Pyloric Stenosis

Inpatient & Emergency Department

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Inclusion Criteria:

- Imaging + for pyloric stenosis
- Patient presents with signs/ symptoms of pyloric stenosis
  - -Progressively worsening non-bilious vomiting
  - -Projectile vomiting
  - -Vomiting immediately after most feeds
  - -Hungry immediately after vomiting
  - -Progressive weight loss or poor weight gain

Exclusion Criteria:

- ≥4 months of age

Initial Assessment: Signs and Symptoms Concerning for Pyloric Stenosis

Moderate or Severe Dehydration?

Yes →

- IVF resuscitation with NS Bolus, followed by D5NS at 1.5x maintenance rate
- Consider POC Glucose; D10 bolus if hypoglycemic
- Labs: CBC/Chem 7

Vital Signs improved?

Yes → Obtain US Abdomen Limited Pylorus

No →

- Continue ED resuscitation & emergency care
- Dispo as appropriate
- Obtain US when able

No → Obtain US Abdomen Limited Pylorus

US Positive?

No → **Off Pathway** Treat as clinically indicated

Yes →

- Consult Pediatric Surgery
- Start D5NS if not started above
- Labs: CBC/Chem 7 if not already done

PICU Admission Considerations:

- Hypopnea, apnea, or desaturation
- Hypotension (MAP <50)
- Tachycardia unresponsive to IV bolus x 3
- Anuria (no wet diaper in preceding 12hrs)
- Serum Cl^- <85mmol/L &/or $HCO3^-$ ≥ 40mmol/L

PICU Admission Warranted?

No → **Admit to Floor Pediatric Surgery Service**

Yes →

Admit to PICU

- Correct electrolytes (see below)
- Consider comorbidities incl. sepsis and AKI
- Subspecialist consults as indicated

Electrolyte Correction Instructions for hemodynamically stable patients:

- Chem 7 at least Q8H until normalized
- D5NS at 1.5 maintenance rate to run concurrently with bolus administration
- Assess for fluid overload
- 20mL/kg NS bolus over 30-60min:
  - x 1 if Cl^- 98-100mmol/L &/or $HCO3^-$ 30-32mmol/L
  - x 2 if Cl^- 85-97mmol/L &/or $HCO3^-$ 33-39mmol/L
  - x 3 if Cl^- <85mmol/L &/or $HCO3^-$ ≥40mmol/L
- Change fluids to D5 NS w/20KCl after void and K <6mmol/L

Serum Cl^- >100mmol/L and HCO_3^- <30mmol/L ?

No → (Electrolyte Correction Instructions)

Yes →

Proceed to OR Post-Operative Algorithm

Serum Cl^- >100mmol/L and HCO_3^- <30mmol/L ?

Yes → Proceed to OR Post-Operative Algorithm

No →

Off Pathway Treat as clinically indicated

Pyloric Stenosis

Post-Operative Care and Discharge Criteria

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See previous page for Initial Assessment

Post Op Care Feeding Regimen

- NPO x 3 Hours After Surgery

*Expressed breast feeding is preferred over direct breastfeeding for initial post-op feeds, but family may elect to direct feed

Yes — Direct Breast Feeding*? — **No**

Yes: Direct Breast Feeding Every Three Hours

No: 30 ml Formula or Expressed Breast Milk (EBM) x1, followed by Weight Based Feeding volume goal **Q3H**

- <2.5 kg: 45 ml
- 2.5 - 3.49 kg: 60 mL
- 3.5 - 4.49 kg: 75 mL
- ≥4.5 kg: 90 mL

Post Op Care Pain Control

Yes — Tolerating PO? — **No**

Yes:
- Acetaminophen 15mg/kg **PO** Q6H
- Ketorolac 0.5 mg/kg **IV** Q6H PRN

No:
- Acetaminophen 15mg/kg **PR** Q6H or Ofirimev 15 mg/kg **IV** Q6H
- Ketorolac 0.5 mg/kg **IV** Q6H PRN
- Change Acetaminophen to PO when tolerating feeds

****Emesis is defined as greater than 25% of the feeding volume**

Tolerating Two Consecutive Goal Feeds With No **Emesis? — **No** → May attempt lower volume feed and advance to goal volume as tolerated

Yes

Tolerating Two Consecutive Feeds With No Emesis? — **No** → Off Pathway Notify Fellow/Surgeon of persistent vomiting

Yes → UOP ≥ 1mL/kg/hr? — **No** → Off Pathway Consider ongoing rehydration

Yes

Discharge Criteria:

- Tolerating weight-based goal volume x 2 consecutive feedings
- Afebrile
- Pain controlled with only Acetaminophen
- Maintaining urine output ≥1.0ml/kg/hr
- Anesthesia protocol for postoperative monitoring satisfied
- Follow up via phone call with General Surgery clinic nurse in 2-4 weeks
- PCP follow up within one week of discharge for weight check

Pre-Pathway Validation

Is this Pyloric Stenosis?

Pyloric Stenosis is characterized by hypertrophy of the pyloric muscle, resulting in gastric outlet obstruction. Infants typically present between 2 weeks to 2 months of life with projectile nonbilious emesis.

Consider Other Alternative Diagnoses when:
- Bilious Emesis
- Age outside of 2 weeks to 2 months
- History and/or physical examination findings concerning for Non-accidental Trauma

Consider a Diagnostic Timeout ("What else could this be?") or using a diagnostic checklist.

Inclusion Criteria

Patients < 4 mo (typically < 10 weeks)

Signs and Symptoms:
- Progressively worsening non-bilious vomiting
- Projectile vomiting
- Vomiting immediately after most feeds
- Hungry immediately after vomiting
- Progressive weight loss or poor weight gain

Exclusion Criteria
- Concern for sepsis, non-accidental trauma, bilious emesis

Diagnostic Timeout
Red Flags
- Bilious Emesis
- Age outside of 2 weeks to 2 months
- History and/or physical examination findings concerning for Non-accidental Trauma

Diagnostic Timeout
Differential Diagnoses
- Gastroesophageal reflux
- Acute Gastroenteritis
- Pylorospasm
- Pyloric Atresia
- Duodenal Webs
- Overfeeding
- Non-Accidental Trauma (i.e. head trauma)
- Increased intracranial pressure

Admission Criteria
- All patients with pyloric stenosis should be admitted to pediatric surgery service.
- Patient with the following should be considered for PICU admission:
  - -Hypopnea, apnea, or desaturation
  - -Hypotension (MAP <50)
  - -Tachycardia unresponsive to IV bolus x 3
  - -Anuria (no wet diaper in preceding 12hrs)
  - -Serum Cl^- <85mmol/L &/or $HCO3^-$ ≥ 40mmol/L

Testing

Abdominal Ultrasound

- Ultrasound has a sensitivity of 98%, and specificity of 100%.
- Ultrasound will demonstrate a pylorus with muscle thickness of 3 mm or greater and length of 15 mm or greater.

Laboratory

- Chem 7 is required for all patients. Chloride should be greater than 100 and bicarbonate less than 30 prior to surgery.

Return to Initial Assessment Algorithm

Severity Assessment

- Patients with apnea, hypopnea, desaturations, or threatened airway should be admitted to PICU and airway managed appropriately.
- Patients with severe hypochloremia (Cl^- <85) and severe metabolic alkalosis($HCO3^-$ ≥ 40mmol/L) should be monitored closely for more severe respiratory compromise in the ED and admitted to PICU.

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Admission Criteria

- All patients with pyloric stenosis should be admitted to Pediatric Surgery service.
- Patient with the following should be considered for PICU admission:
  -Hypopnea, apnea, or desaturation
  -Hypotension (MAP <50)
  -Tachycardia unresponsive to IV bolus x 3
  -Anuria (no wet diaper in preceding 12hrs)
  -Serum Cl^- <85mmol/L &/or $HCO3^-$ ≥ 40mmol/L

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Assessment & Monitoring

- All admitted patients will be placed on cardiorespiratory monitoring.
- Patients should be monitored for response and fluid overload between and after fluid boluses.
- Patients should be monitored for response to fluid resuscitation by monitoring urine output.
- Chloride and bicarbonate should be monitored until they are in the appropriate range for surgery (Chloride >100 , Bicarb <30). Labs should be repeated q8hours.

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Recommended Treatments

- Pyloromyotomy is the gold standard treatment for pyloric stenosis.
- Adequate resuscitation is required for all patients with initial NS fluid bolus 20 ml/kg and followed by D5NS at 1.5 maintenance rate.
- IVF should be started in ED.
- Hemodynamically stable patients with electrolyte abnormalities should receive NS boluses of 20ml/kg over 30-60 minutes.
  - 1 bolus if any abnormal Cl^- or HCO_3^- abnormality.
  - 2 Boluses if Cl^- 85-97 &/or HCO_3^- 33-39.
  - 3 Boluses if Cl^- < 85 &/or HCO_3^- 40.
  - Any sign of hemodynamic instability requires a practitioner assessment.
- IVF should be started without KCl^- and only added after patient is voiding and K^+ is < 6.0. 20mEq of KCl^- should be added to D5 NS.

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Treatments Not Recommended

- UGI will demonstrate failure of passage of contrast. This can be inconclusive as it is difficult to differentiate pylorospasm from permanent obstruction. (Level 2 evidence, Strong Recommendation)
- Non-operative management with atropine is not recommended unless there is prohibitive risk for general anesthesia.
- NG Tube for decompression is NOT recommended for all pyloric stenosis.
- Perioperative antibiotics are not indicated for pyloromyotomy.

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Deterioration & Escalation of Care

Identification of Deterioration

- Decreasing respiratory rate, continued anuria despite resuscitation should prompt ICU evaluation for transfer

Escalation of Care Protocol

- Patients with respiratory compromise or unresponsive to fluid resuscitation should be evaluated for PICU admission

Return to Initial Assessment Algorithm

Discharge Criteria & Planning

Post-Operative Feeding Protocol

- Start formula or expressed breast milk (expressed breast feeding is preferred over direct breastfeeding) 3 hours after surgery at 30 ml followed by Q3H feeds of:
  - < 2.5 kg: 45 ml
  - 2.5 -3.49 kg: 60 ml
  - 3.5-4.49 kg: 75 ml
  - 4.5 kg or more: 90 ml
- If patient vomits a step above, practitioner is to be notified and same step repeated 3 hours later
- Must tolerate weight-based goal x 2 consecutive feeds prior to ad lib

Discharge Criteria

- Tolerating advancement of feeds to discharge goal
- Afebrile
- Maintaining urine output ≥1.0 mL/kg/hr
- Anesthesia protocol for postoperative monitoring satisfied

Follow Up

- PCP follow-up within one week of discharge for weight check
- Patients will be scheduled for a General Surgery nurse call 2-4 weeks for follow-up unless otherwise specified

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Return to Post-Operative Algorithm

Patient & Caregiver Education

Education on:
Helping Hands – Pyloric Stenosis

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Risk Awareness & Zero Hero

- Newborns with non-accidental trauma will present with symptoms similar to pyloric stenosis. In patients with normal US, NAT work-up should be completed.

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Key References

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Quality Measures

Process Metric

- ED Order Set use
- IP Pre-op and Post-op Order Set use
- Time from admission to surgery
- Time from surgery to discharge

Outcome Metric

- ED LOS
- Inpatient LOS

Balancing Metric

- 7 day return to ED/UC rate
- 7 day readmission rate

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Potential Areas for Research

- Retrospective chart review to define true recurrence of pyloric stenosis vs result of incomplete myotomy

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Team & Process

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Clinical Pathway Development

This clinical pathway was developed using the process described in the NCH Clinical Pathway Development Manual Version 6, 2022. Clinical Pathways at Nationwide Children's Hospital (NCH) are standards which provide general guidance to clinicians. Patient choice, clinician judgment, and other relevant factors in diagnosing and treating patients remain central to the selection of diagnostic tests and therapy. The ordering provider assumes all risks associates with care decisions. NCH assumes no responsibility for any adverse consequences, errors, or omissions that may arise from the use or reliance on these guidelines. NCH's clinical pathways are reviewed periodically for consistency with new evidence; however, new developments may not be represented, and NCH makes no guarantees, representations, or warranties with respect to the information provided in this clinical pathway.

For more information about our pathways and program please contact:
ClinicalPathways@NationwideChildrens.org

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Appendix A

- Cl- <100, HCO3 >30 : Normal Saline Bolus 20 ml/kg x1
- Cl- 85-97, HCO3 33-39 : Normal Saline Bolus 20 ml/kg x2 given 1 hour apart
- Cl- <85, HCO3 ≥ 40 : Normal Saline Bolus 20 ml/kg x3, each given 1 hour apart

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