperistalsis (28%, two of seven), Hirschsprung's disease (28%, two of seven), and familial adenomatous polyposis syndrome with large desmoid tumor (14%, one of seven). The type of allograft received varied among study subjects. Composite liver–small bowel–pancreas was the most common type of transplantation performed (21 of 29 subjects, 72%), followed by composite liver–small bowel–colon–pancreas (five of 29, 17%) and then isolated small bowel (three of 29, 10%). All study subjects were placed on an SDD regimen during the first 30 days as per the CCHMC protocol following transplant.

Bloodstream infections

The incidence of CLABSI between the two observed study periods did not differ significantly. There were eight CLABSIs among six transplant recipients (6.9 CLABSI per 1000 catheter days) during the first 30 days following transplant compared to seven CLABSIs among four subjects (4.6 CLABSI per 1000 catheter days) during the subsequent 30 days after discontinuation of the SDD regimen ($p = 0.727$). As a reference, our institutional rate of CLABSI is 1.1 per 1000 catheter days, while among children with intestinal failure, the CLABSI rate is 1.9 per 1000 catheter days. CLABSIs by bacterial gram type (positive vs. negative) were also analyzed (Fig. 1). Gram-positive organisms (*Enterococcus* and coagulase-negative *Staphylococcus*) comprised the majority of CLABSIs (87%) during the initial 30-day post-transplant period, while GNB (*Escherichia coli*, *Klebsiella oxytoca*) encompassed the bulk of CLABSIs (71%) during days 31–60 postoperatively. However, neither of these observations were significantly different between the two study periods ($p = 0.453$ and 0.625 , respectively). Fungal CLABSIs did not occur during either of the study periods following transplantation.

Infections outside the bloodstream

Bacterial infections outside the bloodstream (sites recorded were lung, peritoneum, and wound) among the designated study periods did not differ significantly. During the initial 30-day post-transplant period, outside infections occurred in 11 of 29 transplant recipients (37.9%), compared to six of 29 subjects (20.7%) during the subsequent 30 days following transplant ($p = 0.227$). Lung infections were the most frequent type of outside infection occurring in transplant recipients during the initial post-transplant period (seven of 29 individuals, 24.1%). However, during days 31–60 post-transplant, lung infections were significantly less frequent (3.45%; $p = 0.07$). There was no statistically significant difference in peritoneal or wound infections between the two periods (Fig. 2).

Infections outside the bloodstream were also characterized in frequency among transplant recipients based on organism type (GNB, GPB, fungal). Organisms cultured by type are as follows: GNB (*Pseudomonas aeruginosa*, *Serratia marcescens*, *Enterobacter aerogenes*, *E. coli*, and *Stenotrophomonas maltophilia*), GPB (*Enterococcus* species, coagulase-negative *Staphylococci*, *Enterococcus faecium*, and *Staphylococcus epidermidis*), and yeast (*Candida krusei*, *Candida albicans*). For infections outside of the bloodstream, GNB were recovered more frequently than GPB or yeast in both study periods (31% of subjects [nine of 29] during days 1–30 and 20.7% of subjects [six of 29] through days 31–60; $p = 0.549$; Fig. 3). Infections outside the bloodstream with *Candida* organisms were observed among transplant recipients only during the initial 30 days following transplant and were absent during the second study period (24.1% of recipients (seven of 29); $p = 0.016$), with the peritoneum being the most common site. There was no statistically significant difference in peritoneal or wound infections between the two periods (Fig. 2).

Rejection episodes

Episodes of rejection were reviewed among transplant recipients within each study period. Only episodes of grade 2 or higher rejection were included for analysis. Rejection was more prevalent (34.5%, 10 of 29 recipients) during the initial 30 days post-transplant compared to

days 31–60 (17.2%, five of 29 recipients), but this did not reach statistical significance ($p = 0.302$). Timing of rejection episodes with regard to CLABSI was also reviewed. Among transplant recipients who experienced rejection in the first study period, 30% (three of 10) of these episodes preceded and/or accompanied a CLABSI. During the second study period, rejection episodes did not precede or accompany any of the CLABSIs observed.

Small bowel colonization

As per the protocol following transplant, patients underwent weekly ileoscopy for rejection surveillance during the first 10 wk following transplant (twice weekly for the first four wk, once weekly thereafter). This provided the opportunity to observe for any possible influence of SDD on small bowel bacterial flora composition. During the initial 30 days post-transplant, aspirates composed of only gram-positive flora were more prevalent (10 of 29 subjects, 34.5%) than gram-negative-only, mixed, or yeast-only aspirates. Gram-negative-only aspirates were more common (12 of 29 recipients, 41.4%) than gram-positive-only, mixed, or yeast-only aspirates throughout days 31–60 after transplantation. Mixed aspirates were more prevalent during the second study period (seven of 29 recipients, 24%) compared to first 30 days post-transplant (four of 29, 13.8%). Yeast exclusive aspirates were only found during the initial 30 days after transplant among study subjects (three of 29, 10.3%). None of these observations were significant (Fig. 4).

Discussion

Bloodstream infections are among several significant challenges that healthcare providers encounter in the management of transplant recipients during the immediate post-transplant period. Intestinal translocation of gram-negative aerobic bacteria, engendered by various factors such as the transient compromise of intestinal barrier function, serves as a possible mechanism for the development of CLABSI in these patients. SDD is one method employed in an attempt to reduce the incidence of CLABSI by eradicating the organisms most commonly implicated, aerobic bacteria and yeast, from the gastrointestinal tract.

The primary aim of our study was to evaluate the influence of SDD on the rate of CLABSI in pediatric subjects following small bowel transplantation. We found that in our cohort of pediatric small bowel transplant recipients, the utilization of an SDD regimen did not significantly alter the incidence of CLABSI between the first and second months post-transplantation. This is comparable to the published data in the adult liver transplant population (2, 16, 17). Although the incidence of CLABSI did not differ between the two observed study periods, bacterial gram type did differ with respect to SDD. CLABSI with GNB was less frequent among post-transplant recipients during the first month postoperatively during which an SDD was being administered. This is similar to the conclusion reached in a systematic review and meta-analysis of SDD in liver transplant patients that determined that SDD is Effective in reducing the number of gram-negative bacterial infections (1). We believe this is an important end-point of SDD as CLABSI in the first few weeks following transplantation, particularly with GNB, is very common and has been associated with increased morbidity and mortality in liver and intestinal transplant recipients (18–20). We recognize that SDD does not decrease mortality in transplant

recipients by systematic review, although this particular end-point has historically been difficult to measure statistically due to limited sample size in this population (1).

The potential for SDD to induce bacterial resistance over time is a matter of concern that we investigated. A review of all blood stream isolates up to 12 months following transplantation in our cohort of transplant recipients revealed that resistance patterns of gram-negative organisms were unchanged toward colistin and tobramycin. Insofar as SDD has been part of the post-transplantation management since inception of the small bowel transplant program at CCHMC, a control group of transplant recipients naive to SDD was not available for comparison.

A second aim was to determine the impact of an SDD regimen on the incidence of infections outside the blood stream. In our study, we did not observe a statistically significant difference in the incidence of infections between study periods. Furthermore, while SDD was shown to decrease the load of gram-negative-flora-only aspirates (Fig. 4), gram negatives were the predominant organisms found in infections outside the bloodstream during both study periods (Fig. 3). This suggests that SDD elicits little influence on organism type with regard to outside infections. Among sites for outside infections, the lung was the most commonly infected site during the first 30 days post-transplant. We believe this is related to endotracheal intubation during the immediate post-transplant period rather than administration of SDD as our subjects can remain endotracheally intubated for up to one wk following transplantation. All of the VAPs from the initial 30 days post-transplant occurred between two and 19 days post operatively (median of seven days). We only observed one VAP in the second study period (days 31–60). Although *Candidal* CLABSIs were not seen in our study, *Candidal* infections outside the bloodstream were observed. However, these were only seen during the initial 30 days following transplant and most commonly involved the peritoneum, followed in frequency by the lungs. The reasons for this observation are unclear. Both amphotericin B and nystatin (either can be used in SDD) and fluconazole (intravenous prophylactic dose given for the first 30 days following transplant) provide adequate coverage against most *Candidal* species including *C. albicans*, *C. krusei*, and *C. glabrata* (21). One explanation may be the ubiquitous nature in which *Candida* inhabits the human body (22). Although SDD targets *Candida* in the gastrointestinal tract, other sites that harbor *Candida* still have the potential to serve as sources for fungal transmission despite optimal postoperative care. Another factor to be considered is the level of immunosuppression delivered to transplant recipients. During the first month following transplantation, subjects at CCHMC are on a combination of high-dose steroids and tacrolimus. Although target levels of tacrolimus remain the same throughout the first two months, the dose of steroids declines substantially with the goal of being off completely by eight wks post-transplant. This added suppression of the immune system likely contributes to the greater potential for *Candidal* infection in the first post-operative month.

The impact of an SDD regimen on the incidence of graft rejection was also explored in our study. The basis for this hypothesis stems from the potential relationship discovered between enteric bacteremia and allograft rejection described by Sigurdsson et al. (23) in pediatric intestinal transplant patients. In their cohort of 62 patients, they found that bacteremia (predominantly, gram-negative rods) accompanied rejection at a significant rate (31%). If we

extrapolate from the Sigurdsson data, given that 10 of our patients exhibited rejection in the first 30 postoperative days, we would have expected three bacteremic episodes with gram negatives or Enterococci. Instead, we saw one. However, bacteremia (now with gram-positive organisms) accompanied rejection episodes 30% of the time in our cohort of patients, which is comparable to that reported by Sigurdsson et al. Of note, the incidence of acute cellular rejection during the first 30 days postoperatively was higher compared to days 31–60. Increased rates of rejection following intestinal transplantation early on have been described in the literature and, in general, exceed those rates observed for other solid organ transplants (24). These rates do vary based on selected immunosuppressive therapy regimens and type of allograft (i.e., isolated small bowel vs. multivisceral) (25, 26). Clearly, there are many factors that influence the occurrence of allograft rejection, including immunosuppressive agents, levels of immunosuppression, surveillance for rejection, and compliance. This study could not control for these.

One of the possible mechanisms for the development of CLABSI in the first month following transplantation is via bacterial translocation from the small bowel. This has been described previously in adults following intestinal transplantation (27). Therefore, as an exploratory aim, we attempted to assess the impact of SDD on the bacterial flora of the small intestine. At CCHMC, all post-intestinal transplant recipients undergo weekly ileoscopy for the first 10 wk following small bowel transplantation. This afforded the opportunity to analyze aspirate composition and trends through direct quantitative aerobic and anaerobic culture for the surveillance of enteric flora. We recognize that this technique is largely being supplanted by molecular analysis of the microbiome (28). Whether results employing newer microbiological techniques would differ remains to be seen. Our study did find that SDD does appear to reduce colonization with GNB as intended during the first month following transplantation. When the SDD regimen was discontinued in our cohort, GNB seem to repopulate the small bowel. GPB were not influenced by an SDD regimen. These findings with regard to colonization with gram-negative flora are similar to what Stoutenbeek et al. (10) reported in 1984. In their study, colonization with GNB was reduced from 80% to 16% culturing from oral and rectal swabs in addition to analyzing feces. In our study, gram-negative bacterial aspirates were reduced by 58% with the utilization of an SDD regimen.

Some study limitations that are inherent in this project should be mentioned. Our sample size is small, posing significant difficulty in designing a study sufficiently powered to prove statistical significance. This challenge faces all who attempt to study transplantation and is even more formidable in the analysis of pediatric intestinal transplantation. For example, our study detected a 7% difference in incidence of CLABSIs derived from GNB. If one desired to design a study (power 0.80, type 1 error = 0.05) to replicate this finding, 114 subjects would need to be enrolled. Another limitation is the unknown influence of potential confounders to our outcome variables. For instance, time after transplant may in itself act as an independent variable in risk for the end-points investigated. Logically, transplant recipients are more vulnerable to infection throughout the days and weeks immediately following transplantation primarily as a natural consequence of the surgical process (i.e., intubation, Foley catheter placement, and follow-up surgical procedures). These inherent differences remain influential independent of antimicrobials administered. Without a true

control group (no SDD following transplant), it is difficult to delineate this further. Another potential confounder is the variation in the number and duration of antibiotics (enteral/parenteral) used in study subjects immediately prior to, during, and following transplantation and possible influence with our outcome variables. For example, perioperative piperacillin–tazobactam is provided to all transplant recipients starting on the day of transplantation and continuing for the first week postoperatively. This may have some influence on the suppression of gram-negative organisms. Finally, allograft type (isolated small bowel vs. liver–small bowel–pancreas vs. liver–small bowel–colon–pancreas vs. multivisceral) varied among study subjects. Composite liver–small bowel–pancreas was the most frequent type of allograft transplanted followed by several cases of composite liver–small bowel–colon–pancreas and isolated small bowel. To what extent allograft type influences either the incidence and type of infections or the incidence of acute cellular rejection remains unknown.

While our study displays several limitations, there are certainly strengths that make this study unique. Our study sheds valuable insight into the utilization of SDD on pediatric small bowel transplantation that otherwise has been lacking in the literature. Specifically, SDD, utilizing our particular “cocktail” of agents, does not alter the incidence of CLABSI in the immediate 30 days after small bowel transplantation compared to the subsequent 30 days off SDD. However, SDD does influence CLABSI organism type, suppressing GNB and favoring GPB. SDD does not alter the incidence of bacterial infections outside the blood stream but may exert influence on the rate of *Candida* infections outside the bloodstream during the first month following small bowel transplantation. If SDD is to be utilized, future studies directed at the pediatric small bowel transplant population should be designed at a multicenter level in order to achieve statistical significance and infer greater clinical applicability.

Abbreviations

BSI	bloodstream infection
CCHMC	Cincinnati Children’s Hospital Medical Center
CLABSI	central line-associated blood stream infections
GNB	gram-negative bacteria
GPB	gram-positive bacteria
NHSN	National Healthcare Safety Network
SDD	selective digestive decontamination
VAP	ventilator-associated pneumonia

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Fig. 1.

Effect of SDD and CLABSI among small bowel transplant recipients. Gram-positive organisms (*Enterococcus* and coagulase-negative *Staphylococcus*) comprised the majority of CLABSIs (87% [seven of eight], $p = 0.453$) during the initial 30-day post-transplant period where SDD was utilized. GNB (*Escherichia coli*, *Klebsiella oxytoca*) encompassed the bulk of CLABSIs (71% [five of seven], $p = 0.625$) during days 31–60 postoperatively off SDD. Fungal CLABSIs did not occur during either of the study periods following transplantation.

Fig. 2.

SDD and infections outside the bloodstream among small bowel transplant recipients. Lung infections were the most frequent type of outside infection occurring in 24.1% of transplant recipients (seven of 29) during the initial post-transplant period ($p = 0.070$) where SDD was utilized. Peritoneal infections and wound infections were equally as common throughout days 31–60 following transplantation off SDD among transplant recipients (two of 29 individuals, 6.9%, for each site). Lung infections were much less frequent during days 31–60 post-transplant and occurred in only one of 29 subjects (3.45%).

Fig. 3.

SDD and infections outside the bloodstream by organism type among small bowel transplant recipients. Outside infections with GNB occurred more frequently than outside infections with GPB or fungal organisms among transplant recipients in both study periods (nine of 29 during days 1–30 and six of 29 through days 31–60; $p = 0.549$). Infections outside the bloodstream with *Candida* organisms were more prevalent among transplant recipients (seven of 29) during the initial 30 days following transplant ($p = 0.016$). GNB: *Pseudomonas aeruginosa*, *Serratia marcescens*, *Enterobacter aerogenes*, *Escherichia coli*, *Stenotrophomonas maltophilia*; GPB: (*Enterococcus species*, coagulase-negative *Staphylococci*, *Enterococcus faecium*, *Staphylococcus epidermidis*); Fungal: *Candida krusei*, *C. albicans*.

Small bowel transplant and digestive decontamination

Fig. 4.

Effect of SDD on composition of small bowel intestinal aspirates among transplant recipients. During the initial 30 days post-transplant where SDD utilized, grampositive-flora-only aspirates were the most common type obtained among transplant recipients (10 of 29 subjects, 34.5%). Gram-negative-only aspirates were more commonly obtained (12 of 29 recipients, 41.4%) throughout days 31–60 after transplantation. Yeast exclusive aspirates were only found during the initial 30 days after transplant among study subjects (three of 29, 10.3%).

Table 1

Demographics and characteristics of study subjects enrolled

Number of patients	29
Mean age (yr)	2.75
Median age (months)	12 (range: 5–205)
Primary diagnosis	No. patients (%)
Intestinal failure	7 (24)
Pseudo-obstruction	2 (7)
Megacystis microcolon	2 (7)
Hirschsprung's disease	2 (7)
FAP with desmoid tumor	1 (3.25)
Short gut syndrome	22 (76)
Necrotizing enterocolitis	8 (28)
Gastroschisis	7 (24)
Midgut volvulus	4 (14)
Meconium peritonitis	1 (3.25)
Congenital short gut	1 (3.25)
Mesenteric ischemia	1 (3.25)
Transplant type	No. patients (%)
Composite liver–small bowel–pancreas	21 (72.4)
Composite liver–small bowel–colon–pancreas	5 (17.2)
Isolated small bowel	3 (10.4)

FAP, familial adenomatous polyposis.