Focus: Complex medical patients, such as neuromuscular, requiring spinal fusion that do not fall under the Idiopathic Guideline

**Index:**

- Page 1: **COMPLEX Spine Fusion** - Title Page
- Page 2: Pre-Operative Evaluations/Considerations (obtaining surgery clearance; surgery planning)
- Page 3: Intra-Operative Management
- Page 4: Post-Operative care and in hospital management
- Page 5: Intra-Operative Neuro Monitoring (IONM) Reference
- Page 6: Physical Therapy Goals (Days 1-7 in hospital)
- Page 7: Rehabilitation goals
- Page 8: Pulmonary Pre-Op Screening Questionnaire

**INCLUSION Criteria:**

- Any age needing a spine fusion **and** having one or more of the following:
  - Complex medical problems often involving treatment by multiple specialists
  - Congenital curve > 90 degrees or requiring 3 column osteotomy
  - Idiopathic curve > 90 degrees
  - GMFCS 4 & 5 Cerebral Palsy
  - Anticipated Halo Traction

**EXCLUSION Criteria:**

- Patients that fall under Idiopathic Spine Guideline definition
  - GMFCS 1-3 Cerebral Palsy
- Patient undergoing isolated anterior spinal instrumentation procedure

**List of Medical Abbreviations used in the clinical practice guideline**

- AIS – Adolescent Idiopathic Spine
- ASD – Atrial Septal Defect
- BM – bowel movement
- BMI – Basal Metabolic Index
- CBC – Complete Blood Count
- CBG – Capillary Blood Gas
- CHD – Congenital Heart Disease
- CM – Case Management
- CMP – Complete Metabolic Panel
- CP – Cerebral Palsy
- CPT – chest physiotherapy
- CSF – Cerebrospinal Fluid
- CT – computed tomography (cat scan)
- CTD – Connective Tissue Disorder
- CVL – Central Venous Line
- CXR – Chest X-Ray
d/c – discharge
- DIC – Disseminated Intravascular Coagulation
- EBL – Estimated Blood Loss
- ECG – Echocardiogram
- EF – Ejection Fraction
- FVC – Force Vital Capacity
- FFP – Fresh Frozen Plasma
- GJ – Gastro Jejunal Tube
- gm - gram
- GMFCS – Gross Motor Function Classification Scale
- GT – Gastrostomy Tube
- hr – hour
- HTN – Hypertension
- Hb – Hemoglobin (lab)
- Hct – Hematocrit (lab)
- ICD – Intra-Cardiac Device
- INR – International Normalization Ratio (lab)
- IONM – Intra Operative Neuro Monitoring
- IOP – Intra Ocular Pressure
- IV – intravenous
- IVF – intravenous fluid
- LVEF – Left Ventricular Ejection Fraction
- MAC – Monitored Anesthesia Care
- MAP – Mean Arterial Pressure
- MD – Medical Doctor
- MEP – Maximal Expiratory potential (Pulmonary)
- mg - milligram
- MIP – Maximal Inspiratory Potential (Pulmonary)
- MRI – Magnetic Resonance Imaging
- MVV – Maximal Voluntary Ventilation (Pulmonary)
- NIV – Non-Invasive Ventilation
- NSGY – Neurosurgery
- NV – Nausea/Vomiting
- O&P – Orthotics and Prosthetics
- OOB – out of bed
- OSA – Obstructive Sleep Apnea
- OT – Occupational Therapy
- OR – Operating Room
- PCA – Patient Controlled Analgesia
- PO – by mouth
- PT – Physical Therapy
- PFT – Pulmonary Function Test
- PLOF – Prior level of function
- PRBC – Packed Red Blood Cells
- PRN – as needed
- PT – Thromboplastin Time
- PTT – Partial Thromboplastin Time
- Pulse Ox – pulse oximetry
- RN – registered Nurse
- SLP – Speech Language Pathology
- SMA – Spinal Muscular Atrophy
- SSEP – Somato Sensory Evoked Potential
- SW – Social Work
- Tabs - tablets
- TEG - Thromboelastogram
- TID – 3 times per day
- TIVA – Total Intravenous Anesthesia
- TLSO – Thoraco Lumbar Sacral Orthosis
- TTE – Trans Thoracic Echo
- TXA – Tranexamic Acid
- UOP – Urinary Output
- VNS – Vagal Nerve Stimulator
- VS – vital signs

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# Complex Spine Fusion — **PRE-OP** Clinical Practice Guideline

**Focus: Pre-Operative evaluation and considerations for surgery clearance**

**Service Lines**
- Gastroenterology
- Cardiology
- Pulmonary
- Neurology & Neurosurgery
- Orthotics/Prosthetics/Seating & Mobility
- Orthopaedics
- PT/OT/Child Life

## Referral Need?
- **Yes**
  - No GT + BMI > 10% = see GI if 2-3 months to improve nutrition.
  - GI if surgeon concerned — GI decision
- **No**
  - No GT and normal BMI
  - if obese

## Labs / Tests
- CBC
- Ferritin
- CMP
- Vitamin D (25-hydroxyvitamin D)
- Preadmin
- Vitamin C
- Zinc

## Imaging needs
- **Obtain Echocardiogram if:**
  - history of cardiomyopathy
  - Residual Complex CHD (not simple ASD)—(if history of repaired CHD, no echo need)
  - Concern for possible Right side Heart Failure or presence of Pulmonary HTN
  - Congenital Scallops — if just an echo then no clearance letter or consult needed.
  - If COBB angle > 70 degrees
- **DMD (Duchenne Muscular Dystrophy)**
  - EF > 50% (echo within last 6 months)
  - EF < 50% (echo within last 3 months)
- **MRI**
  - pacemakers OK

## Admission Unit & pre-op needs
- **Consider** miralax or other laxative pre-operatively before day of surgery (parent education)

## Other Consideration and Contra-indications To surgery
- **Consult Cardiac Anesthesia if:**
  - Significant ventricular dysfunction
  - Valvular disease
  - Fontan, single ventricle physiology
  - Pulmonary hypertension

## Pre-operative Admission if:
- **NR or anticipated NR (i.e. CFAP, BIPAP)**
  - History of poor airway clearance or recent respiratory symptoms
  - Need for surgery is urgent
  - SMA and mitochondrial disease — admit night before surgery
  - Notify PICU if post op admit expected.

## Combined Neurosurgery Cases
- **Patient families to be given the “Pulmonary Preop Pamphlet”**
- Spinal Stenosis
- Intral Dural
- Possibly Vertebracotomy
- Myelo with other need cord divided
- With Myelonemtosis: consider resection of cord if placing MAGIC rods.
- consider Plastic Surgery for closure and close monitoring.

## Contact O&O pre-op for:
- Call for Halo Consults & Halo Fittings
- Notify if Post-op TLSO is known to be needed

## Seating and Mobility Clinic:
- **parents to call Vender for appointment for wheelchair adjustment:** 2 - 3 weeks post-operatively.
- **Vent dependent:** custom molded back: parents call vendor for Pre-op appointment or an in-hospital Post-op appointment once surgery date is set.

## Consider Physiatry Referral if:
- Need help with discharge planning
- Anticipating CIRU need

## Child Life:
- consult to ensure spine surgery handbook has been presented to family and to assess post op child life need

## Orthopaedics
- **Patient is to have Type and Cross pre-operatively**
- Arrange for blood products to be ready before surgery

## Consider CIRU if:
- Anticipated decrease in function from baseline due to anticipated lengthy hospital stay / difficulty with pain tolerance in relation to mobility.
- To qualify for Inpatient Rehab, requires eval from 2 of 3 (PT / OT / SLF) and a decrease in function

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### Lines and Positioning

**Positioning**
- Accommodative: Position upper extremities with less than 90 degrees abduction
- Verify Baclofen pump positioning before start of case

**Traction**
- Pelvic Obliquity > 30-40 degrees

**Halo-Femoral Traction**
- 10-15 lbs on head
- 15-20 lbs on high pelvis

**Facial**
- Prone view works for AIS vs pillow for Neuromuscular CP
- Consider reverse Trendelenberg to decrease IOP

### Medications and Labs

**Surgeons Order prior to Surgery start**
- TXA (Tranexamic Acid) for all Complex Spine Cases – 20 mg/kg loading dose (max 2 grams) with 10mg/kg/hr maintenance dose (max 500mg/hr)
- Gabapentin 15mg/kg administer pre-operative (Max dose 900 mg)
- Gabapentin 5mg/kg TID x 2 days post - op. (max dose 300 mg)

**Antibiotics (Reference Link)**
- Vancomycin and Fortaz if:
  - Neuromuscular patient
  - Incontinent
  - Has a surgically created orifice
  - Has Antibiotic resistance
  - History of gram negative infection
- Suggest Neuromuscular cases get antibiotic powder
- Beta-Lactam allergy – give Vancomycin and Cipro

**Anesthetic**
- Use TIVA in Neuromuscular cases (discuss TIVA + paralytic as needed)
- Volatile at <0.5 MAC and adjust by signals

### Neuromonitoring / Vital Signs

**When not to use Neuromonitor**
- Incontinent of urine and stool
- No protective reflex
- High level GMFCS 5

**Considerations**
- TIVA if unable to obtain reliable signals using gas
- If cannot get baselines - can consider to send out monitoring personnel and consider to cancel.

### After Incision

- Consider decreasing the room temperature
- Increase Bair Hugger temperature output
- Antibiotic Redosing timing
- Recommend vanc/fortaz
- Antibiotic Powder – Vancomycin and Tobramycin
- Order labs when:
  - EBL 10% - get CBC, Fibrinogen, PT, PTT, and TEG. (TEG – available at EG only)
  - Consider to Transfuse when:
    - PRBC’s if Hb/Hct < 8/24 and/or hemodynamically unstable in the setting of acute blood loss
    - FFP if PT/PTT/INR is 1.5 times the normal range for patient
    - Platelets if < 50K
    - Cryoprecipitate if Fibrinogen <150

### During / After Closure

- Warm room up to 72 degrees
- Neuromonitor until patient is on the bed
- Verify Baclofen pump positioning
- Baclofen Pump - If more than a few mL of CSF leaks off, then may need Physiatry/ Neurology to prime line.

### Patient Prep

- 2 Large Bore IV’s
- A-Line
- CVL if pressors expected (Double/Triple Lumen Cath.)
- Room Temp 72 degrees
- Bair Hugger Blanket or warming pads

### TIMEOUT Discussion

- Anesthetic being used
- EBL Anticipated
- Implant being used
- Antibiotics being used
- MAPS- targets to be 65-75 mmHg during exposure and instrumentation. Then >80 mmHg during correction.
- Consider short acting paralytic during exposure (Rocuronium)

### LABS

**Fibrinogen Labs**
- If anticipate EBL > 15 ml/kg
- Consider PT, PTT
- Consider TEG lab (EG only)

**All Complex Spine Patients**
- arterial blood gas

### VNS information

- Position electrodes away from pulse generator on legs
- Magnet not needed if not running SSEP’s – can make an artifact if SSEP’s
- Do not need to turn off unless SSEP
- Should interrogate them afterwards – consult with Neurology or Neurosurgery

**Dural Tears**
- 4.0 Nurulon
- Consider a lumbar drain if cannot get a good repair
- Consider having Duraseal or Tisseal in room

### Neuromonitor until patient on bed

**IONM - Neuromonitoring Guide Reference - Page 5 of guideline**
<table>
<thead>
<tr>
<th>Timeline</th>
<th>Surgical Day</th>
<th>POST OP Day 1</th>
<th>POST OP Day 2</th>
<th>POST OP Day 3</th>
</tr>
</thead>
</table>
| **Assessment and Monitoring**<br>Post Op Day 1 | **IV fluids**<br>Zofran IV 0.1 mg/kg per dose (max dose 4mg/kg IV q8h PRN N/V over 60 minutes)<br>Fortaz 50mg/kg (max 2 g) IV over 15 min.<br>Consider Cefazolin 20mg/kg (max 2 g)<br>IV q8h times 2 doses (for NON-neuromuscular)<br>discontinue all antibiotics 24 hrs post-op<br>See Ortho Prophylaxis Guideline for additional Antibiotic Treatments (link)<br>**Pain Control**<br>Valium 0.1 mg/kg IV q4h (schedule as per order, max dose 5 mg) - PCA pump with bolus doses 0.1 mg/kg base rate<br>Optional:<br>Neurontin 5mg/kg TID, PO (max 1000 mg TID)<br>Toradol 0.5mg/kg IV q 4h (max 10 mg)<br>Zantac 1mg/kg dose IV q8h if using Toradol (max dose 50 mg)<br>Toradol and Zantac linked together in order set<br>Consider Methocarbamol 15 mg/kg IV q8h (Max dose 1000 mg) - to replace Valium. (do not use with Valium)<br>**Pulmonary & Respiratory Treatments**<br>Inspiration distortion q4h – awake (if unable, consider bubble/pinwheel therapy)<br>If intubated, extubate as soon as possible (possibly 24 hrs in PICU if BIPAP)<br>order Pulmonary Hygiene care if indicated<br>**Procedures**<br>Check surgical dressing q 4hr and reinforce as needed<br>**Nutrition**<br>Ice chips & sips of clear as tolerated (carbonated free)<br>Assess bowel sounds<br>Start Tube feeds within 24-48 hours of being hemodynamically stable (start slowly and hold if high vasoconstrictor use)<br>**Activity**<br>log roll q 2hr with patient assisting as able<br>log roll q 2hr with patient assisting as able<br>Goal is OOB to chair with PT initially. Then Caregiver/RN 2:1 more times as tolerated<br>Goal to ambulate 2 times, if applicable, based on prior level of function<br>**Consults**<br>Critical Care Medicine Consult if admit to PICU<br>‘Pain’ Service consult if needed<br>Nutrition – plan calorie counts/feeding regimen<br>Case Management Assessment for Durable Medical Equipment need and for new BIPAP patients<br>Pulmonary consult if patient on positive pressure<br>Plan for subspatial consultation<br>**Partnering with Parents and Education Discharge Planning**<br>Partner with parents for OOB/ambulation schedule<br>**D/C Criteria**<br>Tolerating regular diet (home diet or equivalent)<br>Caregiver independent with assisting patient with all transfers/mobility (ambulating per PT protocol based on prior level of function)<br>**Risk for Infection**<br>Post Op Day 2 | **IV fluids**<br>IV fluids – Int IV and discontinue IV Fluid when tolerating PO liquids without N/V<br>Discontinue Antibiotics after 24 hrs<br>order Moxal (0.5 mg/kg/day up to 17 g/day), if tolerating some nutrition.<br>Start POD 1 night, prn if no BM in last 24 hours<br>discontinue all antibiotics 24hrs post-op<br>**Pain Control**<br>Valium 0.1 mg/kg IV q4h PRN muscle spasticity (max dose 5 mg) - Consider to Change Valium to PO q 4h PRN for muscle spasticity.<br>Discontinue PCA pump<br>Start Perocet or Norco PO q 4hrs (5 mg, 7.5mg, 10mg available)<br>Morphine 0.05 mg/kg/dose (max 4 mg) Vp4h prn mod-severe pain not relieved by Perocet / Norco<br>**Pain Control**<br>Discontinue Toradol after 48 hours<br>Consider Motrin (max 10mg/kg/dose q8h)<br>Percocet or Norco PO q 4h PRN pain (5 mg, 7.5mg, 10mg available)<br>Morphine 0.05 mg/kg/dose (max 4 mg) Vp4h prn mod-severe pain not relieved by Perocet / Norco<br>**Nutrition**<br>Ice chips & sips of clear as tolerated (carbonated free)<br>Assess bowel sounds<br>Start Tube feeds within 24-48 hours of being hemodynamically stable (start slowly and hold if high vasoconstrictor use)<br>**Activity**<br>log roll q 2hr with patient assisting as able<br>log roll q 2hr with patient assisting as able<br>Goal is OOB to chair with PT initially. Then Caregiver/RN 2:1 more times as tolerated<br>Goal to ambulate 2 times, if applicable, based on prior level of function<br>**Consults**<br>Critical Care Medicine Consult if admit to PICU<br>‘Pain’ Service consult if needed<br>Nutrition – plan calorie counts/feeding regimen<br>Case Management Assessment for Durable Medical Equipment need and for new BIPAP patients<br>Pulmonary consult if patient on positive pressure<br>Plan for subspatial consultation<br>**Partnering with Parents and Education Discharge Planning**<br>Partner with parents for OOB/ambulation schedule<br>**D/C Criteria**<br>Tolerating regular diet (home diet or equivalent)<br>Caregiver independent with assisting patient with all transfers/mobility (ambulating per PT protocol based on prior level of function)
# Complex Spine Fusion
## Intra-Operative Neuro Monitoring

### IONM - Response to changes in Pediatric Spine Patients

<table>
<thead>
<tr>
<th>Surgeon</th>
<th>Circulating Nurse</th>
<th>Neuromonitoring</th>
<th>Anesthesia</th>
<th>Ongoing Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Gain control of room – Intraoperative surgical pause; Stop case and announce to room.</td>
<td>• Mark Time</td>
<td>• Check electrodes – Monitor working? Connections intact?</td>
<td>• Optimize MAP: &gt;80 mmHg</td>
<td>• REVISIT anesthetic/systemic considerations and confirm that they are optimized.</td>
</tr>
<tr>
<td>• eliminate extraneous stimuli (i.e. music, conversations, etc.)</td>
<td>• Shut off music</td>
<td>• Discuss status of anesthetic agents</td>
<td>* Decrease propofol and narcotic</td>
<td>• Wake-up test</td>
</tr>
<tr>
<td>• Anticipate need for intraoperative / perioperative imaging if not readily available to evaluate implant placement</td>
<td>• Get X-Ray Tech to Room</td>
<td>• Check extent of Neuromuscular blockage or paralysis</td>
<td>* Decrease inhalational agents</td>
<td>• Consult with Colleague</td>
</tr>
<tr>
<td>• Discuss events and actions immediately prior to signal loss and reverse actions</td>
<td>• Immediately contact Charge Nurse for assistance</td>
<td>• Repeat SSEPs and MEPs</td>
<td>* IVF</td>
<td>• Continue with surgical procedure vs staging procedure – abort if &lt; 70% baseline returns</td>
</tr>
<tr>
<td><strong>Surgical Actions</strong></td>
<td></td>
<td>• Determine/communicate pattern and timing of signal changes-unilateral?</td>
<td>* Dopamine or Phenylephrine -discuss with surgeon</td>
<td>• Consider post-op TLSO</td>
</tr>
<tr>
<td>• Remove traction if necessary</td>
<td></td>
<td>• Check neck and limb positioning – especially if unilateral loss</td>
<td></td>
<td>• Post – Op imaging: CT myelogram, MRI diffusion sequence</td>
</tr>
<tr>
<td>• Undo distraction or corrective forces</td>
<td></td>
<td>• Continue data collection for a minimum of 30 minutes after the last maneuver</td>
<td>• Prepare for potential wake-up test with ATTENDING Anesthesiologist.</td>
<td>• Recommend PICU admission for q1hr NV monitoring</td>
</tr>
<tr>
<td>• Remove rods</td>
<td></td>
<td>• Immediately contact Neurologist or Neurophysiologist</td>
<td>• Consider lidocaine 2mg/kg – vasodilation</td>
<td></td>
</tr>
<tr>
<td>• Remove screws, probe for breach and check x-ray</td>
<td></td>
<td></td>
<td>• Summon ATTENDING Anesthesiologist</td>
<td></td>
</tr>
<tr>
<td>• Check for spinal cord compression, evaluate osteotomy or laminotomy sites (bone graft, gel foam, wax)</td>
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</tr>
</tbody>
</table>

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Rehabilitation

Non-Ambulatory at baseline:

- Patient is evaluated and goals are set based on patient’s prior level of function (PLOF)
- Patient and caregiver are educated on the role of PT, post-op activity goals, and spinal precautions including; avoiding bending or twisting of the patient’s back with all mobility.
- Caregiver assists patient with log rolling and appropriate transfer from bed to/from wheelchair, with minimal assistance from physical therapist
- If a mechanical lift is the only option for transfers, a TLSO is first obtained from orthotics and prosthetics, by physician order
- Patient to sit out of bed in a wheelchair a minimum of 2-3 times, for 1-2 hours each time*
- Equipment needs identified and addressed

*Physical therapy will evaluate and assist caregiver the first time out of bed. Nursing staff to assist the second time, with physical therapy available as needed

If patient is Ambulatory at baseline:

- In addition to the goals listed above, patient ambulates 2-3 times daily; goal for distance and level of assistance to be set by PT based on PLOF
- PT to see patient twice a day post-op days 1 and 2, then daily until all PT goals are met

If a temporary wheelchair is ordered, a plan is set for adjusting the patient’s permanent chair:

- Minor adjustments: the caregiver calls their specific vendor for an appointment at least 2-3 weeks post operatively
- Major adjustments OR a new chair: a prescription is signed by the doctor for seating and mobility clinic, and a referral is made to the rehab case managers, for an appointment at least 2-3 weeks post operatively

Occupational Therapy consulted post-op day 2 for initial evaluation

- Caregiver is educated on the role of occupational therapy and post-op activity goals
- Caregiver demonstrates independence with assisting patient with dressing, bathing, diapering/toileting
- Equipment needs identified for bathing and personal hygiene as appropriate
**Rehab Goals - Checklist - Prior to Discharge**

**For Non-Ambulatory Patients**

<table>
<thead>
<tr>
<th>Physical Therapy:</th>
<th>Occupational Therapy:</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ 1. Caregiver is independent with assisting patient in &amp; out of a wheelchair</td>
<td>□ 1. Caregiver is independent with assisting patient with Activities of Daily Living</td>
</tr>
<tr>
<td>□ 2. Patient has a safe wheelchair for discharge home, either:</td>
<td>○ Dressing</td>
</tr>
<tr>
<td>○ His/her current custom wheelchair</td>
<td>○ Bathing</td>
</tr>
<tr>
<td>○ A temporary reclining wheelchair, with either:</td>
<td>○ Diapering</td>
</tr>
<tr>
<td>▪ An appointment (at least 2-3 weeks after surgery) with their current vendor for MINOR modifications/adjustments to the patient’s permanent custom chair</td>
<td></td>
</tr>
<tr>
<td>▪ An appointment for seating and mobility (at least 2-3 weeks after surgery) for MAJOR modifications/adjustments, OR needs a new permanent custom chair</td>
<td></td>
</tr>
<tr>
<td>□ 3. Patient is able to tolerate sitting in a wheelchair 1-2 hours at a time, 2-3 times each day</td>
<td>□ 2. Caregiver has identified use of 3-in-1, bath chair, or bedside commode for showering/toileting use and is independent with safe use</td>
</tr>
<tr>
<td>□ 4. Additional equipment has been ordered as needed</td>
<td>□ 3. <em>Individualized goal as set by your occupational therapist:</em></td>
</tr>
<tr>
<td>□ 5. Caregiver understands process for resuming prior therapies if indicated</td>
<td></td>
</tr>
<tr>
<td>□ 6. <em>Individualized goal as set by your physical therapist:</em></td>
<td></td>
</tr>
</tbody>
</table>

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Pulmonary Pre-Op Screening Questionnaire:

The following questions are to find out if the patient has any problems with his/her lungs and breathing; which are common in children with scoliosis. Please answer YES, NO or DON’T KNOW to the following questions.

<table>
<thead>
<tr>
<th>Does the patient have: (questions to ask family/guardian)</th>
<th>Yes</th>
<th>No</th>
<th>Don’t Know</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Have persistent cough, chest congestion, or coughing up mucous with viral illnesses or colds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Snore, have had an abnormal sleep study, gasp in sleep or have restless sleep such that he/she is always tired during the day</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Hold his/her breath, turn blue around the lips or have difficulty breathing in, or catching his/her breath</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Have difficulty with prior surgery and needed oxygen or help breathing afterward</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>5. Have trouble handling saliva (spit) and secretions in his/her mouth or throat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Cough or choke when eating, drinking or swallowing saliva</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Have a history of 2 or more pneumonias</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>