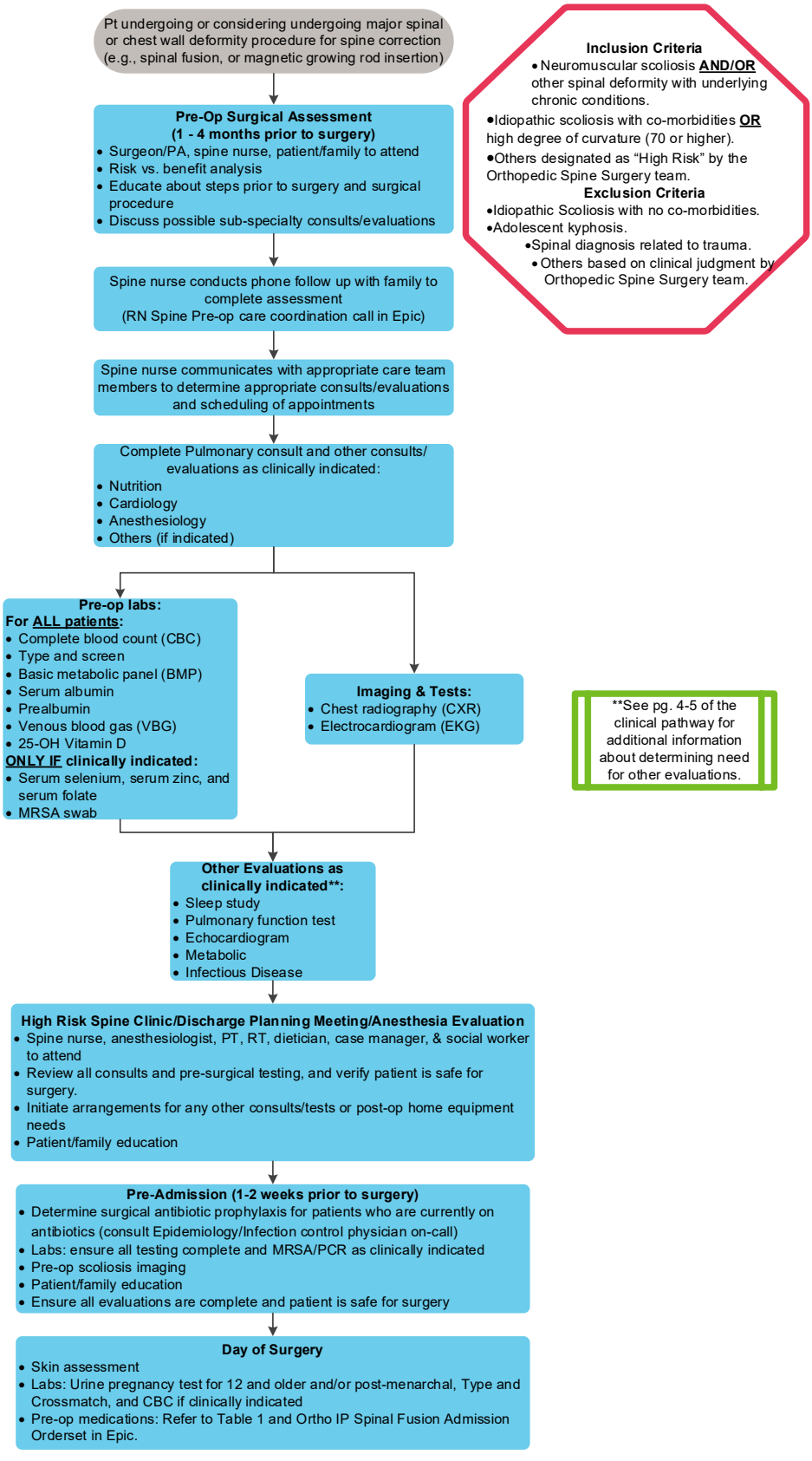
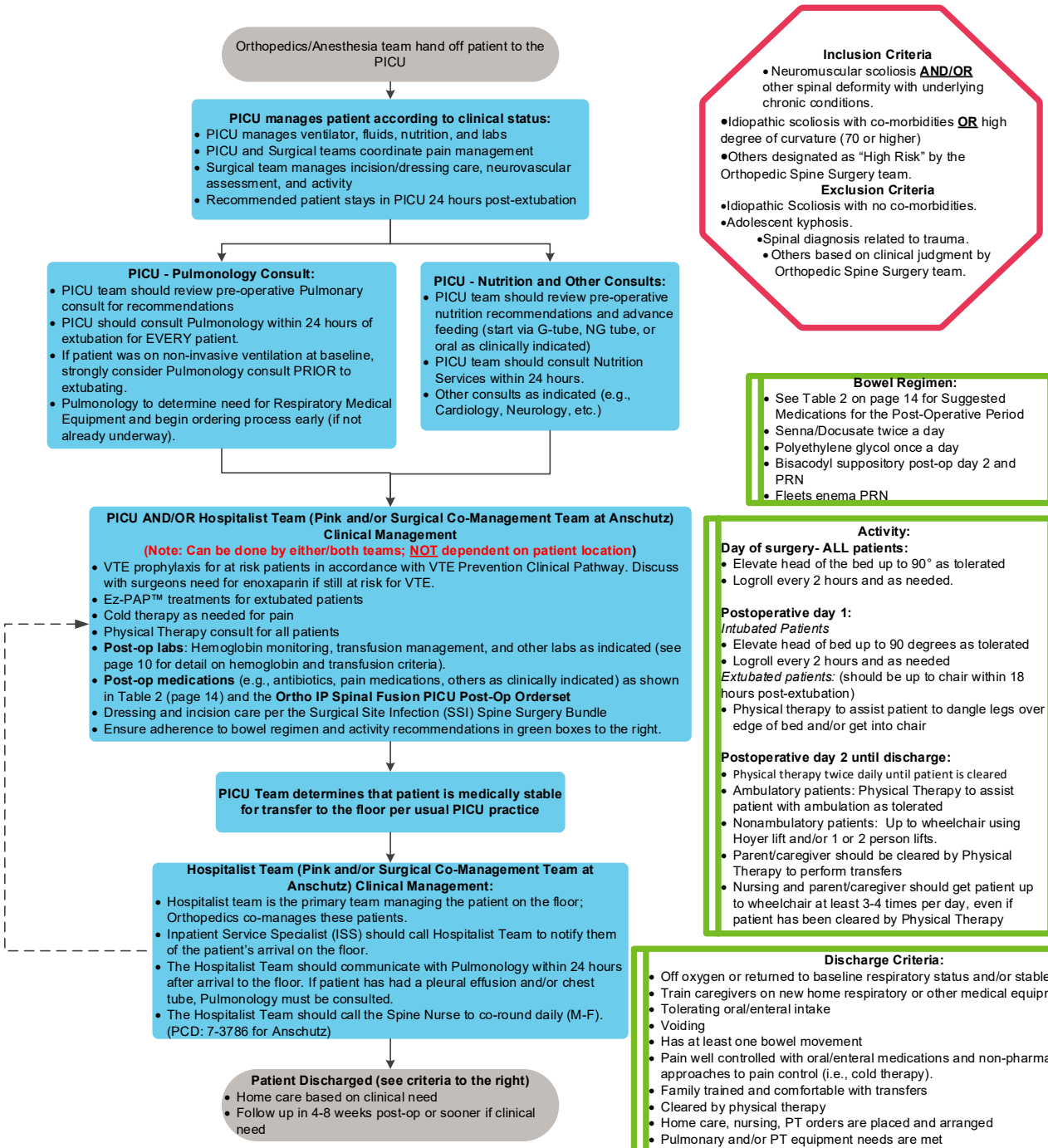
High-Risk Spinal Fusion

ALGORITHM 1. Pre-Operative High Risk Spinal Fusion Care Path



ALGORITHM 2. Post-Operative High Risk Spinal Fusion Care Path



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TARGET POPULATION

Inclusion Criteria

- Patients undergoing or considering undergoing major spinal or chest wall deformity procedure, such as spinal fusion (primary or major revision), or magnetic growing rod insertion, who require further medical evaluation prior to spine surgery. Including:
    - Patients with neuromuscular scoliosis and/or other spinal deformity with underlying chronic conditions
    - Idiopathic Scoliosis with comorbidities OR high degree of curvature (70 degrees or higher). Any other patient designated as “High Risk” by the Orthopedic Spine Surgery team

Exclusion Criteria

- Idiopathic Scoliosis with no comorbidities
- Adolescent kyphosis
- Patients with spinal diagnosis related to trauma
- The Orthopedic Spine Surgery team may exclude a patient from this pathway if their underlying disease or planned surgery does not justify an escalated level of care.

BACKGROUND

- This clinical pathway is based on the published Care Pathway for Spine Surgery (CAPSS)[1] developed by CHCO.
- Patients who require major spinal procedures, such as fusions and growing spine implants, often have many co-morbidities in addition to scoliosis.
- Scoliosis surgery requires extensive planning and coordination with the Orthopedic Surgery Team, providers in other disciplines (e.g., pulmonary, hospitalist, anesthesiology, etc.), and the patient's family.
- Many elements of the process, from pre-operative evaluation and preparation to surgery to post-operative care, are time sensitive and need to have a formal workflow to ensure that all appropriate steps are completed.

Ethical Considerations

The goal of spine surgery for patients with progressive neuromuscular scoliosis or other similar diagnoses is to maintain or improve quality of life. Because of the many associated risk factors in these complex patients, the option of surgical treatment needs to be considered carefully as surgery may not be the best option for every patient/family. The ethical issues surrounding these decisions are multi-faceted and complex. The purpose of this clinical pathway is to evaluate the patient medically, determine risks, and to assess the families' resources and ability to care for the patient once discharged to home. The patient (if able), the parents/caregivers, and the surgeon should all come to a consensus as to whether surgical management is the best option.

PRE-OPERATIVE CLINICAL MANAGEMENT (2-6 MONTHS PRIOR TO SURGERY)

Initial Evaluation

- Surgeons and spine team will discuss ethical considerations and risk/benefit analysis with patients/families to determine candidacy for spinal surgery.
- During initial meeting/call with patient and family in orthopedic clinic, discuss the following:
  - Education on the surgical procedure and pathway
  - Ethical issues related to surgical options
  - Unique family resources and factors impacting clinical decision-making
  - Initial assessment of consults that may be needed (cardiology, neurology, pulmonology, nutrition, etc.)
- Follow-up and complete assessment by phone
  - Completion of initial evaluation in Care Coordination call/note by Spine Nurses, including psychosocial assessment, involvement of specialty services, past medical and surgical history, current medications, previous hospitalizations, eligibility for sleep study, and history of UTI.
  - Spine nurse will communicate with surgeon, surgeon's PA, and subspecialists to determine work up as indicated.

Consults

- Pulmonary consult is indicated for all patients.
- Nutrition assessment by registered dietician (often coordinated with pulmonary appointment) for:
  - Patients with a body mass index (BMI) less than 10% for age or greater than 85% for age
  - Patients on tube feeds or parenteral nutrition at home
  - Patients with known eating disorders, or with diagnosed gastrointestinal conditions
- Neurology consult is indicated for patients with uncontrolled seizures, severe dystonia, or if parents have questions about seizure medications
- Acute Pain Service consult is indicated for patients with baseline opioid medication use or history of chronic pain
- Cardiology as clinically indicated for patients with history of heart condition or known cardiac issues.

- Infectious Disease consult if patient has had previous spine surgery and had an infection.
- Other consults as indicated by patient's medical history.

Laboratory Studies

The following labs are indicated for all patients (to be done approx. 1 month before surgery):

- Complete Blood Count (CBC)
- Type and screen
- Basic metabolic panel (BMP)
- Serum albumin
- Prealbumin
- Venous blood gas (VBG)
- 25-OH, Vitamin D
- Refer to periop lab testing procedures for further testing

The following labs should be conducted only if clinically indicated:

- Serum selenium, serum zinc, and serum folate
- MRSA swab

Imaging & Tests (for all patients):

- Chest radiography (CXR)
- EKG

Evaluations

- Sleep Study (if clinically indicated) if concerns for sleep disordered breathing
    - Complete sleep assessment to determine if sleep study is indicated by asking the following four questions:
        - Does your child pause in their breathing at night?
        - Does your child struggle to take a breath at night?
        - Does your child feel sleepy during the day?
        - Does your child snore more than half of the night?
- **Pulmonary Function Tests**- indicated for patients with a thoracic scoliosis curve greater than 70°, kyphosis greater than 70°, any planned chest wall violation during surgery, or history of poorly controlled asthma.
- **Cardiac Evaluation**
    - **For patients with a history of cardiac disease, pulmonary hypertension, or abnormal cardiovascular exam**, The spine nurses or their designee will contact the patient's cardiologist via Epic Inbasket to determine whether another visit and/or EKG is indicated prior to surgery. The cardiologist will determine if further testing is needed, arrange for any further evaluations, and make recommendations prior to surgery.
    - **Patients without a history of cardiac disease** will have a screening EKG performed. (Note: congenital scoliosis patients have a higher incidence of cardiac defects[2]. Screening EKG has a high negative predictive value and was deemed appropriate by CHCO Cardiology Department).
        1. As standard CHCO procedure, a cardiologist will review the EKG and document the final interpretation in Epic.

2. The spine nurses or designee will review the final EKG results.
3. EKG results will guide the next step in cardiac evaluation:

   If the EKG is normal, no further cardiac evaluation is necessary.

   If the EKG is abnormal, call One Call at 7-3999 and ask for the outpatient cardiologist on call (aka "City Team") to discuss whether an echocardiogram and/or cardiology consult is indicated.

   a. If there is no concern about the abnormal EKG, proceed with pathway.

   b. If a cardiology consult is done, the cardiologist's peri-operative recommendations will be documented in a letter sent to the PCP. If risk is identified, cardiologist will consult with cardiac anesthesiologists to determine possible need for cardiac anesthesia.

   c. If the City Team determines an echocardiogram only is indicated, a spine team provider (hospitalist, surgeon or anesthesiologist) should order the echocardiogram.

      - **If the echocardiogram is normal**, a report is documented in Epic and no further cardiac workup is needed
      - **If the echocardiogram is abnormal,** the echocardiogram physician will intervene to ensure appropriate follow up and will communicate with the ordering provider.

   d. Any spine team member, including the anesthesiologist, may order an echocardiogram at their discretion even if not recommended by the City Team.

   e. When ordering an echocardiogram, ensure that the appropriate provider, nurse, and contact number are included in the order. These details will help the Cardiologist contact the Spine Team in case there is an abnormality.

   f. For help on interpreting echocardiogram results, contact the Echocardiogram Reading Room at x74359.

High Risk Spine Clinic/Discharge Planning/Anesthesia Evaluation

- Patient/family attends **High Risk Spine/Discharge Planning Meeting/Anesthesia Evaluation**
  - High Risk Spine Clinic should be attended by representatives from: nursing, respiratory therapy, nutritional services, social work, physical therapy, case management (if available), and anesthesia.
  - Provide families with the preoperative Spine book.
  - Review prior consults and initiate any other consults or diagnostic tests needed and coordinate with family
  - Physical therapy will order/contact DME company about new equipment needed postoperatively.
  - Address family's concerns for surgery and ensure adequate family resources for hospital stay and home recovery. Ethical and medical safety conversations as indicated by clinical evaluation.

PRE-ADMISSION CLINICAL MANAGEMENT (1 - 2 WEEKS PRIOR TO SURGERY)

Preoperative visit

- Determine surgical antibiotic prophylaxis
  - If patient is currently on antibiotics, consult with designated **Epidemiology MD** for recommended antibiotic prophylaxis
  - Anesthesiology Pre-Operative Clinic – only for patients who are not seen by an anesthesiologist during the High Risk Spine Clinic/Discharge Planning visit, unless requested by the family.
  - Complete all pre-surgical education still needed by family

Laboratory Studies

- Ensure all ordered laboratory testing is completed
- Perform UA as clinically necessary (See appendix C for guidance)
    - Patients with Spina Bifida, current UTI symptoms, baseline intermittent straight cath routine
- PCR nasal swab for methicillin-resistant Staphylococcus aureus (MRSA)* is recommended for all patients less than 13 years of age and/or pre-menarcheal:
    - *Note current CHCO guideline is to test patients who will undergo spinal fusion and use results to guide surgical prophylaxis. Guideline does not recommend routine treatment of positive MRSA nasal swab results.
    - Preoperative testing and treatment of patients positive for MRSA has been shown to decrease the incidence of postoperative infections[4,5].

Imaging

- Scoliosis patients: two view spine, one view supine, and/or bending radiographs as ordered by provider
- Kyphosis patients: AP lateral bolster radiographs of the thoracic spine
- Other radiographs as clinically indicated and ordered by provider
- Traction spine film as ordered by provider
- MRI and/or CT as clinically indicated

Parent | Caregiver Education

- Shower and CHG cleanse guidelines - please refer to the Surgical Site Infection (SSI): Spine Surgery Target Zero Bundle
- Nil per os per NPO guidelines
- Patients and caregivers should receive preoperative teaching prior to surgery, either in-person or via Zoom.
- The surgical procedure is explained and consents are obtained by the provider via telehealth and/or in-person.
- It is suggested that patients and caregivers receive a tour of the hospital prior to surgery.

DAY OF SURGERY CLINICAL MANAGEMENT

Assessment

- Skin assessment to examine skin integrity and presence of pressure ulcers or other concerns.

Laboratory Studies

- Urine pregnancy test: all females 12 years and older and/or post-menarchal (may be cancelled per anesthesia the morning of surgery)
- Type and crossmatch to determine if antigens are present
    - Day of surgery: If 72 hours or less confirmatory type and screen. If greater than 72 hours obtain type and crossmatch.
- CBC if clinically indicated

Pre-Operative Medications

Please refer to Table 1. Suggested Medications for the Pre-Operative Period and refer to the Order set in Epic: **Ortho IP Spinal Fusion Admission.**

Antibiotics

- Please refer to Appendix A. Spine Surgery Patient Prophylactic Antibiotic Guidelines for guidance on antibiotic ordering

- If patient is currently on antibiotics, consult Epi MD for recommended antibiotic prophylaxis.

Other Medications

- Administer the following on arrival to the pre-op area. (Please refer to Table 1. Suggested Medications for the Pre-Operative Period for further detail).
  - Liquid Acetaminophen or Acetaminophen oral tablet
    - IV acetaminophen (for patients who can't take oral medications)

INTRA-OPERATIVE CLINICAL MANAGEMENT

Please refer to the Anesthesiology Protocol for Spinal Fusion Surgeries for further detail.

- All patients will have a specialized Spine Anesthesiologist for their surgery
- All patients will have the following lines placed: at least 2 large bore peripheral IVs, arterial line, and central venous catheter

Medications

- Limit use of volatile anesthetic, terminate use as soon as possible after induction, ok to use after neuromonitoring is complete.
- Antibiotics- Please refer to Appendix A. Spine Surgery Patient Prophylactic Antibiotic Guidelines
  - Vancomycin infusion should be started after the arterial line is established
  - Other antibiotics should be administered after the patient is flipped prone
  - Re-dose antibiotics for blood loss and/or elapsed time Appendix A. Spine Surgery Patient Prophylactic Antibiotic Guidelines.
- Intrathecal morphine
  - 7.5 mcg/kg (maximum dose 500 mcg)
  - If patient has documented obstructive sleep apnea (OSA), decrease dose to 5 mcg/kg (maximum dose 350 mcg)
- Total intravenous anesthetic (TIVA) with propofol (75-200 mcg/kg/min) and remifentanil (0.05-0.3 mcg/kg/min) infusions
- Ketamine infusion 0.1-0.4 mg/kg/hr
  - Dose based on ideal body weight (unless actual body weight is less than ideal body weight)
- Tranexamic Acid: 10 mg/kg bolus over 30 minutes (maximum 1 gram), then 5 mg/kg/hr
- Ketorolac 0.5 mg/kg (maximum 30 mg) at end of surgery, if approved by surgeons
- Acetaminophen re-dose (15 mg/kg) at 6 hours after initial acetaminophen dose
- Transfusion Management
  - Hemoglobin goal is > 8-9 or hematocrit > 24-27%
  - FFP, platelets, cryoprecipitate- guide use based on thromboelastogram

- Intra-op xray to evaluate hardware and residual curve per provider preference

POST-OPERATIVE CLINICAL MANAGEMENT

Assessment | Monitoring

Initial management following transfer from Orthopedics/Anesthesia Team to the PICU:

- Upon arrival to PICU, Anesthesiology team and Surgery team give full report and handoff the patient to the PICU team.
- Admission orders to PICU done by Surgical team. Orders are reviewed and modified by PICU team as needed.
- PICU manages patient based on clinical status.
- Ventilator, fluids, nutrition, and labs- managed by PICU.
- Pain management is coordinated between the PICU and Surgical teams. Multimodal standardized pain management algorithm for spine fusion patients will be followed when appropriate. Final clinical management will be decided by the PICU team.
- Incision/dressing care, neurovascular assessment, and activity- managed by Surgical team.

Coordination of Specialty Services in the PICU:

- Pulmonology Consult:
  - PICU team should review preoperative Pulmonology consult for recommendations.
  - PICU should consult Pulmonology as soon as possible upon admission to the PICU for EVERY patient.
  - If patient was on non-invasive ventilation at baseline, **strongly consider** a pulmonary consult PRIOR to extubating.
  - Determine the need for Respiratory Medical Equipment and, if the patient does not have that equipment at home, begin process of ordering early.
- Nutrition Consult:
  - PICU should consult Nutrition Service within 24 hours.
  - See preoperative nutrition recommendations and advance feeding. Start via g-tube/NG/oral as clinically indicated.
- Other Consults as indicated based on individual patient characteristics (e.g. Cardiology, Neurology, etc.)

Daily considerations that apply throughout hospital stay, both in PICU and on floor:

- Urinary catheter (foley): assess for necessity every day. Ideally, foley should stay in for a minimum of 48 hours. Reasons to keep the foley include:
  - Patient is unable to ambulate to the bathroom
  - Patient cannot return to baseline diapering
  - Accurate measurement of urine output is needed for clinical decision-making
  - Urinary retention due to opioids
- Central line (CVC): assess for necessity every day. Ideally, these should be removed prior to the patient leaving the ICU. Reasons to keep central line include:
  - Hemodynamic instability
  - Ongoing need for frequent laboratory draws. Consider that hematocrit and sodium may be checked with finger-stick

  - Ongoing need for medication that cannot be given through peripheral IV, such as Parenteral Nutrition (PN) and lipid emulsion (assess whether patient is tolerating enteral nutrition)
  - Lack of other intravenous access or very high level of concern (provider and parent) about losing and replacing peripheral IVs
- If patient has chest tube, please consult General Surgery team for guidance regarding chest tube management.
- Patients at risk for Venous Thromboembolism (VTE) receive prophylaxis in accordance with the VTE guideline
- All spine patients receive SCD's post-op
- Chest x-ray as clinically indicated for clinical suspicion of pneumothorax or pneumomediastinum
- Ez-PAP™ treatments for extubated patients every 4 hours for 24 hours, continued 3 times/day until discharge
  - Local expert consensus supports the use of Ez-PAP™ for prevention of post-operative atelectasis. Refer to the Lung Expansion policy for more information.
- Cold therapy as needed to decrease pain. Cold therapy unit belongs to the family and should be sent with the patient to floor when transferred. Cold therapy is provided to patients for comfort and not necessarily to manage swelling or drainage
- Neurovascular checks every 2 hours for 24 hours, then every 4 hours afterward.
- Elevate head of the bed to 90 degrees as tolerated. Log roll every 2 hours. Dangle on edge of bed or transfer to chair on post-op day 1 or when extubated. Progress to ambulation and/or time in wheelchair as tolerated, minimum 3 to 4 times a day.

Transition of patient from PICU to Hospitalist (Pink and/or Surgical Co-management Team at Anschutz) team:

- PICU team determines when patient is medically stable for transfer to floor per usual PICU practice.
- Hospitalist/Surgical Co-Management team is the primary team when transferred out of PICU to the 6th floor. Ortho co-manages these patients.
  - Inpatient Service Specialist (ISS) should call Hospitalist/Surgical Co-Management Team to notify them of the patient's arrival on the floor.
  - The Hospitalist/Surgical Co-Management Team will communicate with Pulmonology as soon as possible upon arrival to the floor to determine if formal consult is necessary, pulmonary should follow, or if pulmonary can sign off from patient.
    - Any patient on CPAP or BiPAP must have a pulmonary consult (and any patient on noninvasive ventilation who is not in the ICU must have their support managed by pulmonary).
    - Any patient with trach or trach/vent must have a pulmonary consult
    - Patients with a pleural effusion and/or chest tube should have a pulmonary consult
    - Any patient with neuromuscular disease (e.g., muscular dystrophy, SMA) must have a pulmonary consult. These do not include CP, spina bifida, etc., but pulmonology can consult on a case-by-case basis as needed. Please contact them if needed.
    - Please work with pulmonary to determine if outpatient oxygen should be ordered for a patient upon discharge. If possible, hypoxemia should be managed with pulmonary prior to discharge to prevent home oxygen.
  - Ensure Durable Medical Equipment (DME) has been ordered.
  - Call the Spine Nurse to co-round daily on Monday-Friday. The Spine Nurse rounding phone number is x73786.
    - The Spine Nurse contact for Colorado Springs is x59272

Laboratory Studies

The following laboratory studies generally do not vary based on patient location and may be done in the PICU and/or on the floor depending on clinical indication:

- Hemoglobin monitoring (Blood bank has requested that hemoglobin be monitored. Approximate conversion from hemoglobin to hematocrit is multiplication by 3. Hgb 7 = Hct 21%, Hgb 8 = Hct 24%, etc.)
    - POD #1: All patients have hemoglobin checked
    - POD # 2: Only check hemoglobin if the hemoglobin from POD #1 is less than 10
    - POD #3: Only check hemoglobin if the hemoglobin from POD #2 is ~~greater~~less than 9
- Transfusion management:
    - Criteria for transfusion of PRBCs: Hemoglobin is less than 8 **AND** the patient has symptoms of tachycardia unrelated to pain, hypotension despite euvolemia, dizziness with ambulation, or oxygen requirement.
    - Blood product choice
        - Patient less than or equal to 25 kg: 10 ml/kg PRBCs
        - Patient greater than 25 kg: 1unit PRBCs
    - If considering additional transfusion, recheck hemoglobin and refer to above criteria
- Other labs to be ordered as clinically indicated by the provider

Medications

Medications generally do not vary based on patient location and may be ordered/administered in the PICU and/or on the floor depending on clinical indication.

- Please refer to Table 2. Suggested Medications for the Post-Operative Period and refer to **Ortho IP Spinal Fusion PICU Post-op Order set**

Antibiotics

- Continue antibiotic prophylaxis for 24 hours post-operatively. Please refer to Appendix A. Spine Surgery Patient Prophylactic Antibiotic Guidelines

Pain Medications

- IV pain medication as needed
    - All patients prescribed IV narcotic every 3 hours PRN. Available until patient is tolerating pain medications orally/by G-tube.
    - To be determined by managing team and nursing
- Acetaminophen
    - Oral/NG/GT every 4 hours for 48 hours, then every 4 hours PRN
- Oxycodone
    - Oral/NG/GT every 4 hours scheduled for 48 hours, then every 4 hours PRN
    - First post-op dose to begin first post-op day at 0900 ("Start PRN dose 4 hours after scheduled dose.")
- Ketorolac
    - IV scheduled every 6 hours beginning 0900 on the first post-operative day for 48 hours (total of 8 doses), then ibuprofen every 6 hours PRN until discharge
    - Do not give Ketorolac to patients with underlying kidney disease.
- Diazepam
    - Oral/NG/GT - Every 6 hours PRN for spasms. Use lowest effective dose.

Other Medications

- Nalbuphine every 3 hours as needed for pruritis

- Ondansetron every 6 hours for 24 hours, then every 6 hours PRN for nausea
- Scopolamine patch every 72 hours, for patients 12 years of age and older, for nausea
- Famotidine once or twice daily until patient is tolerating food intake/PO

Bowel Regimen

- Please refer to Table 2. Suggested Medications for the Post-Operative Period
- Senna/Docusate twice a day
- Polyethylene glycol once a day
- Bisacodyl (Magic Bullet) suppository post-op day 2 and then PRN
- Fleets enema every day PRN

Dressing and Incision Care:

- Please refer to the Surgical Site Infection (SSI): Spine Surgery Target Zero Bundle
  - Please consult plastic surgeons for wound care and activity orders if plastics surgery did the wound closure
  - Reinforce dressings if saturated until first dressing change
  - For any concerns for dressing being non-occlusive (or concern for urine or fecal contamination), please contact the spine nurses to determine next steps.
    - Especially important for diapered patients. For any concerns with incision or dressing, please contact spine nurse (x73786).
  - Dressing options (3)
    - Prineo w/Mepilex and Tegaderm
      - Remove mepilex and tegaderm on POD3 (if discharged POD2, caregivers remove at home on POD3).
        - Do not replace mepilex prior to discharge unless incision is draining.
        - Leave prineo intact upon discharge
      - Parents to remove Prineo 3 weeks after day of surgery
    - Zipline
      - Remove mepilex and tegaderm on POD3 (if discharged POD2, caregivers remove at home on POD3).
        - Do not replace mepilex prior to discharge unless incision is draining.
        - Leave Zipline intact upon discharge
      - Caregiver may remove zipline 3 weeks after discharge by applying baby oil along the whole length of the zipline, which will allow for gentle separation from the skin.
- If patient has Prevena Wound Vac
    - This is left on for 7 days after surgery. It is removed at home by the family or by an RN in the clinic. The wound vac is disposable.
    - The family should be sent home with the black charging plug, or the wound vac will run out of battery. Family should be instructed on how to troubleshoot the wound vac prior to discharge.
    - When removing the wound vac, care should be taken to leave the Zip surgical closure on the incision.
  - The prineo or zipline is allowed to get wet in the shower
  - No tub baths, no hot tubs, no swimming in lakes or oceans until your surgeon says it's OK
  - Assess for clinical signs and symptoms of surgical site infection and, if present, report to surgical team
  - Discharge teaching includes hand hygiene, dressing/wound care and showering.

Activity:

- Day of surgery – ALL patients: Elevate Head of the bed up to 90 degrees as tolerated
    - Logroll every 2 hours and as needed
  - Postoperative Day 1:

    Intubated Patients
    - Elevate head of bed up to 90 degrees as tolerated
    - *Logroll every 2 hours and as needed*

    Extubated Patients (should be up to chair within 18 hours post-extubation)
    - Physical therapy to assist patient to dangle legs over edge of bed and/or get into chair

- Postoperative Day 2:
  - Ambulatory patients: Physical therapy to assist patient with ambulation as tolerated
  - Non-ambulatory patients: Up to wheelchair using Hoyer lift and/or 1-2 person lifts.
  - Parent/caregiver should be cleared by Physical Therapy to perform transfers

Nursing and parent/caregiver should get patient up to wheelchair at least 3-4 times per day, even if patient has been cleared by Physical Therapy.

DISCHARGE

Discharge Criteria:

It is suggested that the following criteria be met prior to discharge:

- Off oxygen or returned to baseline respiratory status and/or stable
- If new home respiratory equipment needs to be ordered and obtained, caregivers need to be trained and able to use any new equipment
- Tolerating oral/enteral intake
- Voiding
- Has at least one bowel movement prior to discharge
- Pain well controlled with oral/enteral medications and non-pharmacological approaches to pain control (i.e., cold therapy)
- Cleared by physical therapy
- Family trained and comfortable with transfers and use of any new equipment
- Home care, nursing, PT orders are placed and arranged
- Pulmonary and/or PT equipment needs are met
- Patient or caregiver can verbalize understanding of discharge teaching instructions

FOLLOW-UP

- Follow up by nurse telehealth visit or phone call (if telehealth not available) within 2 weeks of discharge
- Home care: if patient has Prevena wound vac.
  - Nursing- RN: 1 visit to help with wound vac removal and incision assessment,
  - CNA: as needed or available
  - Physical therapy: 2 to 3 visits to assess and train patient/caregiver on transfers and use of new equipment if new equipment prescribed
- Follow-up visits with provider occur at 4 to 8 weeks post-operatively and annually from the surgical date until discharged from care by the provider.
  - Visits can be virtual or in-person per provider discretion
  - Additional visit may be advised per provider discretion

APPENDIX A. STANDARD & EXPANDED INFECTION RISK SPINE SURGERY PROPHYLACTIC ANTIBIOTIC GUIDELINES

Standard & Expanded Infection Risk Spine Surgery Prophylactic Antibiotic Guidelines

Infection Risk	Pre-operative (pre-incision)	Intra-operative re-dosing	Post-operative
STANDARD: • Idiopathic scoliosis with no underlying comorbidities and BMI less than the 95th percentile • Anterior or posterior cervical spine fusions (less than 6 levels fused) • Vertebral body tethering (VBT) and anterior scoliosis correction (scoliosis tethering)-instrumentation without a fusion and includes 4-5 incisions • Trauma: cervical instrumentation with no other trauma or comorbidities	Patient is <13 years, premenarchal, or MRSA –: cefazolin	From start of pre-incision dose: cefazolin every 4 hours + vancomycin every 8 hours (if given pre-incision) · · · · · ALSO · · · · · For every 50% blood volume loss, give ½ doses [b]: cefazolin + vancomycin (if given pre-incision)	Patient is <13 years, premenarchal, or MRSA –: cefazolin every 8 hours x 3 doses
	Patient is ≥13 years, postmenarchal, MRSA + or <13 years with unknown MRSA status: cefazolin + vancomycin		Patient is ≥13 years, postmenarchal, MRSA + or <13 years with unknown MRSA status: cefazolin every 8 hours x 3 doses + vancomycin every 8 hours x 3 doses
EXPANDED: • All other patients with scoliosis that is not idiopathic with underlying conditions that increase risk of infection • Includes neuromuscular, syndromic, early onset (< 10y) that is not idiopathic, kyphosis, spondylolisthesis, scoliosis related to other underlying conditions/processes • BMI ≥ 95th percentile • History of prior spine infection • Any revision surgery • Posterior cervical cases with one of the following: instrumentation of ≥ 6 levels, multisystem trauma, history of myelomeningocele • Anterior (non-cervical) spine fusions with intraabdominal, retroperitoneal and transthoracic approaches • Trauma patients who have spine implants for open reduction internal fixation (no fusion)	Patient is <13 years, premenarchal, or MRSA –: cefazolin + ceftriaxone	From start of pre-incision dose: cefazolin every 4 hours + vancomycin every 8 hours (if given pre-incision) · · · · ALSO · · · · · For every 50% blood volume loss, give ½ doses [b]: cefazolin + vancomycin (if given pre-incision) + ceftriaxone	Patient is <13 years, premenarchal, or MRSA –: cefazolin every 8 hours x 3 doses
	Patient is ≥13 years, postmenarchal, MRSA + or <13 years with unknown MRSA status: cefazolin + vancomycin + ceftriaxone		Patient is ≥13 years, postmenarchal, MRSA + or <13 years with unknown MRSA status: cefazolin every 8 hours x 3 doses + vancomycin every 8 hours x 3 doses
If patient is currently on antibiotics, consult Epidemiology MD for recommended antibiotic prophylaxis.			

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Approved 12/02/21

Table 1. Surgical Prophylaxis Doses for Children 29 Days of Age or Older

A. Antibiotic	B. Pre-operative Dose [a]	C. Re-dose for time (using dose from Column B) intraoperatively every:	D. Intraoperative Replacement Dose for Blood Loss [b]
cefazolin	30 mg/kg up to 2000 mg (if greater than or equal to 120 kg, dose is 3000 mg)	4 hours	15 mg/kg up to 1000 mg (if greater than or equal to 120 kg, dose is 1500 mg)
ceftriaxone	50 mg/kg up to 2000 mg	No re-dose	25 mg/kg up to 1000 mg
clindamycin	10 mg/kg up to 900 mg	6 hours	5 mg/kg up to 450 mg
levofloxacin	10 mg/kg up to 500 mg	No re-dose	5 mg/kg up to 250 mg
vancomycin	15 mg/kg up to 2000 mg	8 hours	7.5 mg/kg up to 1000 mg

[a] These doses apply to patients with normal renal and hepatic function. Otherwise, consult Pharmacy for most appropriate doses.
[b] Replace with dose in column D for every one-half blood volume loss.
- If within 30 minutes of next re-dose, give full suggested dose in Column B.
- When antibiotic re-dosing is based on time requirement, blood volume loss resets to 0% for that specific antibiotic.

Table 2. Alternative Antibiotics for Allergies

Allergy	Alternative
cefazolin	vancomycin
ceftriaxone	levofloxacin
If vancomycin true allergy (not infusion reaction)	cefazolin + clindamycin
If allergy to cefazolin + true allergy to vancomycin	clindamycin

TABLE 1. SUGGESTED MEDICATIONS FOR THE PRE-OPERATIVE PERIOD

Medication	Indication	Dose	Frequency	Route	Maximum Dose	Comments
ANTIBOITCS						
Cefazolin	Pre-operative antibiotic prophylaxis for MSSA	30 mg/kg	ONCE Intra-op: re-dose every 4 hours or 50% of dose with one-half blood volume loss	IV	2,000 mg (if greater than or equal to 120 kg, dose is 3,000 mg)	Complete infusion within 60 minutes before surgical incision
Vancomycin	Pre-operative antibiotic prophylaxis for beta-lactam allergy, MRSA positive, *P. acnes* coverage also for age > 13 years and/or post-menarchal	15 mg/kg	ONCE Intra-op: re-dose every 8 hours or 50% of dose with one-half blood volume loss	IV	2,000 mg	Pre-op dose completed within 60 minutes of incision. Patients with documented Red Mans Syndrome should receive diphenhydramine pre-medication and 120 minute infusion of vancomycin
Ceftriaxone	Pre-operative antibiotic prophylaxis for gram negative coverage	50 mg/kg	ONCE Intra-op: No regular interval redosing needed, 50% of the dose with one-half blood volume loss	IV	2,000 mg	
Clindamycin	Pre-operative antibiotic prophylaxis for patients allergic to vancomycin	10 mg/kg	ONCE Intra-op: re-dose every 6 hours or 50% of the dose with one-half blood volume loss	IV	900 mg	Complete infusion within 60 minutes of surgical incision
Levofloxacin	Pre-operative antibiotic prophylaxis for patient allergic to ceftriaxone	10 mg/kg	ONCE Intra-op: No regular interval redosing needed, 50% of the dose with one-half blood volume loss	IV	500 mg	Preop dose started and completed within 120 min prior to incision
Topical Vancomycin Powder	For topical use only in the OR	Short segments: 500 mg Segments that include the thoracic OR lumbar curve: 1000 mg Segments that include the thoracic AND lumbar curve: 2000 mg	ONCE	Topical	2,000 mg	
PRE-MEDICATIONS						
Diphenhydramine	Vancomycin pre-medication for patients with documented Red Mans Syndrome	1 mg/kg	ONCE	IV	50 mg	
PAIN MEDICATIONS						
Acetaminophen	Pre-operative pain medication	10 to 15 mg/kg	ONCE	PO	650 mg	For patients who cannot swallow pills give IV acetaminophen 15 mg/kg (max dose 650 mg)

TABLE 2. SUGGESTED MEDICATIONS FOR THE POST-OPERATIVE PERIOD

Medication	Indication	Dose	Frequency	Route	Maximum Dose	Comments
ANTIBIOTICS						
Cefazolin	Post-operative antibiotic prophylaxis for MSSA	30 mg/kg/dose	Every 8 hours x 24 hours post-op (3 doses)	IV	2,000 mg (if greater than or equal to 120 kg, dose is 3,000 mg)	
Vancomycin	Post-operative antibiotic prophylaxis for beta-lactam allergy, MRSA positive, *P. acnes* coverage also for age > 13 years and/or postmenarchal	15 mg/kg/dose	Every 8 hours x 24 hours post-op (3 doses)	IV	2,000 mg	Patients with documented ~~Red Mans Syndrome~~true reaction to vancomycin should receive diphenhydramine pre-medication and 120 minute infusion of vancomycin
Clindamycin	Post-operative antibiotic prophylaxis for patients allergic to vancomycin	10 mg/kg/dose	Every 8 hours x 24 hours post-op (3 doses)	IV	900 mg	
PAIN MEDICATIONS						
Acetaminophen	Mild pain	10 to 15 mg/kg/dose	Every 4 hours x 48 hours, then every 4 hours prn	Oral	650 mg	Tablet or suspension
Oxycodone	Moderate to severe pain	0.05 to 0.15 mg/kg/dose	Every 4 hours x 48 hours, then every 4 hours prn	Oral	10 mg/dose	Tablet or solution. Start on post-op day 1 at 0900. Use conservative dosing for patients with OSA (start on the low end of the dosing range) Consider lower range dosing for patients with neuromuscular disease.
Ketorolac	• Post-operative, around-the-clock analgesia	0.5 mg/kg/dose	Every 6 hours x 48 hours, then ibuprofen every 6 hours prn pain	IV	30 mg/dose	Maximum duration: 48 hours. Start on post-op day 1 at 0900. Do not use in patients with underlying kidney disease
Ibuprofen	• Mild to moderate pain • Adjunct for more severe pain	10 mg/kg/dose	Every 6 hours prn	Oral	800 mg/dose	Tablet or suspension. Start 6 hours after last ketorolac dose. Do not use in patients with underlying kidney disease
Diazepam	Muscle spasms	0.05 to 0.1 mg/kg/dose	Every 6 hours prn	Oral	4 mg/dose	Tablet or solution
OTHER						
Nalbuphine	Opioid related pruritis	0.05 mg/kg/dose	Every 3 hours prn	IV	5 mg	
ANTIEMETICS						

Ondansetron	Post-operative nausea/vomiting (PONV)	0.1 mg/kg	Every 6 hours x 24 hours, then q6h prn	Oral/IV	4 mg/dose	May be given undiluted over 2 to 5 minutes when used as a single dose for prevention of PONV
Scopolamine patch	Post-operative nausea/vomiting (PONV)	1 patch	Every 72 hours	Transdermal	1 patch	For patients 12 years and older
ACID BLOCKERS						
Famotidine	Stress ulcer prophylaxis	<3 months: 0.5 mg/kg every 24 hours 3 months and older: 0.5 mg/kg every 12 hours	Start post-op day 1	PO	20 mg/dose	Discontinue after patient starts tolerating PO
LAXATIVES						
Bisacodyl (Magic Bullet)	Constipation	2 to <12 years: 5 mg 12 years and older: 10 mg	Once daily	Rectally	10 mg/dose	Give on post-op day 2, then QD PRN
Fleets enema	Constipation	2 to <4 years: 33 mL 4 to <10 years: 66 mL 10 years and older: 133 mL	Once daily prn	Rectally	2 to <4 years: 33 mL/dose 4 to <10 years: 66 mL/dose 10 years and older: 133 mL/dose	Start post-op day 2. May repeat x1 if needed.
Senna-docusate (8.6-50mg/tablet)	Constipation	2 to <6 years: ½ tablet 6 to <12 years: 1 tablet 12 years and older: 2 tablets	Twice daily	Oral	2 to <6 years: 1 tablet twice daily 6 to <12 years: 2 tablets twice daily 12 years and older: 4 tablets twice daily	Start on post-op day 1
Sennosides 8.8mg/5ml syrup	Constipation	2 to <6 years: 4.4 mg (2.5 mL) 6 to <12 years: 8.8 mg (5 mL) 12 years and older: 17.6 mg (10 mL)	Twice daily	Oral	2 to <6 years: 6.6 mg (3.75 mL) twice daily 6 to <12 years: 13.2 (7.5 mL) mg twice daily 12 years and older: 26.4 mg (15 ml) twice daily	Start on post-op day 1
Polyethylene glycol 3350 oral powder	Constipation	0.5-1.5 g/kg/dose Standard dosing: 4.25 g, 8.5 g, 17 g	Once daily	Oral	17 g	Start on post-op day 1

APPENDIX B. ASSSESSMENT OF ELIGIBILITY FOR PRE-OP SLEEP STUDY

Note: This assessment is completed by the Spine Nurses as part of the RN Spine Pre-Op Call flowsheet.

Evaluation Questions

1. Has your child had a sleep study? If yes, when and where?
2. Has your child used oxygen at home? If yes, When?
3. Does your child use CPAP or BiPAP? Have you even been told they need it?
4. Does your child snore, stop breathing at night, gasp at night?
5. Has your child had breathing or oxygen problems after surgery?

Scoring rubric for high risk spine sleep study evaluation:

- If yes to 1: need date and results. If has sleep disordered breathing, needs to see sleep clinic if not seen in the last year. If does not have sleep disordered breathing, answer questions 2-5 and see below.
- If no to 1, but yes to 2, 3, or 4: sleep study is indicated; Spine RN to send note to pulmonology via Epic In Basket. Pulmonology will review the note and order a sleep study if indication is confirmed.
- If no to 1-4, but yes to 5: see pulmonary; RN to send note to pulmonology via Epic InBasket. Pulmonology will review the note and order a sleep study if indication is confirmed.

APPENDIX C. EVALUATION OF NEED FOR PRE-ADMISSION URINE ANALYSIS AND/OR CULTURE

Obtain UA and/or culture preoperatively (7-14 days preoperatively) on all patients who have ANY of the following:

Spina bifida – UA and culture

Routine intermittent straight cath programs – UA and only obtain culture if positive UA as described

A history of UTI (with in the past 3 months) – UA and only obtain culture if positive UA as described

Are currently symptomatic - UA and culture

Evaluate all other high risk spinal fusion patients using the following questions:

- Do you have a history of urinary tract infections (UTIs)? If yes, when was the most recent UTI?

  Answer: NO – No urinalysis (UA) is needed

  Answer: YES – Clean catch UA and hold for culture if positive

- Do you currently have any frequency, burning or foul-smelling urine?

  Answer: NO – No UA is needed

  Answer: YES – Clean catch UA and culture

  Note: If UA is suggestive of UTI, a urine culture should be obtained and appropriate antibiotic coverage should be initiated

Refer to the Urinary Tract Infection clinical pathway for guidance on interpreting UA results.

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APPROVED BY

Clinical Pathways and Measures Committee – May 2, 2022
Pharmacy & Therapeutics Committee – April 7, 2022

MANUAL/DEPARTMENT	Clinical Pathways/Quality
ORIGINATION DATE	May 13, 2013
LAST DATE OF REVIEW OR REVISION	May 2, 2022
COLORADO SPRINGS REVIEW BY	 Michael DiStefano, MD Chief Medical Officer, Colorado Springs
APPROVED BY	 Lalit Bajaj, MD, MPH Medical Director, Clinical Effectiveness

REVIEW | REVISION SCHEDULE SCHEDULED FOR FULL REVIEW ON MAY 2, 2026.

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