



# A Comparison of Pediatric Intestine Transplantation Between the Current Era (2015-2019) and the Peak Period (2002-2006)

Horslen S<sup>1,2</sup>; Weaver T<sup>2</sup>; Skeans M<sup>2</sup>

<sup>1</sup>Seattle Children's Hospital, Seattle, WA; <sup>2</sup>Scientific Registry of Transplant Recipients, Minneapolis, MN

## Introduction

- Intestine transplant became a clinical reality for children with intestinal failure in the early 1990s
- Demand increased, driven by very high mortality rates for infants and children on long-term parenteral nutrition (PN) and improving posttransplant survival
- Demand peaked in 2007, with 111 small bowel-containing transplants in pediatric recipients
- Since 2007, referral and listing of infants and children for intestine transplant declined
- Pretransplant mortality rates have declined due to improvement in the care of children with chronic intestinal failure
- This poster compares listing and recipient cohorts in a contemporary 5-year cohort (January 2015-December 2019) with the 5 years just before peak intestine transplant activity (January 2002-December 2006)

## Methods

- For Table 1, all intestine transplant *candidates* younger than 18 at listing are included
- For all other results, all intestine transplant *recipients* younger than 18 at listing are included
- For each era, we present descriptive summary statistics for both new waitlist candidates and transplant recipients
- For transplant recipients, statistics related to their transplant are also presented
- New waitlist candidates and transplant recipients are considered independently:
  - Some, but not all, listed in either may have received transplants in that era
  - Some who received transplants in either era may have been listed in that era, but some may have been listed earlier
- Kaplan-Meier estimates of posttransplant graft survival are presented by era and by additional organ transplants

Table 1: Demographic Characteristics of Pediatric Intestine Transplant Candidates by Listing Year

Characteristic	Total	Listings in 2002-2006	Listings in 2015-2019
	N (%)*	N (%)*	N (%)*
<b>All</b>			
Total	1181	828	353
<b>Age At Listing (Years)</b>			
Median (Q1,Q3)	1.0 (0.0,4.0)	0.0 (0.0,2.0)	3.0 (1.0,7.0)
Mean (SD)	3.1 (4.8)	2.4 (4.4)	4.9 (5.1)
Minimum	0.0	0.0	0.0
Maximum	18.0	18.0	18.0
0-1 years	716 (60.6%)	596 (72.0%)	120 (34.0%)
2-10 years	337 (28.5%)	157 (19.0%)	180 (51.0%)
11-18 years	128 (10.8%)	75 (9.1%)	53 (15.0%)
<b>Weight (KG)</b>			
Median (Q1,Q3)	9.1 (6.5,16.9)	8.0 (6.0,12.7)	14.8 (9.0,22.3)
Mean (SD)	14.5 (13.8)	12.5 (12.2)	19.4 (16.0)
Minimum	2.0	2.0	3.4
Maximum	120.3	89.6	120.3
[2.6,6]	301 (25.5%)	263 (31.8%)	38 (10.8%)
(6.6,9.07]	294 (24.9%)	243 (29.3%)	51 (14.4%)
(9.07,16.6]	281 (23.8%)	162 (19.6%)	119 (33.7%)
(16.6,120]	301 (25.5%)	156 (18.8%)	145 (41.1%)
Unknown	4 (0.3%)	4 (0.5%)	0
<b>Sex</b>			
Female	503 (42.6%)	356 (43.0%)	147 (41.6%)
Male	678 (57.4%)	472 (57.0%)	206 (58.4%)
<b>Diagnosis</b>			
SGS: NEC	200 (16.9%)	143 (17.3%)	57 (16.1%)
SGS: Other	583 (49.4%)	412 (49.8%)	171 (48.4%)
IN-FBP	193 (16.3%)	123 (14.9%)	70 (19.8%)
Other Disease	203 (17.2%)	148 (17.9%)	55 (15.6%)
Unknown	2 (0.2%)	2 (0.2%)	0
<b>Any Previous Transplants</b>			
No	1039 (88.0%)	749 (90.5%)	290 (82.2%)
Yes	142 (12.0%)	79 (9.5%)	63 (17.8%)
<b>Any Previous Intestine Transplants</b>			
No	1059 (89.7%)	760 (91.8%)	299 (84.7%)
Yes	122 (10.3%)	68 (8.2%)	54 (15.3%)

Note: Pediatric candidates were 18 years old and younger at the time of listing. \*N(%), except as indicated in row label.

Table 2: Demographic Characteristics of Pediatric Intestine Transplant Recipients by Transplant Year

Characteristic	Total	Transplants in 2002-2006	Transplants in 2015-2019
	N (%)*	N (%)*	N (%)*
<b>All</b>			
Total	665	420	245
<b>Age At Listing (Years)</b>			
Median (Q1,Q3)	1.0 (0.0,6.0)	1.0 (0.0,4.0)	3.0 (1.0,8.0)
Mean (SD)	3.8 (4.9)	3.1 (4.8)	5.0 (5.0)
Minimum	0.0	0.0	0.0
Maximum	18.0	18.0	18.0
0-1 years	346 (52.0%)	266 (63.3%)	80 (32.7%)
2-10 years	235 (35.3%)	106 (25.2%)	129 (52.7%)
11-18 years	84 (12.6%)	48 (11.4%)	36 (14.7%)
<b>Weight (KG)</b>			
Median (Q1,Q3)	10.5 (7.2,20.0)	9.1 (6.7,17.0)	15.2 (9.6,22.7)
Mean (SD)	16.3 (14.3)	14.4 (13.1)	19.6 (15.7)
Minimum	2.3	2.3	3.3
Maximum	120.3	72.6	120.3
[2.6,6]	121 (18.2%)	101 (24.0%)	20 (8.2%)
(6.6,9.07]	145 (21.8%)	109 (26.0%)	36 (14.7%)
(9.07,16.6]	180 (27.1%)	99 (23.6%)	81 (33.1%)
(16.6,120]	215 (32.3%)	107 (25.5%)	108 (44.1%)
Unknown	4 (0.6%)	4 (1.0%)	0
<b>Sex</b>			
Female	299 (45.0%)	202 (48.1%)	97 (39.6%)
Male	366 (55.0%)	218 (51.9%)	148 (60.4%)
<b>Diagnosis</b>			
SGS: NEC	94 (14.1%)	54 (12.9%)	40 (16.3%)
SGS: Other	343 (51.6%)	222 (52.9%)	121 (49.4%)
IN-FBP	136 (20.5%)	86 (20.5%)	50 (20.4%)
Other Disease	91 (13.7%)	57 (13.6%)	34 (13.9%)
Unknown	1 (0.2%)	1 (0.2%)	0

Note: Pediatric recipients were 18 years old and younger at the time of listing. \*N(%), except as indicated in row label.

Figure 1: Kaplan-Meier Estimates of Graft Survival in Pediatric Intestine Alone and Intestine With Liver (+Pancreas) Transplant Recipients by Transplant Year

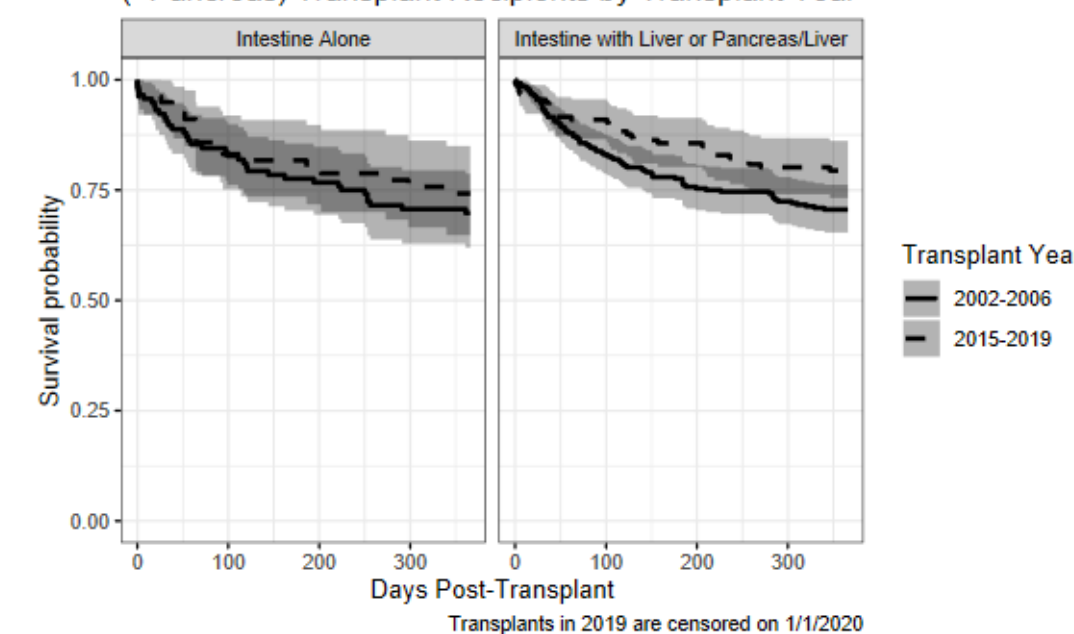


Table 3: Transplant Characteristics of Pediatric Intestine Transplant Recipients by Transplant Year

Characteristic	Total	Transplants in 2002-2006	Transplants in 2015-2019
	N (%)*	N (%)*	N (%)*
<b>All</b>			
Total	665	420	245
<b>Age At Transplant (Years)</b>			
Median (Q1,Q3)	2.5 (1.2,7.7)	1.7 (1.0,5.6)	4.8 (2.2,9.1)
Mean (SD)	5.0 (5.2)	4.2 (4.9)	6.5 (5.4)
Minimum	0.2	0.3	0.2
Maximum	25.0	19.3	25.0
0-1 years	293 (44.1%)	238 (56.7%)	55 (22.4%)
2-10 years	275 (41.4%)	128 (30.5%)	147 (60.0%)
11 years and older	97 (14.6%)	54 (12.9%)	43 (17.6%)
<b>Any Previous Transplants</b>			
No	570 (85.7%)	381 (90.7%)	189 (77.1%)
Yes	95 (14.3%)	39 (9.3%)	56 (22.9%)
<b>Any Previous Intestine Transplants</b>			
No	583 (87.7%)	385 (91.7%)	198 (80.8%)
Yes	82 (12.3%)	35 (8.3%)	47 (19.2%)
<b>Waiting Time</b>			
Median (Q1,Q3) Days	121.0 (44.0,256.0)	116.0 (42.8,234.0)	131.0 (47.0,383.0)
Mean (SD) Days	271.1 (475.7)	206.6 (331.2)	381.8 (638.8)
Minimum Days	0.0	0.0	1.0
Maximum Days	4015.0	3624.0	4015.0
[0,90] Days	273 (41.1%)	178 (42.4%)	95 (38.8%)
(90,180] Days	142 (21.4%)	92 (21.9%)	50 (20.4%)
(180,270] Days	91 (13.7%)	64 (15.2%)	27 (11.0%)
(270,365] Days	36 (5.4%)	27 (6.4%)	9 (3.7%)
(1,2] Years	68 (10.2%)	40 (9.5%)	28 (11.4%)
(2,5] Years	41 (6.2%)	16 (3.8%)	25 (10.2%)
>5 Years	14 (2.1%)	3 (0.7%)	11 (4.5%)
<b>Organs Transplanted Along With Intestine</b>			
Pancreas/Liver	332 (49.9%)	179 (42.6%)	153 (62.4%)
Intestine Alone	195 (29.3%)	116 (27.6%)	79 (32.2%)
Liver	95 (14.3%)	93 (22.1%)	2 (0.8%)
Pancreas	24 (3.6%)	20 (4.8%)	4 (1.6%)
Pancreas/Liver/Kidney	15 (2.3%)	9 (2.1%)	6 (2.4%)
Pancreas/Kidney	2 (0.3%)	2 (0.5%)	0
Kidney	1 (0.2%)	1 (0.2%)	0
Liver/Kidney	1 (0.2%)	0	1 (0.4%)

Note: Pediatric recipients were 18 years old and younger at the time of listing. \*N(%), except as indicated in row label.

## Results

### Listing

- The number of new intestine-containing pediatric candidates fell from 828 in the early era to 353 in the latter (Table 1)
- Median age at listing has increased from 0 to 3 years (mean 2.4 vs 4.9), most notably:
  - A reduction in candidates <2 years from 72.0% in the early era to 34.0% more recently
  - A reciprocal increase in the 2- to 10-year age-group (19.0% vs 51.1%)
- The distribution of diagnoses at listing did not change between the two eras

### Transplant

- The number of intestine-containing pediatric transplants fell from 420 in the early era to 245 in the latter (Table 2)
- Median age at transplant has increased from 2 to 5 years (mean 4.2 vs 6.5), most notably:
  - A reduction in recipients <2 years from 56.7% in the early era to 22.4% more recently
  - A reciprocal increase in the 2- to 10-year age-group (30.5% vs 60.0%)
- The fraction of retransplant (any previous transplant) has more than doubled, from 9.3% in the early era to 22.9% in the latter
- Short bowel syndrome was the predominant cause of intestinal failure in both cohorts
- Similar proportions received isolated intestine or liver-containing allografts in the two eras
- Patients were also waiting longer from listing to transplant
- One-year posttransplant survival shows improved trends in the more recent era (Figure 1)

## Discussion

- The growth in intestinal transplant numbers from 1990 to 2007 resulted from increased access and confidence in intestine transplant and changes in allocation policy giving priority to candidates awaiting liver-inclusive allografts
- Increased referral of ever smaller infants led to the highest waitlist mortality rates of any organ candidate group
- Response was a more aggressive approach to managing pretransplant patients with the intent to support them to transplant and the establishment of formal intestinal rehabilitation programs
- Waitlist deaths started to fall even before 2007 and now, even for infants with intestinal failure, mortality rates are comparable to other solid organs
- More than a decade since the peak, how has the landscape of pediatric intestinal transplant changed?
- More children are now able to wean from PN before life-threatening complications occur
- Those unable to fully adapt can continue PN largely free from serious complications, especially progressive liver disease
- Numbers of intestine allograft recipients fell after 2007 but appear to have plateaued over the last 4 to 5 years
- There is still a need for intestine transplant, but those listed and receiving an allograft are generally older than their counterparts before 2007
- Intestine transplant survival has improved
- Whether the future trend will be still fewer transplants or a resurgence of intestinal transplant will depend largely on either improving long-term allograft survival or further advances to free children from long-term PN

Conflict of interest statement: SH received research funding from Tekada as center PI for the teduglutide studies in children; TW & MS have no conflicts to declare.