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Alvin Thampalakattu April 10, 2018

Implications of an Accelerated Discharged Following Posterior Spinal Fusions for Adolescent Idiopathic Scoliosis

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Abstract

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Scoliosis is defined as an abnormal, three-dimensional spinal deformity associated with a lateral curvature of at least 10 degrees within the coronal plane and a rotational misalignment of the spinal column within the sagittal and transverse planes of the body. Although there are many classifications of scoliosis, the most common type, by far, is Adolescent Idiopathic Scoliosis (AIS). AIS is estimated to be found in as many as 4 in 100 children between the ages of 10 and 18, and depending on the deviation and magnitude of the curve, surgical intervention may be necessary for treatment. The most common surgical procedure used to treat AIS is called a posterior spinal fusion. In 2005, Children's Healthcare of Atlanta began the development of an accelerated discharge following posterior spinal fusions that would maximize post-operative efficiency without compromising care. Afterwards, through a retrospective analysis comparing patients treated with and without the accelerated discharge, it was revealed that the accelerated discharge resulted in a 31.7% decrease in length of stay without any increase in adverse effects, but the major limitation with this initiative was the lack of health assessments to determine the quality of life for the patients after their discharge. With this in mind, our medical team at Children's Healthcare of Atlanta began an initiative in order to prospectively evaluate the feasibility, efficacy, safety, and quality provided by the accelerated discharge following posterior spinal fusions for AIS. In addition to measuring the patient's perspective of the quality of care delivered, the secondary objective of the following study was to create a parent satisfaction survey that would ultimately be utilized in order to compare how a patient's perspective of their quality of care differed from their parent's perspective. The implications of this study are important as they will help determine if the accelerated discharge is able to expedite the discharge process without compromising care, and if this is true, the accelerated discharge following posterior spinal fusions for AIS developed at Children's Healthcare of Atlanta can ultimately serve as a model for future widespread adoption.

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Introduction

Understanding Adolescent Idiopathic Scoliosis

At first glance, it is easy to define the spine as simply the backbone of the human body. In fact, when we first think of our spine, it is almost instinctual to associate it as merely a support structure, but the reality is that the spine is actually much more complicated than it is initially perceived to be. In fact, the human spine is estimated to be connected to over 120 muscles throughout our body, making it imperative for our strength and flexibility. More than this, our spine serves as an integral protective structure for our spinal cord that runs along the dorsal side of our body making it just as important for our nervous system. The spine consists of 33 smaller bones called vertebrae, and each vertebra is composed of a body, spinous process, laminae, pedicles, transverse processes, par interarticularis, and facet joints[1]. In an ideal human body, the vertebrae of the spinal column are aligned in a perfectly straight line in the frontal plane of the human body, but the reality is that for nearly 2 to 3 percent of the population, an estimated 6 to 9 million people in the United States, their spine is not aligned properly, and when this happens, it is commonly referred to as scoliosis[2,].

The term scoliosis is derived from the Greek word "skoliosis" which means crooked[3]. Today, the term scoliosis is used as a way to define an abnormal, three-dimensional spinal deformity associated with a lateral curvature of at least 10 degrees within the coronal plane and a rotational misalignment of the spinal column within the sagittal and transverse planes of the body[3, 4, 5, 6]. Scoliosis can be classified in a variety of ways including by: curve location, age of onset, major versus minor curvature, structural versus nonstructural curvature, and etiological classification. In fact, with all of these combinations in mind, according to the Scoliosis Research Society (SRS), there are over 90 ways to classify scoliosis, and although it, can present itself in a

variety of forms, the most common type of scoliosis, by far, is Adolescent Idiopathic Scoliosis (AIS)[5,7].

AIS can be distinguished from the various other types of scoliosis on the basis of two factors: age of onset and etiology[8]. As the name indicates, Adolescent Idiopathic Scoliosis, if found primarily in patients between the ages of 10 and 18. In terms of prevalence, it is estimated that two percent of adolescents have idiopathic scoliosis, but some sources, such as the SRS, go as far as saying that AIS can be found in as many as 4 in 100 adolescents in select populations[7]. The ratio of males to females presenting with scoliosis is equal in curvatures less than 15 degrees; however, in curvatures greater than 20 degrees, females appear to be eight times more likely to be affected than males[9, 10].

The other factor that makes AIS distinguishable is its etiology. In medical terminology, the expression idiopathic is used to describe medical conditions with no known cause. Thus, as expressed by its name, AIS is a condition with no known medical explanation. A significant amount of research is currently being conducted in order to determine the etiopathogenesis of AIS, and although many theories exist including hormone imbalance, asymmetrical growth, and muscle imbalance, the definitive cause of AIS remains elusive. Research regarding the etiology of AIS has proven that AIS is not caused by common misconceptions such as wearing a heavy backpack or poor posture. In fact, some studies have actually shown that approximately 30% of patients with AIS have some sort of family history with scoliosis, providing strong evidence for a genetic cause[7].

Depending on the deviation and progression of the curvature, three different treatment options are available for patients with AIS: observation, bracing, and surgery[7].

In terms of deviation, curvatures can be measured by calculating the Cobb angle on a patient's x-ray. In order to determine Cobb Angle, the first step is to identify the end vertebrae of the curvature. The end vertebrae help define the proximal and distal end of the curvature and these are the vertebrae with the largest tilt from the horizontal. After identifying the end vertebrae, a line is drawn across the top of the superior end vertebrae and another line is drawn across the bottom of the inferior end vertebrae. The angle created between these two lines is known as the Cobb Angle[4].

The parameters used to evaluate a patient's risk for further curve progression include: the location of the curvature, the magnitude of the curvature, age, sex, and remaining skeletal grown[4,]. Regarding curve location and curve magnitude, studies have shown that curvatures with an apex above T12 are more likely to progress than lumbar and lumbosacral curvatures[4, 11]. In addition to this, curve magnitude at the initial diagnosis can also serve as an indicator for curve progression in skeletally immature patients[4]. In fact, studies have shown that curve progression occurs in only 22 percent of patients with an initial curvature of 5 to 19 degrees, but this statistic rises to a 68 percent probability of curve progression if the initial curvature is 20 to 29 degrees and a 90 percent probability of curve progression if the initial curvature is between 30 and 59 degrees[12].

Aside from curve location and curve magnitude, sex and age are two other factors that are confirmed to demonstrate potential curve progression[4, 13]. As mentioned earlier, female patients are seven times more likely to have scoliosis than male patients in curvatures greater than 20 degrees[8, 9]. With this in mind, sex proves to be a valid predictor in determining the likelihood of curve progression. In addition to this, for females, menarche can also help provide an indicator of curve progression, as the onset of menses is often times preceded by a year of rapid skeletal

growth[13]. Likewise, age also proves to be a valid indicator of curve progression as well. At first glance, this may not be obvious, but as age is an indicator of growth and development, it can also act as an indicator of curve progression. For example, an adolescent patient with a confirmed diagnosis of scoliosis is much more likely to exhibit curve progression than an adult patient with the same magnitude of curvature, and the reason for this is simply because the adolescent patient is at an age of greater growth velocity and bone development[14].

Finally, skeletal maturity is also a significant indicator of potential curve progression. Although there are many ways in which an orthopedic surgeon can measure remaining skeletal growth, one of the most common methods is the utilization of the Risser Scale. According to the Risser scale, the degree of ossification of the iliac apophysis can be utilized to evaluate overall bone development. Ossification of the iliac apophysis begins at the anterolateral crest and advances medially towards the spine over time. Once the apophysis is completely ossified, it progressively fuses with the ilium in a medial to lateral direction, and it is this same ossification and fusion of the apophysis that is utilized as a timeline in order to determine skeletal maturity[15].

The Risser Scale is based on a five-stage hierarchy. Risser Grade 1 the stage in which 25 percent of the apophysis is completely ossified correlating to the early phases of puberty. Risser Grade 2 is when 50 percent of the apophysis is calcified which corresponds to the stage right before one's adolescent growth spurt. Grade 3 corresponds to the stage in which 75 percent of the apophysis is mineralized, and Grade 4 coincides with the stage of development in which 100 percent of the apophysis is calcified[9]. Finally, Risser Grade 5, is indicative of when the iliac apophysis is fully ossified and fused to the iliac crest, confirming the end of one's growth spurt[15].

One major fault with the Risser Scale is that the greatest amount of curve progression and growth velocity occurs early in puberty before the ossification of the apophysis of the iliac crest[4,

[15]. To compensate for this limitation, orthopedic surgeons are able to assess skeletal maturity during rapid growth phases in other ways such as the assessing the rate of closure of the triradiate cartilage of the acetabulum and the capping of the digital epiphysis of the femur[4, 16]. With all of this in mind, it is easy to see how scoliosis treatment is dependent on more than just the magnitude of the curvature. A variety of factors also impact the rate of progression, and thus, as consequence, have a tremendous impact on treatment and intervention as well.

For patients with curvatures that are less than 25 degrees the best assessment for treatment is observation. Observation simply means that the physician will evaluate the patient's curvature every six to twelve months along with follow-up x-rays until the patient is fully grown to ensure that the curvature does not deviate further[7].

In contrast, if a patient's spinal curvature is between 25 and 45 degrees with a risk of curve progression, the best assessment for treatment is bracing in the skeletally immature patient[7]. Depending on the exact severity of the curve, patients are often times required to wear their scoliosis brace for 13 to 23 hours a day, and the use of a brace is continued until the patient receives a minimum of a Risser Grade 4[3]. Although there is much skepticism regarding the efficacy of bracing, studies have shown that there is indeed a relationship between the use of a scoliosis brace and curvature progression. In fact, in one particular study, the Bracing in Adolescent Idiopathic Scoliosis Trial (BrAIST) study conducted by Dr. Stuart Weinstein, patients who wore braces during their growth period proved to be much less likely to require surgery for their scoliosis compared to patients that did not wear a brace. According to Weinstein's results, 72 percent of the patients with braces were able to avoid surgical intervention, but only 48 percent of patients in the observational group were able to avoid surgical intervention. Furthermore, for patients that wore their brace for more than 13 hours a

day, the success rate (avoiding surgery) was greater than 90 percent, providing significant evidence for a correlation between time spent wearing a brace and curve progression[17].

For patients in which bracing proves to be ineffective and the curvature progresses to become greater than 45 to 50 degrees, surgical intervention is recommended[7]. The primary focus of surgical treatment for AIS is to prevent further curve progression and obtain three-dimensional realignment while maximizing coronal and sagittal balance[4]. The surgical procedure used to treat AIS is called a spinal instrumentation and fusion. Orthopedic surgeons can approach a spinal fusion in one of two ways: an anterior approach and a posterior approach. The anterior approach for spinal fusions may be chosen when a patient presents with a single curvature either in the lumbar or thoracic region. A posterior approach can be used in all types of curvatures, and as a result, this approach is used more often in treating AIS[7].

During a posterior spinal instrumentation and fusion, patients are anesthetized while a surgeon makes a straight incision along the dorsal side of the back corresponding to the levels of the spinal deformity. After the incision is made, the patient's soft tissues are dissected away from the posterior spinal column until there is a clear view of the spine. Afterwards, the surgeon will then remove part or all of the facet joints of the vertebrae involved in the fusion. This allows the surgeon to mobilize the spinal segments to facilitate curve correction and also to induce fusion of the spinal elements. The surgeon then uses hardware that may include pedicle screws, hooks, sublaminar bands and/or wires, and rods to stabilize the spine. Finally, in the end, bone graft is placed against the newly stabilized spine to facilitate fusion, and the incision is closed[18].

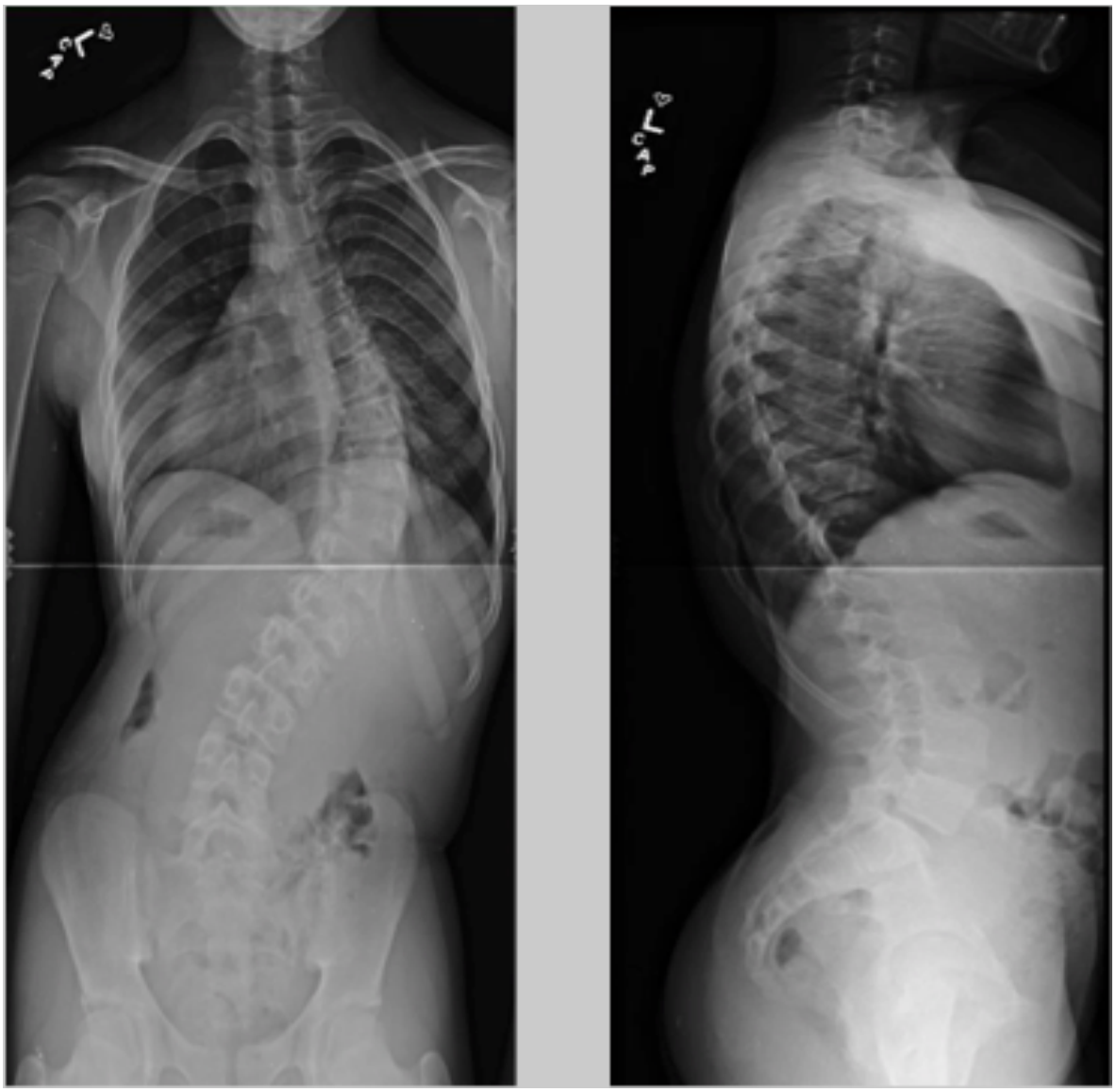

Figure 1: PA radiograph of a patient presenting with Adolescent Idiopathic Scoliosis before surgical intervention. (A) A posteroanterior radiograph of the coronal plane of the curvature is used in order to visualize symptoms and determine curve severity. (B) In contrast, a lateral radiograph of the curvature from the sagittal plane shows no visible signs of scoliosis.

Figure 2. PA Radiograph of patient from Figure 1 after posterior spinal fusion for Adolescent Idiopathic Scoliosis. (A) After surgery, a coronal posteroanterior radiograph demonstrates the level of curve correction after the posterior spinal fusion. (B) A lateral radiograph demonstrates no dramatic changes in appearance in the sagittal view of the spine.

Quality Assessment of Accelerated Discharge Following Posterior Spinal Fusion

In the early 2000s, after a posterior spinal fusion, the average patient in the United States stayed in the hospital for three to six days[7]. At first glance, this may not appear to be a problem, especially when considering the intensive recovery process following a posterior spinal fusion, but this large range for the length of stay was actually indicative of a major issue following posterior spinal fusions at that time and that was the lack of standardization for the discharge process. In fact, in years past, the discharge process following a posterior spinal fusion for AIS was largely under the discretion of the orthopedic surgeon, and due to the lack of an established protocol, there was a large variety in the treatment and experiences of patients throughout the discharge process.

In 2005, Children's Healthcare of Atlanta began the development of a standardized discharge that would minimize variability to ensure that all patients receiving a posterior spinal fusion for AIS would be treated equally. In order to determine the efficiency of this standardized discharge, Children's Healthcare of Atlanta initiated a study in which one of their two campuses would adopt the standardized discharge while the other campus would continue to allow the discharge process to be under the discretion of the preforming orthopedic surgeon[19].

Afterwards, through a retrospective analysis comparing patients treated with and without the standardized discharge pathway, it was revealed that the standardized discharge pathway resulted in a 31.7% decrease in length of stay without any increase in adverse effects[19]. Compared to the average discharge process at that time, the newly standardized discharge process was able to expedite hospital stay due to its focus on earlier and more frequent post-operative mobilization with a physical therapist, improved nursing education, earlier transitions to oral narcotics, and authorization to discharge patients prior to complete return of bowel

function, and due to its increased efficiency, it was eventually recognized as an accelerated discharge following posterior spinal fusions for AIS[19].

Table 1: Summary of Accelerated Discharge

	Accelerated Discharge
Post Operation Location	Floor
PCA, Epidural, or Both	PCA
Initiation of PO feeds	Day 0
Initiation of Oral Medication	Day 1
When to d/c Foley	Day 1
When to d/c Drain (if present)	Day 1
When to get out of bed with physical therapy	Day 1
How many times/day out of bed with PT	3
Discharge Prior to First Bowel Movement	Yes

Although there are many benefits to implementing an accelerated discharge including a decrease in length of stay, a decrease in hospital resource utilization, and an increase in turn over rate, the major limitation of this study was the lack of health assessments in order to determine the quality of life of patients after their discharge. Were patients who underwent the accelerated discharge receiving the same quality of care as patients who underwent a traditional discharge? Were patients with an accelerated discharge equally as satisfied with the results of their procedure? Most importantly, did the accelerated discharge make patients feel as if they were rushed out of the hospital?

Over the past few years, a multitude of studies have shown that a patient's perspective of their quality of care often times differs from the perspective of their medical provider[30,47]. With that being said, the notion of measuring patient satisfaction has gained a tremendous amount of precedence within healthcare, and understanding patient satisfaction has evolved to become a cornerstone within healthcare. Patient satisfaction is important to measure as it affects clinical outcomes, patient retention, and medical malpractice claims. With this in mind, our medical team at Children's Healthcare of Atlanta began an initiative in order to prospectively evaluate the

feasibility, efficacy, safety, and quality provided by the accelerated discharge following posterior spinal fusions for AIS, and the primary hypothesis of this study was that the implementation of an accelerated discharge following posterior spinal fusions for Adolescent Idiopathic Scoliosis would ultimately decrease hospital stay without compromising the overall care provided.

In order to accomplish the primary objective of this study, a prospective, longitudinal study was initiated at Children's Healthcare of Atlanta. The inclusion criteria for subjects enrolled in this study include: signed informed consent, male and female patients between the ages of 10 and 18, and a posterior spinal fusion with a pedicle screw and/or hybrid instrument. In contrast, the exclusion criteria for the following study included: patients under the age of 10 or over the age of 18, patients with a neuromuscular, syndromic, or congenital scoliosis diagnosis, patients undergoing an anterior or circumferential spinal fusion, as well as patients with a history of a prior spinal surgery.

Shortly after the start of this project, a similar study was published comparing patient satisfaction with parent satisfaction in the operative treatment of idiopathic scoliosis. In this study, a prospective, cross-sectional analysis was used in order to determine the disparity in SRS-24 scores between patients who received surgical treatment for idiopathic scoliosis and their parents. According to this study, parents consistently scored higher than their children in terms of satisfaction, self-image, and overall score, but in contrast, parents scored lower than their children in terms of perception of pain and function[20].

Although the objective of this study was to evaluate the variation between patient satisfaction and parent satisfaction, the major limitation of this study design is that the SRS-24 is designed in order to be a self-assessment for patients, and thus, many of its questions simply cannot be assessed accurately from a parent's perspective[20]. For example, within the SRS-24, patients are asked subjective questions such as, "Which of the following best describes the amount of pain you have experienced" and "Have you been a happy person?" Although such questions can certainly be answered from the parent's perspective, the reality is that such subjective measurements can only truly be assessed from a patient's perspective.

The other major limitation for this study is that it assumes that the criteria for patient satisfaction and parent satisfaction are the same. After the discharge following a posterior spinal fusion for AIS, patients take at least two to four weeks off before returning back to school. Thus, parents are often times required to take time off work as well in order to help their child recover. Parents must ensure that their child's incision remains clean and dry, monitor their child's diet, and administer their child's medication. Therefore, often times, the recovery process following a posterior spinal fusion can be just as stressful, if not more stressful, for parents. Thus, in addition to worrying about the patient's pain and comfort, parents also often times take on the stress of managing a variety of other factors within the recovery process, and as a result measuring a parent's level of satisfaction must also take into consideration a multitude of other factors that are simply not assessed in patient satisfaction surveys such as the SRS.

The following study was integral in changing the trajectory of our study as it introduced the notion that the quality of care in pediatrics is multifaceted, and although it is often times overlooked, parent satisfaction is just as important to monitor as patient satisfaction. With this in mind, our medical team decided to expand of our current study's objective in order to ultimately

encompass parent satisfaction as well. Thus, the objective of this study was modified to now measure the feasibility, efficacy, safety, and quality provided by the accelerated discharge following posterior spinal fusions for AIS from both the patient's perspective and the parent's perspective. The implications of this study are important, as it will compensate for the limitations of our previous study design (not assessing parent satisfaction). More than this, if the following study is able to demonstrate that an accelerated discharge is able to provide equal levels of satisfaction when compared to traditional discharges for both patients and parents, then the results of this study may also be indicative of the fact that the accelerated discharge is able to provide equally as effective but more efficient results. It is our hope that this novel pathway truly is able to expedite the discharge process without compromising care, and if this is true, then the accelerated discharge pathway following posterior spinal fusions for AIS developed at Children's Healthcare of Atlanta can ultimately serve as a model for future widespread adoption.

Materials and Methods

Literature Review for Parent Satisfaction Survey

In order to accomplish this new objective of the study, a literature review was first initiated in order to find a parent satisfaction survey that could be implemented within our study. A review of the literature was preformed using the search engines OVID, BIOSIS, HEALTHSTAR, MEDLINE, and PubMed. Within the following databases, the following key terms were utilized in order to find a parent satisfaction survey for an accelerated discharge following posterior spinal fusions for Adolescent Idiopathic Scoliosis within the past twenty-five years: "Adolescent Idiopathic Scoliosis Posterior Spinal Fusion Parent Satisfaction Survey," "Adolescent Idiopathic Scoliosis and parent satisfaction survey," "parent satisfaction survey and Adolescent Idiopathic Scoliosis," "posterior spinal fusion for scoliosis and parent satisfaction," "posterior spinal fusion discharge and parent satisfaction," and "Adolescent Idiopathic Scoliosis discharge and parent satisfaction." After the following searches, a total of 27 publications were collected, but no publications provided a potential parent satisfaction survey that could be utilized within our own study. Afterwards, another literature review was conducted using the same key terms except in differing databases including: Google Scholar, Academic Search Complete, and PMC. But again, the same results from the previous literature search were gathered.

With this in mind, one final literature search was conducted, but this time, the key terms utilized were broader in hopes of deriving parent satisfaction surveys within other realms of pediatric medicine. For the final literature review, the following key terms were used in order to find a parent satisfaction survey: "pediatric surgery parent satisfaction survey," "pediatric parent

satisfaction survey discharge," "scoliosis research society parent satisfaction survey," "pediatric parent satisfaction survey," "parent satisfaction survey surgery and discharge," "patient versus parent satisfaction surgery," and "parent satisfaction survey surgery and discharge." After the following searches, a multitude of results presented, and from this selection, a total of 71 sources measuring parent satisfaction were identified. The parent satisfaction surveys originated from medical fields such as the PICU, NICU, Day-Surgery, Orthopedics, Internal Medicine and more, and in addition to this, many validated surveys were gathered including the Parent Feedback Questionnaire[47], the Neonatal Index of Parent Satisfaction (NIPS)[44], the NICU Picker Survey[32], and the Parent Satisfaction Survey with Paediatric Day-Surgery Survey[38].

Table 2: Frequency of Qualitative Measures of Parent Satisfaction Survey

Criteria of Parent Satisfaction	**References**	**Total**
Access	27, 29, 37-40, 42-44, 49-52, 54, 62, 72, 82	17
Quality of Care	23, 25-27, 30-31, 33-34, 36-43, 45-50, 53-54, 57-60, 62-65, 68-69, 74-75, 77-82	42
Communication	21, 22, 26-30, 32-34, 39-45, 47-50, 54-55, 58, 65, 67-68, 70-72, 75-78, 80	34
Competency	23, 25, 32, 34-35, 39-43, 50, 52, 54-55, 63, 79	16
Environment	24, 36, 39, 40, 42, 43, 48, 50, 53, 54	10
Pain Management	34, 39-40, 42-43, 45-47, 50, 54, 57, 60, 62-64, 73, 75, 81	18
Participation	26, 28, 39-40, 42-43, 50, 54, 61, 65, 68-71, 74-78, 83	20
Education	27, 29, 33-34, 39-40, 42-44, 52, 57-59, 67-70, 73-75, 81, 83	21
Support	22, 27, 29-30, 32, 35-40, 42-44, 50, 53-54, 56-59, 62, 64-65, 70, 73, 76, 80-81	29

In an attempt to derive a better understanding of the criteria used to measure parent satisfaction, each publication was then evaluated for its study design, procedure, and criteria that were utilized in order to measure parent satisfaction, as seen in Table 2. The left column represents the criteria that parents look for a medical provider, and for the sake of simplicity, synonymous criteria were placed within the same category (i.e. atmosphere and environment or participation and decision-making). In addition to this, if a qualitative measure was not observed at least ten times within the literature review, it was also not included within table. Thus, with all of this in mind, the qualitative measures with the highest prevalence amongst parent satisfaction surveys included: access, quality to care, communication, competency, environment, pain management, participation, education, and support.

Once the criteria for the foundation of the parent satisfaction survey were established, each article was reevaluated questions to be utilized in order measure these specific criteria. In an ideal study, the parents satisfaction survey would evaluate each of the nine criteria with a multitude of questions, but due to the numerous other quality measurements assessed in the following study, such as the PRP, SRS-22, and QoR-9, the number of questions within the parent satisfaction was cut in order to reduce survey fatigue.

Table 3: Parent Satisfaction Survey.

Question	0	10
1. Are you satisfied with the results of your child's procedure?[84-88]	Very Dissatisfied	Very Satisfied
2. Do you feel that your child was discharged within a sufficient time frame after surgery?[87-89]	Strongly Disagree	Strongly Agree
3. Do you feel that your child required more time prior to discharge home?[88,90]	Strongly Disagree	Strongly Agree
4. How organized was the discharge process?[93,94]	Very Disorganized	Very Organized
5. Do you believe you were adequately educated about your child's operative recovery discharge process?[87-88]	Strongly Disagree	Strongly Agree
6. Did the providers give sufficient feedback and communicate discharge expectations clearly?[83]	Strongly Disagree	Strongly Agree
7. Do you feel that you were actively involved in the decision making process to discharge your child from the hospital?[93]	Strongly Disagree	Strongly Agree

Administration of Parent Satisfaction Survey

In the following study, the parent satisfaction survey was administered either through phone call or in person. Each question was scored on a scale from 0 to 10, and a patient's overall score was measured by calculating the average score for all of the questions. One item that is important to note is that for all questions except for the third question, a higher score corresponded with a higher level of satisfaction. In the parent satisfaction survey, the third score asks, "Do you feel that your child required more time prior to discharge home?" Thus, for this particular question, a lower score corresponded with a higher level of satisfaction. Therefore, when calculating the average overall score, the patient's score for question 3 was subtracted from 10, and the result of this, was utilized when calculating the patient's overall average level of satisfaction.

Since it has first been implemented, the parent satisfaction survey has only undergone one major change, and that is the timing of the survey. At first, the parent satisfaction survey was administered on the patient's last day as an in-patient; however, this was eventually changed as parents felt as though they could not answer questions regarding the quality of the discharge until a few days after being released from the hospital. With this taken into account, the survey was then administered 3 to 5 days after discharge for the remainder of the study.

Quality of Life Questionnaires

In addition to the parent satisfaction survey patient satisfaction surveys were administered pre-operatively, intra-operatively, and post-operatively in order to assess how a patient's quality of life changes before and after surgery. In terms of pre-operative measurements, our medical team gathered the radiographic data and medical history of each patient in order to help determine the severity and possible risk factors related to the patient's onset of scoliosis. In addition to this information, patients were also asked to complete three surveys including the Post-Operative Recovery Profile (PRP), Scoliosis Research Society Patient Questionnaire (SRS 22), and the Quality of Recovery Questionnaire (QoR-9). The PRP is a questionnaire designed to measure a patient's self-assessment of their physical symptoms, physical functions, psychological health, social health, and overall activity. The SRS 22 is a survey that is administered to evaluate a patient's self-perspective of their overall health-related quality of life including both physical and mental health over time, and the QoR-9 is a survey that is administered in order to assess a patient's overall health within a variety of categories such as pain and worry after surgery and an anesthetic event. Altogether, the data from these surveys are collected and evaluated in order to create a baseline measuring a patient's perspective of their own health before surgery.

After surgery, subjects were evaluated at follow-up appointments six weeks, six months, twelve months, and twenty-four months after discharge. At the 6-week follow-up, the only patient satisfaction survey subjects were asked to complete was the QoR-9, but for the 6-month follow-up appointment, all three patient satisfaction surveys, the PRP, SRS, and QoR-9 were administered. Finally, for the 12 month and 24 month follow-up appointments, only the SRS-22 and QoR-9 were administered in order to evaluate how the patient's perspective of their health changed as their recovery progressed. In addition to all of this, patients were also to complete a Return to Work/School Survey in order to provide supplemental information regarding the patient's perspective on their recovery, and patients were evaluated for their radiographic data and safety, just as they were as an in-patient, in order to monitor for complications after their surgery.

Table 4: Timing of Quality of Life Questionnaires

	Enrollment (1-30 days before surgery)	Surgery	In-Patient Admission	6 weeks ±14 days	6 Months ±30 days	12 Months ±3 months	24 Months ±3 months
Informed Consent	X						
Medical History	X	X					
Operative Data		X					
Length of Hospital Stay			X				
PRP	X				X		
SRS 22	X				X	X	X
QoR-9				X	X	X	X
Return to School/Work				X	X	X	X
Financial Data			X				
Safety Data			X	X	X	X	X
X-ray imaging	X			X	X	X	X
Parent Satisfaction Survey			X				

Table 5: Summary of QoR-9 Questionnaire

Question: Over the last ___ hours/days have you:	**Responses**		
Had a feeling of general well being	Not at all	Some of the time	Most of the time
Had support from others (especially doctors and nurses)	Not at all	Some of the time	Most of the time
Been able to understand instructions and advice. Not being confused.	Not at all	Some of the time	Most of the time
Been able to look after personal toilet and hygiene unaided	Not at all	Some of the time	Most of the time
Been able to pass urine “waterworks” and having no trouble with bowl function	Not at all	Some of the time	Most of the time
Been able to breathe easily	Not at all	Some of the time	Most of the time
Been free from headache, backache or muscle pains	Not at all	Some of the time	Most of the time
Been free from nausea, dry-retching or vomiting	Not at all	Some of the time	Most of the time
Been free from experiencing severe pain or constant moderate pain	Not at all	Some of the time	Most of the time

Table 6: Summary of SRS 22 Questionnaire

Question	**Response Options**				
1. Which of the following best describes the amount of pain you have experienced in the past 6 months?	None	Mild	Moderate	Moderate to Severe	Severe
2. Which one of the following best describes the amount of pain you have experienced over the last month?	None	Mild	Moderate	Moderate to Severe	Severe
3. During the past 6 months, have you been a very nervous person?	None of the Time	A little of the time	Some of the time	Most of the time	All of the time
4. If you had to spend the rest of your life with your back as it is right now, how would you feel about it?	Very unhappy	Somewhat unhappy	Neither Happy nor Unhappy	Somewhat Happy	Very Happy
5. What is your current level of activity?	Bedridden	Primarily no activity	Light labor, such as household chores	Moderate manual labor and moderate sports, such as walking and biking	Full activities without restriction
6. How do you look in clothes?	Very Good	Good	Fair	Bad	Very Bad
7. In the past 6 months, have you felt so down in the dumps that nothing could cheer you up?	Very Often	Often	Sometimes	Rarely	Never
8. Do you experience back pain when at rest?	Very Often	Often	Sometimes	Rarely	Never
9. What is your current level of work/school activity?	100% Normal	75% Normal	50% Normal	25% Normal	0% Normal
10. Which of the following	Very	Good	Fair	Poor	Very Poor

best describes the appearance of your trunk, defined as the human body except for the head and extremities?	Good				
11.Which one of the following best describes your medication usage for your back? 11a. Other Medications _____. 11b. Other Medication Usage __Weekly __Less __Daily	None	Non-narcotics weekly or less (e.g. aspirin, Tylenol, Ibuprofen)	Non-narcotics daily	Narcotics daily	Other
12. Does your back limit your ability to do things around the house?	Never	Rarely	Sometimes	Often	Very Often
13. Have you felt calm and peaceful during the last six months?	None of the time	A little of the time	Some of the time	Most of the time	All of the time
14. Do you feel that your condition affects your personal relationships?	None	Slightly	Mildly	Moderately	Severely
15. Are you and/or your family experiencing financial difficulties because of your back?	None	Slightly	Mildly	Moderately	Severely
16. In the past six months,	Never	Rarely	Sometimes	Often	Very

have you felt down hearted and blue?					Often
17. In the past three months, have you taken any sick days from work/school due to back pain and, if so, how many?	0	1	2	3	4 or more
18. Does your back condition limit your going out with friends/family?	Never	Rarely	Sometimes	Often	Very Often
19. Do you feel attractive with your current back condition?	No (not at all)	No (not very much)	Neither attractive nor unattractive	Yes (somewhat)	Yes (very)
20. Have you been a happy person during the past six months?	None of the time	A little of the time	Some of the time	Most of the time	All of the time
21. Are you satisfied with the results of your back management?	Very Unsatisfied	Unsatisfied	Neither satisfied nor dissatisfied	Satisfied	Very Satisfied
22. Would you have the same management again if you had the same condition?	Definitely not	Probably not	Not sure	Probably yes	Definitely yes

Table 7: Summary of 6 Month Post-Operative Recovery Profile (PRP) Questionnaire

Parameter	Score			
Pain	None	Mild	Moderate	Severe
Nausea	None	Mild	Moderate	Severe
GI Problems (ie. Constipation/Diarrhea)	None	Mild	Moderate	Severe
Lack of Energy	None	Mild	Moderate	Severe
Muscle Weakness	None	Mild	Moderate	Severe
Effect on my Appetite	None	Mild	Moderate	Severe
Sleep Difficulty	None	Mild	Moderate	Severe
Worry and Anxiety	None	Mild	Moderate	Severe
Depression	None	Mild	Moderate	Severe
Restriction on my social life (i.e Spending time with family and friends)	None	Mild	Moderate	Severe
Difficulty with taking care of my personal hygiene	None	Mild	Moderate	Severe
Difficulty in keeping up with what's happening in the outside world (such as newspapers and/or TV)	None	Mild	Moderate	Severe
Problems with passing urine	None	Mild	Moderate	Severe
Problems to be up and moving	None	Mild	Moderate	Severe
Feelings of loneliness	None	Mild	Moderate	Severe
Dependent on help from others	None	Mild	Moderate	Severe
Concentration Problems	None	Mild	Moderate	Severe

Comparison of Patient Satisfaction with Parent Satisfaction

Finally, the last step in the following study is to compare how a patient's perspective of their quality of care differs from their parent's perspective. Although there are a variety of patient satisfaction surveys that can be used from this study in order to create this comparison, the correlation between patient and parent satisfaction will be evaluated by comparing the QoR-9 with the parent satisfaction survey. The primary reason for utilizing the QoR-9 over the PRP and SRS-22 in order to make this comparison is timing. The SRS-22 and PRP are both administered six months after the parent satisfaction survey. In contrast, the QoR-9 is only administered six weeks after the parent satisfaction survey. Although this may not appear to be a big issue at first, the timing of when the survey is administered is important to minimize recall bias. Studies have shown that after major surgeries, patient satisfaction increases tremendously over time. The

reason for this is because as time elapses, a patient's perspective and memory of the challenges and difficulties of surgery alleviate over time. With that being said, if patient satisfaction scores were measured six months after parent satisfaction survey scores were calculated, then patient satisfaction scores would appear to be much higher when compared to parent satisfaction scores. Thus, since the QoR-9 is the patient satisfaction survey administered closest to the date of the parent satisfaction survey, it will also be the patient satisfaction survey with the least amount of recall bias.

Ideally, in the following study, both the parent satisfaction survey and the QoR-9 would be administered at the same time rather than six weeks apart, but if both surveys were administered on the same day, a number of problems would arise. For example, if both surveys were administered upon discharge, the major issue with this study design would be that patient's would not be far enough in their recovery process to complete the QoR-9. For example, the QoR-9 assesses patients for their ability to look after their personal hygiene and pass complete bowel movements, both of which are functions that are not fully present until after discharge. Thus, if the QoR-9 was administered too early, then patient satisfaction survey would appear much lower than parent satisfaction. In contrast, if the parent satisfaction survey was administered six weeks after discharge along with the QoR-9, then parents would not be able to accurately remember the quality of care, communication, education, and support provided by the medical team. The difference between the parent satisfaction survey and the QoR-9 is that the parent satisfaction survey relies on the subject's memory whereas the QoR-9 is an assessment of the subject's current status. Thus, in order to maximize retention for the parent satisfaction survey and to ensure that patients have recovered far enough to accurately assess the progress of their recovery,

the parent satisfaction survey should be administered a few days after discharge, and the QoR-9 should be administered at the closest follow-up after discharge (6-week follow-up appointment).

Results

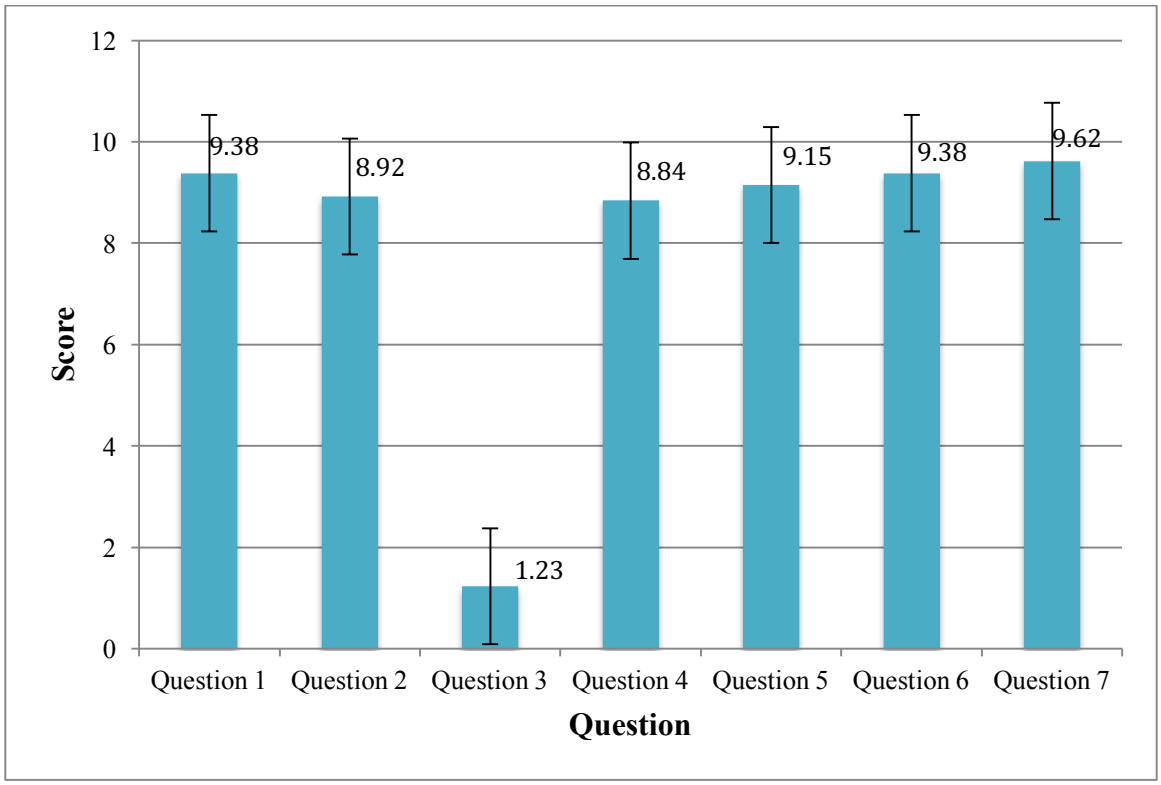

Figure 3. Parent Satisfaction Survey scores of subjects enrolled at Children's Healthcare of Atlanta after accelerated discharge following posterior spinal fusion for AIS. The following survey was a questionnaire developed in order to determine the quality of care, level of education, communication, and support provided by a medical team from a parent's perspective. In the Parent Satisfaction Survey, each question was evaluated on a scale from 0 to 10, and the overall score for each subject was calculated by finding the average score amongst all questions. The Parent Satisfaction Survey was administered upon discharge, and will later be compared to the patient satisfaction surveys of this study in order to determine if the patient's perspective of their health varies from their parent's perspective.

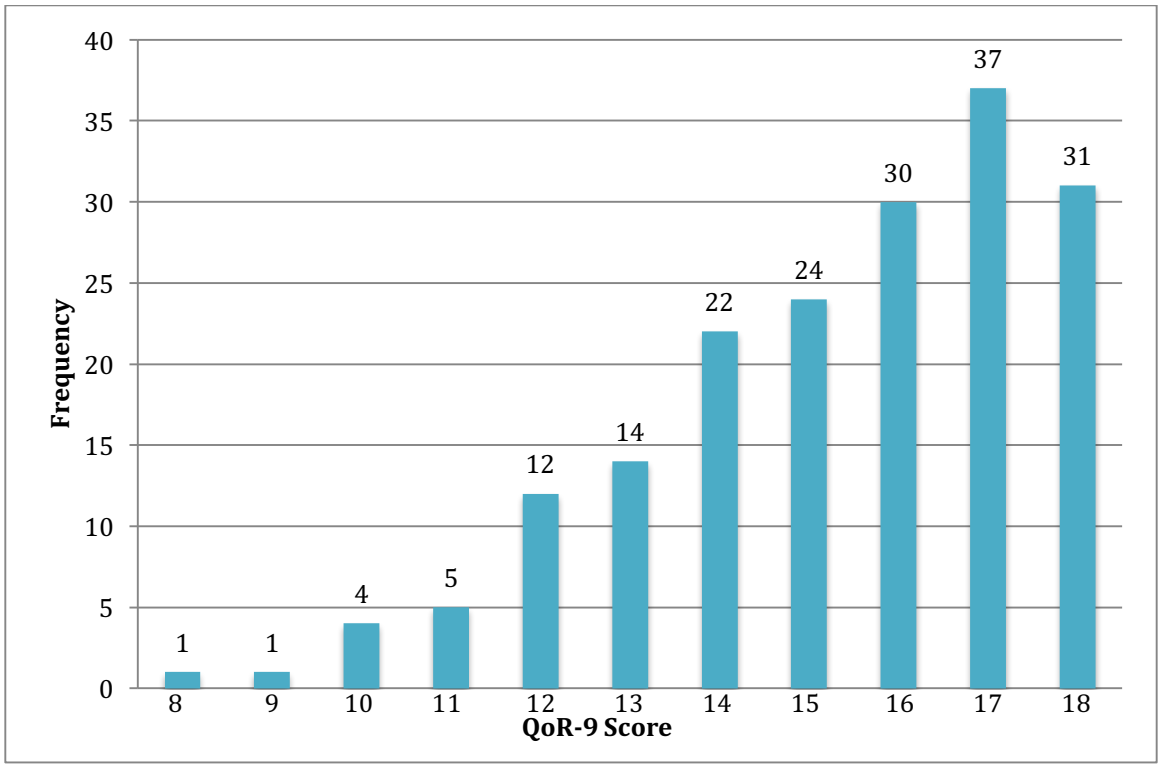

Figure 4. QoR-9 scores of AIS patients at Children's Healthcare of Atlanta after accelerated discharge. The QoR-9 is a quality assessment survey designed to evaluate a patient's perspective of their health after undergoing an anesthetic event. In the QoR-9, each question is scored from zero to two points, and the total score is attained from the summation of the score for each question. For the QoR-9 a higher scorer corresponds to a higher level of satisfaction, and as shown in the figure above, the maximum score attainable is 18.

Discussion

Analysis of Results

As mentioned earlier, the primary objective of the following study is to compare how a patient's perspective of their quality of care differs from their parent's perspective. In order to accomplish this objective, patient satisfaction was measured using the QoR-9 and compared to the results of the parent satisfaction survey. In terms of patient satisfaction as measured by the QoR-9, a total of 181 patients were evaluated for their 6-week QoR-9 scores. The average QoR-9 score for patients that underwent the accelerated discharge at Children's Healthcare of Atlanta was 15.32 ± 2.22. With this information in mind, a confidence interval was calculated for the QoR-9 scores revealing a 95 percent probability that the true mean of QoR-9 scores for patients that had undergone the accelerated discharge at Children's Healthcare of Atlanta is between 15.0 and 15.64.

In contrast to the QoR-9, the parent satisfaction survey was not administered until later in the study, and as consequence, fewer subjects were evaluated for their scores on the parent satisfaction survey. A total of 20 patients were evaluated for their parent satisfaction survey. The average score for the parent satisfaction survey was 9.17 ± 0.32. With this information, a confidence interval was also calculated for the parent satisfaction survey revealing a 95 percent probability that the true mean for the parent satisfaction survey for patients that had undergone the accelerated discharge at Children's Healthcare of Atlanta is between 9.03 and 9.31.

Finally, in order to determine how a patient's perspective of their quality of care differs from their parent's perspective, we must compare the results of the parent satisfaction survey with the results of the QoR-9. Although this might seem simple, a direct comparison is limited

by the fact that each survey has its own respective scoring system. Thus, in order to compensate for this limitation, we must first convert each score into a percentage. With this in mind, the average QoR-9 score is 85.11%. The average parent satisfaction survey score is 91.7%, and the percent difference between the QoR-9 and the parent satisfaction survey is 13.5% percent.

Future Directions

As we are beginning the preliminary data collection of our study, future directions include: enrolling more patients, validating the parent satisfaction survey, and finally comparing the QoR-9 and parent satisfaction survey scores between a traditional and accelerated discharge. According to a power analysis based on the complication rate of our previous retrospective study evaluating the efficiency of a standardized/accelerated discharge, a minimum of 404 patients would be needed in the following study in order to attain a power of at least 80 percent. Children's Healthcare of Atlanta preforms 500 posterior spinal fusions yearly, and approximately 75 percent (375 cases) are for AIS. With this in mind, our study currently has 181 patients enrolled, and in order to reach the enrollment goal of 404 patients, we would have to continue this study for at least seven more months. However, due to the high rate of attrition at follow-up the following study will most likely enroll patients for a much longer period of time. It is important to note that since the Parent Satisfaction Survey was not administered until January 2018, the enrollment target for this measurement will differ, and this survey will be administered either till the end of the study or until the Principle Investigator decides to stop enrollment.

After enrolling enough patients, the next step for the following study will be to validate the parent satisfaction survey. Although a detailed literature review was conducted in order to establish the criteria and questions of the parent satisfaction survey, the survey itself still remains to be validated before applying it to evaluate the traditional discharges. In order to validate the

parent satisfaction survey we will first evaluate our data collected here at Children's Healthcare of Atlanta. After an initial evaluation of our data, a PCA analysis and an internal consistency measurement will be utilized in order to ensure that the survey is measuring what it is supposed to be measuring and that it is reliable in its measurements. Afterwards, the last step in validating the survey would be to revise the survey based on the PCA analysis before officially implementing the parent satisfaction survey within the final phase of the study.

Finally, once the parent satisfaction survey becomes verified, we can officially use it as a measurement in our participating hospitals with a traditional discharge. Altogether, once we have enough participants enrolled in the study, we will finally be able to conclude whether or not the accelerated discharge is able to provide equally as effective results. The implications of this study are important. If the accelerated discharge is able to provide equal levels of satisfaction when compared to traditional discharges for both patients and parents, then the results of this study may also be indicative of the fact that the accelerated discharge is able to provide equally as effective but more efficient results. It is our hope that this novel pathway truly is able to expedite the discharge process without compromising care, and if this is true, then the accelerated discharge pathway following posterior spinal fusions for AIS developed at Children's Healthcare of Atlanta can ultimately serve as a model for future widespread adoption.

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