

SPINAL DEFORMITY SURGERY PATHWAY

EXECUTIVE SUMMARY

Physician Owner(s): Dr. Brian Hasley



Primary Objective

The purpose of this pathway is to optimize the efficiency, safety, and overall care for all patient undergoing spinal fusion at Children's Hospital and Medical Center. Also, to standardize pre-operative management of patients receiving spine fusion surgery by clarifying expectations for surgery based on anticipated level of complexity and reduce time from decision of surgery until surgery is performed. Lastly, to establish evidence-based clinical pathway also for antimicrobial surgical prophylaxis in high-risk patients undergoing major spinal surgery at Children's Hospital and Medical Center.

Spine Deformity Surgery Pathway, High-Risk:

Inclusion Criteria (BOTH bullets):

- Any age patient needing a major spine surgery:
 - Posterior spine fusion
 - Anterior and posterior spine fusion
 - Initial VEPTTR placement
 - Initial growing rod placement
- **AND** have one or more of the following:
 - Complex medical problems often involving treatment by multiple specialists
 - Cerebral palsy or similar diagnosis – GMFCS 3-5
 - Neuromuscular conditions (muscular dystrophies, spinal muscular atrophy, congenital myopathies, etc.)
 - Syndromes (Marfan syndrome, Angelman syndrome, Rett syndrome, etc.)
 - Myelomeningocele
 - Other
 - Idiopathic or idiopathic-like scoliosis with significant co-morbidities or high degree of curvature (>100 degrees)
 - Malnutrition
 - Complex surgeries as designated as “high risk” by the Orthopedic Spine Surgery Team – Three column osteotomies, etc.

Exclusion Criteria:

- Cerebral palsy or similar diagnosis – GMFCS 1-2
- Patients that fall under the Low-Risk Spine fusion Pathway definition
- Vertical expandable prosthetic titanium rib (VEPTTR) or growing rod expansion/adjustments.
- Spinal diagnosis related to trauma
- Others based on the clinical judgement of the Spine Fusion Pre-Operative Committee (SSPOC)
- Patients undergoing isolated anterior fusion or spinal instrumentation procedures (vertebral tethering)
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Spine Deformity Surgery Pathway, Low-Risk:

Inclusion Criteria (ALL bullets):

- Patients 8-21 years of age with one of the following diagnoses:
 - Idiopathic
 - Congenital scoliosis

CLINICAL



EFFECTIVENESS

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- Kyphosis
- Spondylolysis/spondylolisthesis.
- AND absence of complex chronic medical conditions or comorbidities:
 - Chronic diagnoses with low risk for cardiopulmonary or neurologic conditions such neurofibromatosis or cerebral palsy (GMFCS 1-2) may be included in this pathway.
- AND patient is undergoing a major spine surgery:
 - Posterior spine fusion
 - Anterior vertebral body tethering or anterior spinal fusion
 - Anterior and posterior spine fusion
 - Initial VEPTTR placement
 - Initial growing rod placement

Exclusion Criteria:

- Vertical expandable prosthetic titanium rib (VEPTTR) or growing rod expansion/adjustment
- Spinal diagnosis related to trauma
- Other criteria based on clinical judgment by Orthopedic Spine Surgery team

Recommendations

Spine Deformity Surgery, High-Risk

Timeline

- The goal is for surgery to be performed within 2 to 6 months to prevent the progression of the spinal deformity.
- Neuromuscular spinal deformities including scoliosis can progress rapidly over several months which leads to an increase surgical risk. [1-3]

Referral Diagnostic Recommendations

Referrals are necessary to optimize these high-risk patients prior to surgery so the patient has the best intraoperative and postoperative experience. [4]

- Pulmonology
 - Pulmonary function can be affected by spinal deformities; therefore, pulmonology specific tests are needed including but not limited to a sleep study, pulmonary function tests, etc. based on patient specific needs. [4, 5]
 - Pulmonary complications of scoliosis include hypoxemia, atelectasis, pneumonia, persistent respiratory support post-procedure, and extubation failure. [Wazeka, Toll, Burjek] While these vary in severity, even in high-risk patients, preventative, multi-disciplinary care can help reduce significant complications in patients with impaired respiratory function [Wazeka]. While general pre-op pulmonary function testing (without consideration for interventions) has not been consistently shown [Toll, Burjek, Wazeka] to improve outcomes we recommend pulmonary function testing within 6-12 months of the planned surgery with timing per the discretion of the pulmonologist. Specifically, recent research reveals specific pulmonary function parameters, such as FVC <50 increase risk for sleep related hypoventilation in the absence of clinical symptoms in certain populations. [Zamboni] Additionally, common post-operative respiratory complications such as hypoxemia and atelectasis

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[Wazeka] are worsened by impaired airway clearance we recommend MIP/MEP/Peak cough flow testing as part of pre-op pulmonary function testing. Sleep studies can be beneficial to diagnose sleep disordered breathing and hypoventilation, which can be difficult to diagnose in neuromuscular populations [Zambon, Birnkrant], but which would be expected to worsen post-operatively due to anesthesia, supine positioning, and post-operative opiates. Diagnosing and initiating non-invasive respiratory support or ENT interventions can better optimize post-operative respiratory status which could contribute to extubation failure or persistent respiratory support, which are uncommon [Wazeka], but significant complications of this procedure.

- Cardiology
 - An echocardiogram and electrocardiogram are completed prior to surgery due to potential restrictive lung disease and obstructive sleep apnea.
 - For patients on ACE inhibitors, it should be held at least 24 hours pre-operative due to the risk of hypotension with anesthesia in conjunction with these medications. (citation)
- Neurology
 - For patients on Depakote, there is a risk of Depakote induced thrombocytopenia and coagulopathy. Therefore, TEG and platelet function study labs are obtained prior to surgery to determine risk versus benefit of stopping Depakote prior to surgery. [6, 7]
- Neurosurgery
 - Ventriculoperitoneal (VP) shunt complications are common. Patients with VP shunts should be evaluated periodically and CHMC neurosurgery recommendation is for annual shunt evaluations. [8, 9]
 - For patients with myelomeningocele, tethering of the spinal cord frequently occurs and can result in associated symptoms. However, asymptomatic tethered cord in patients with myelomeningocele may not warrant detethering surgery prior to scoliosis surgery. [10, 11] Therefore, all patient with myelomeningocele should be evaluated by neurosurgery to determine if detethering is needed in conjunction with spine deformity surgery.
- Gastroenterology
 - Nutrition should be optimized prior to surgery to enhance their postoperative course. If there is concern of nutrition the following labs may be necessary to help gastroenterology determine necessary interventions in a timely manner: Ferritin, Vitamin D, Prealbumin, Vitamin C, and Zinc. However, caution is advised for delay of spine fusion surgery as risks of scoliosis progression may outweigh benefits of delaying surgery for optimization of nutritional status. [12]
- Orthopedics
 - Radiographs are obtained in the standing, seated, and supine full-length positions to assess the curve of the spinal deformity. [13-15]
 - Type and screen is completed early on to prepare for potential blood product administration during surgery to check for atypical antibodies. If the type and screen is negative, they need a type and cross on the morning of surgery. If it is positive, a type and cross will be arranged with blood bank to ensure blood is available at the time of surgery. [16]

CLINICAL



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Antibiotic Recommendations

- Refer to the [Spine Deformity Surgery Antibiotic](#) Algorithm for specific recommendations.
- Cephalosporin antibiotics are a mainstay in antimicrobial surgical prophylaxis. An attempt should be made to include these antibiotics as first line agents in surgical prophylaxis. [17]
- These high-risk patients are at increased risk for infection with gram negative bacilli organisms (including several *pseudomonas* infections observed at this institution) and warrant broader spectrum antimicrobial coverage. [18, 19]
- Consistent with the established [Perioperative Antimicrobial Guidelines](#) and [The Antibiogram](#) Children's Hospital and Medical Center.
- Refer to the [Penicillin allergy fact sheet](#) if needed. Allergies to beta-lactam antibiotics (penicillin) are also commonly implicated medications in allergic reactions. Therefore, the patient/guardian/family need to be carefully questioned about the history regarding symptoms pertaining to the allergic reaction in question.
- Follow all SSI Prevention Bundle Elements:
 - Preoperative CHG Bathing ([Pre-Operative Bathing](#))
 - Appropriate Skin Antisepsis and Hair Removal ([Skin Preparation for Surgical Patients](#))
 - Normothermia ([Preoperative Patient Temperature Management to Minimize Intraoperative and/or Postoperative Hypothermia](#)) ([Perioperative Comfort, Maintaining Normothermia](#))
 - Appropriate Antibiotic Timing ([Surgical Antibiotic Prophylaxis](#))

Antibiotic	Dose	Frequency Intra-op	Frequency Post-op	Route	Maximum Dose	Time to Incision	Comments
Ceftazidime	50 mg/kg/dose	Every 4 hours	Every 6 hours	Intravenous	2000 mg	Within 60 minutes of incision	
Vancomycin	15 mg/kg/dose	Every 6 hours	Every 8 hours	Intravenous	1000 mg	Infusion started 60 to 120 minutes prior to incision	Infusion for 120 minutes with history of Vancomycin Flushing Syndrome. Modify frequency with renal dysfunction – Contact pharmacy for recommendations.
Clindamycin	10 mg/kg/dose	Every 6 hours	Every 6 hours	Intravenous	900 mg	Within 60 minutes of incision	
Levofloxacin	10 mg/kg/dose	No re-dose	No re-dose	Intravenous	500 mg	Within 120 minutes of incision	Infusion to be run over 60 minutes
Gentamicin	2.5 mg/kg/dose	No re-dose	No re-dose	Intravenous	250 mg/kg	Within 60 minutes of incision	For renal dysfunction, contact pharmacy for recommendation.
Cefazolin	30 mg/kg/dose	Every 3 hours	Every 6 hours	Intravenous	<120kg – 2 g >120kg – 3 g	Within 60 minutes of incision	

Bacterial Decolonization Protocol

- Bacterial decolonization protocol is completed to reduce the risk of bacterial infection related to surgery. MRSA swabs are less sensitive; therefore, it will be performed on all patients. [20-22]



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- Chlorhexidine pre-surgical wash to reduce the risk of surgical site infections from skin contaminants. [23, 24]

Implementation Items

- Ortho Low risk Spine order set
- Ortho Complex Spine order set
- Bacterial decolonization protocol

Supporting Documents

- Pre-spinal fusion evaluation template
- My Spinal Fusion Guide (Education handout for patient)
- Spinal Fusion Preoperative check list

Rationale

The surgical management of spinal deformity in patients with multiple comorbidities is complex. Perioperative complications are higher in the neuromuscular scoliosis patients, [5] and clinical care pathways have been shown to improve clinical outcomes in this high-risk patient population. [4] The rationale for this pathway is to optimize patient care and satisfaction, and is as follows:

- **Safety:** Improved communication between providers (orthopedic surgeon, anesthesiology, hospitalists, and referrals) and standardized care coordination will optimize patient care leading to decreased complications and improved patient outcomes. [4]
- **Quality:** Enhanced quality will be achieved by consistent approach to the management of patients leading to less variation in treatment.
- **Cost:** Will be reduced by reducing the variation in treatment and the ability to tracking of consults and tests to determine their cost effectiveness.
- **Workflow/Care Delivery:** Improved care delivery will be achieved by basing clinical management on established guidelines and current evidence in the literature. Coordination of care will lead to better efficiency in care delivery and less delays.
- **Patient/Family/Provider Satisfaction:** Coordination of care through a dedicated nurse care coordinator will lead to improved patient/family satisfaction. This will be accomplished by better communication between providers and families, and enhanced efficiency through this pre-operative process.
- **Downside Risks:** A potential unintended consequent of the high-risk spine fusion pathway will be increase in tests and consults being performed. This erring on the side of caution to ensure patient safety for surgery may increase costs and delay care in the short term. However, the consistent approach and tracking over time will enable us to determine the long-term value and necessity of these tests.

Metrics

1. Reduce time from decision to perform surgery until surgical scheduling AND day of surgery to 4 months and 8 months respectively by December 2023. (Outcome)
2. Increase use of Procedure Pass to 80% by December 2023. (Process)

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3. Monitor the number of first-time consults from orthopedics to each of the following specialties: Gastroenterology, Cardiology, Pulmonology, Neurology & Neurosurgery of denominator. (Balancing)
4. Monitor length of stay (from check in to pre/post) to discharge of patients. (Balancing)

Team Members

Champion: Brian Hasley, MD (Orthopedic Surgery)
Kaitlyn Pellegrino, MD (Anesthesiology)
Eli Rhoads, MD (Pulmonology)
Jaci Timmons, MD (Hospitalist, Chronic Care)
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Rhea Weber PT, DPT (Physical Therapy)
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Stakeholders:

Neurosurgery: Arnett Klugh, MD & Afhsin Salehi, MD, MS
Neurology: Geetanjali Rathore, MD
Cardiology: Rachel Taylor, MD
Clinical Effectiveness Medical Director: Bridget Norton, MD, MBA
Intensive Care Unit: Andrew MacFadyen, MD
Pulmonology: Casey Burg, MD
Gastroenterology: Andrew Huang Pacheco, MD
Pharmacy & Antimicrobial Stewardship: Jen Zwiener PharmD
Infectious Disease: Andrea Green Hines, MD
Child Life: Nicole Walker
Physical Therapy: Rhea Weber PT, DPT

Evidence

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