Clinical Pathways

Diabetes Insipidus (DI) Post-operative Neurosurgical Management

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What is a Clinical Pathway?

An evidence-based guideline that decreases unnecessary variation, and therefore promotes safe, effective, and consistent patient care.

Background

- Diabetes insipidus (DI) refers to the passage of large volumes of dilute urine and may result from decreased secretion of antidiuretic hormone (ADH) by the posterior pituitary gland.
- Patients undergoing surgery in the sellar or parasellar region are at risk for postoperative DI, which may be transient, triphasic [DI > SIADH > DI], or permanent.
- Patients without an intact thirst mechanism (adipisic central DI) are a particular challenge, as they may not drink enough to replace their urine losses, resulting in severe hypernatremia.

Why is the DI Pathway Necessary?

- Uncontrolled hypernatremia has adverse effects, including an increased risk of neurological sequela and venothromboembolism
- Provider variability and inconsistent care delivery/monitoring are barriers to establish diagnosis and deliver timely and effective care in the absence of a standardized protocol

Objectives of the DI Pathway

- Standardize the management of postoperative patients at risk for developing DI
  - Initial PICU monitoring for development of DI
  - Initial PICU management if DI develops
  - Standardized clearance for patient's transfer to med/surg floors
- Standardize the management of post-operative patients with confirmed DI in the PICU and on the floors
  - Minimize fluctuations in sodium level and volume status
  - Expedite the development of an outpatient plan in order to facilitate a safe discharge to home

Pathway Overview

- This is the Diabetes Insipidus (DI) Post-operative Neurosurgical Management Clinical Pathway.
- There are 3 portions of the pathway:
  1) PICU Post-operative Monitoring for DI
  2) PICU Management of DI
  3) Med/Surg Management of DI
- We will be reviewing each component in the following slides.

Page 1

CLINICAL PATHWAY:
Diabetes Insipidus (DI) - Post-operative Neurosurgical Management
PICU Post-operative Monitoring for DI

Page 2

CLINICAL PATHWAY:
Diabetes Insipidus (DI) - Post-operative Neurosurgical Management
PICU Management of DI

Page 3

CLINICAL PATHWAY:
Diabetes Insipidus (DI) - Post-operative Neurosurgical Management
Med/Surg Management of DI

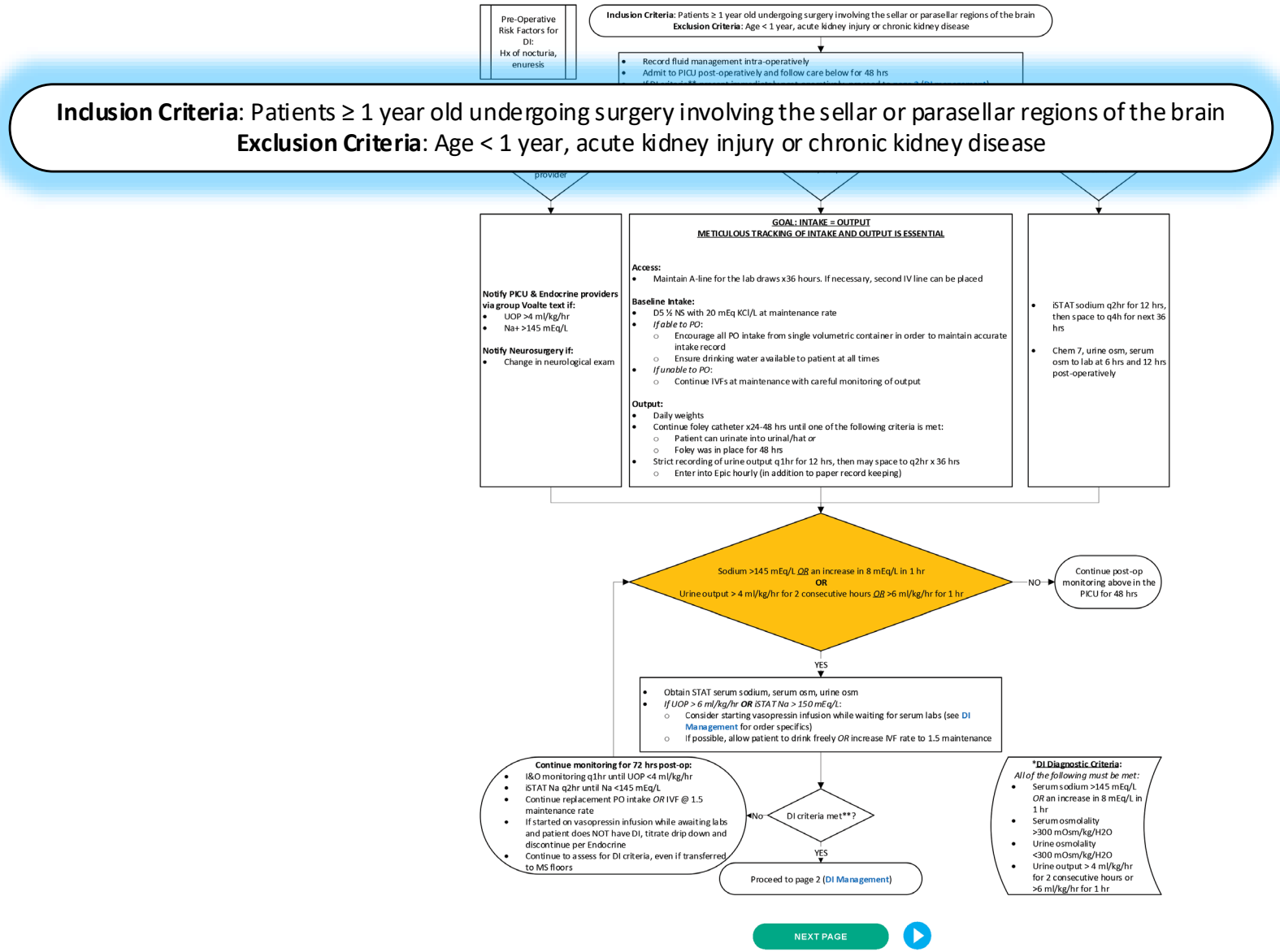
PICU Post-Operative Monitoring for DI

CLINICAL PATHWAY:
Diabetes Insipidus (DI) Post-operative Neurosurgical Management
PICU Post-operative Monitoring for DI

THIS PATHWAY SERVES AS A GUIDE AND DOES NOT REPLACE CLINICAL JUDGMENT.

Because any surgical procedure that involves the sellar or parasellar regions of the brain can increase the risk of DI development, any child that is ≥1 year of age that has such a procedure will be monitored for the development of DI post-operatively.

Of note, those with any acute kidney injury or chronic kidney disease are excluded from the pathway.



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PICU Post-Operative Monitoring for DI

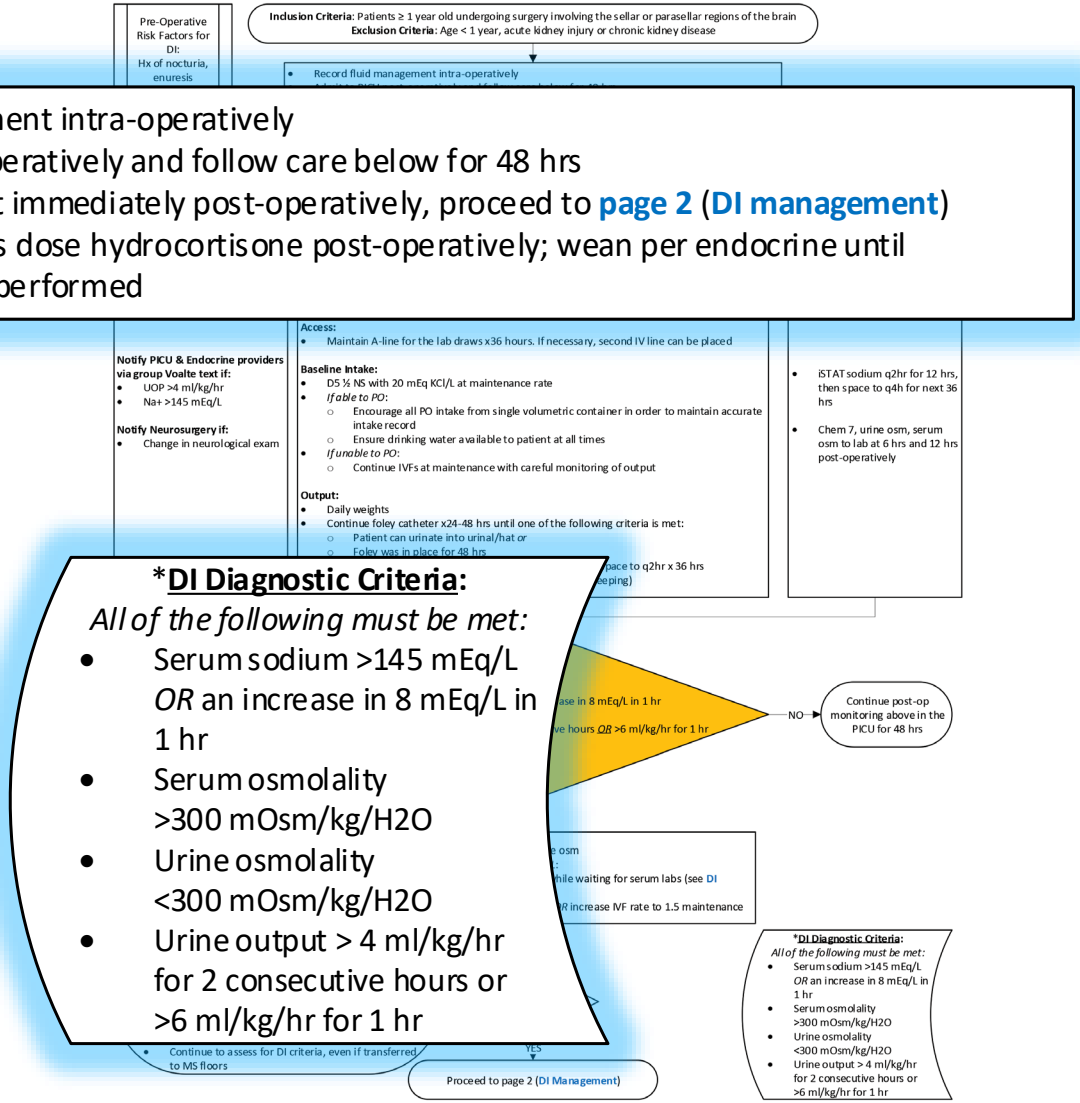
All patients with sellar/parasellar surgery will be admitted to the PICU for monitoring of DI development.

If DI is noted immediately post-op, DI management should be followed.

DI criteria are noted here.

Note that all of the criteria must be met, which includes serum sodium, serum osmolality, urine osmolality, and urine output. These parameters will be assessed frequently.

- Record fluid management intra-operatively
- Admit to PICU post-operatively and follow care below for 48 hrs
- If DI criteria** present immediately post-operatively, proceed to **page 2** (**DI management**)
- Neurosurgery to stress dose hydrocortisone post-operatively; wean per endocrine until cosyntropin stim test performed



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PICU Post-Operative Monitoring for DI

The most important aspect of DI is to ensure intake = output. **Meticulous tracking of I&Os is essential.**

Intake:

- All should be started on maintenance IVF.
- In order to maintain accurate intake, PO from one container is encouraged, and patient should have water available at all times.

Output:

- Foley catheter is maintained for 24-48 hours until the patient can urinate or the foley has been in for 48 hours.
- Strict recording of output is needed every 1 hour for 12 hours, and then every 2 hours for 36 hours thereafter.

CLINICAL PATHWAY:
Diabetes Insipidus (DI) Post-operative Neurosurgical Management
PICU Post-operative Monitoring for DI

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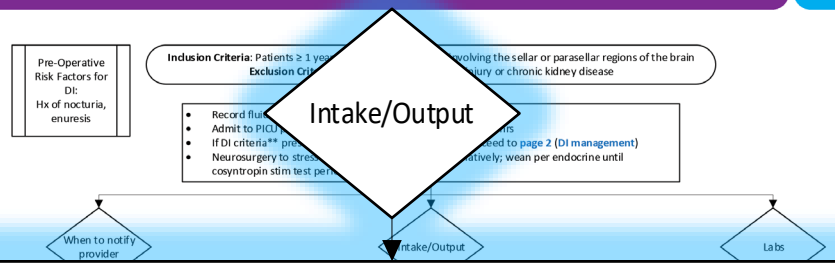

GOAL: INTAKE = OUTPUT
METICULOUS TRACKING OF INTAKE AND OUTPUT IS ESSENTIAL

Access:

- Maintain A-line for the lab draws x36 hours. If necessary, second IV line can be placed

Baseline Intake:

- D5 ½ NS with 20 mEq KCl/L at maintenance rate
- *If able to PO*:
  - Encourage all PO intake from single volumetric container in order to maintain accurate intake record
  - Ensure drinking water available to patient at all times
- *If unable to PO*:
  - Continue IVFs at maintenance with careful monitoring of output

Output:

- Daily weights
- Continue foley catheter x24-48 hrs until one of the following criteria is met:
  - Patient can urinate into urinal/hat *or*
  - Foley was in place for 48 hrs
- Strict recording of urine output q1hr for 12 hrs, then may space to q2hr x 36 hrs
  - Enter into Epic hourly (in addition to paper record keeping)

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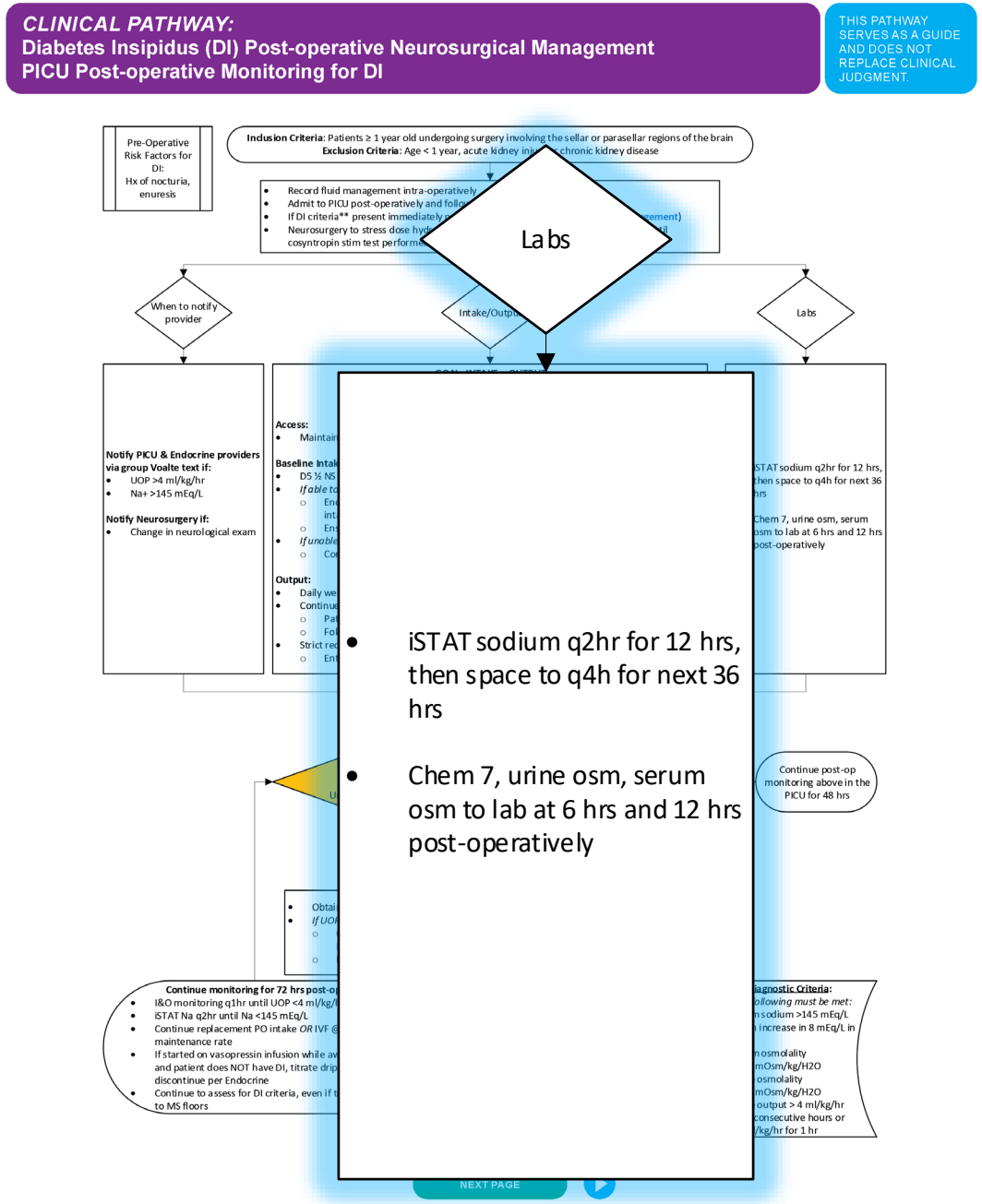
PICU Post-Operative Monitoring for DI

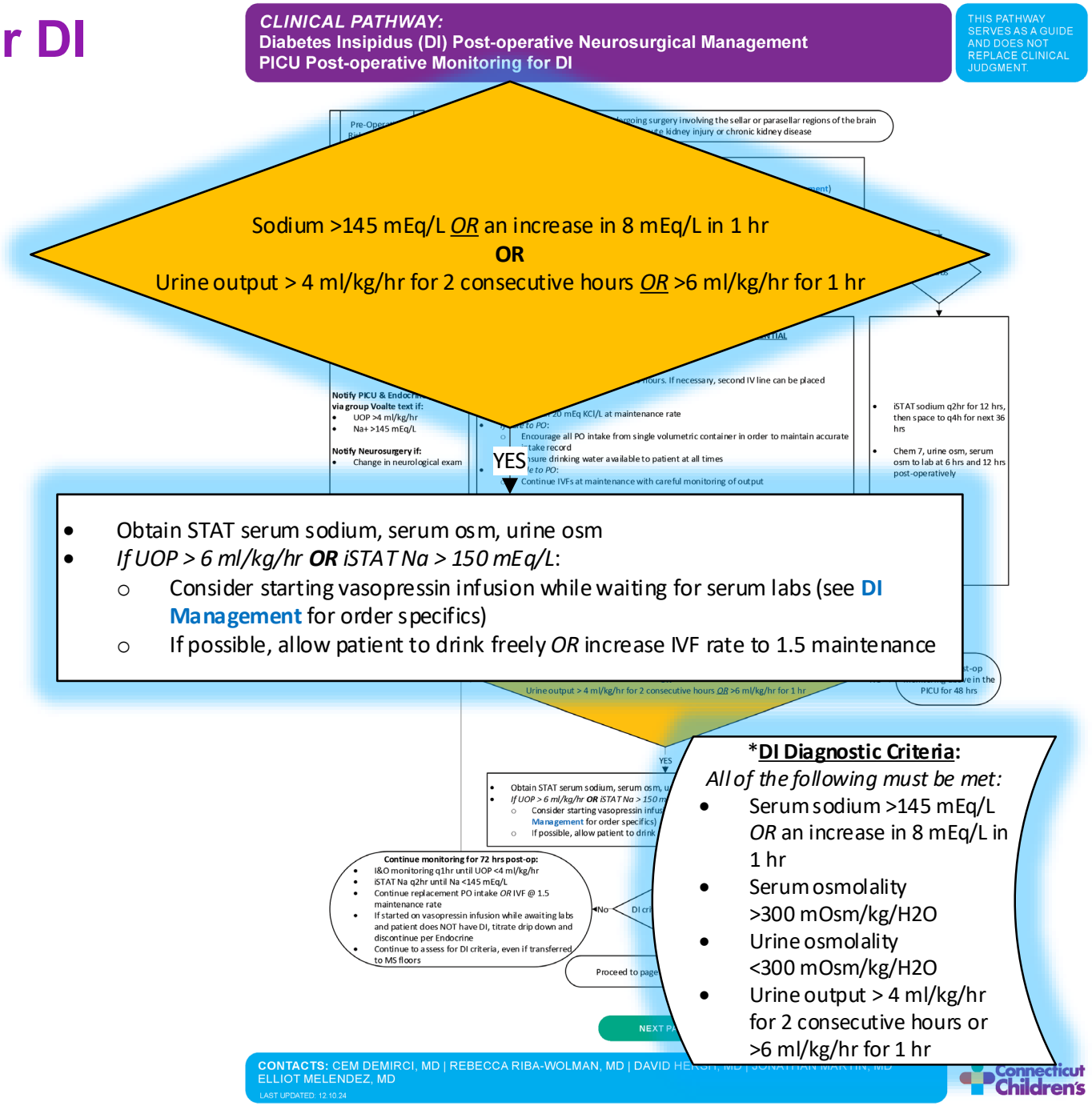
Laboratory monitoring is also essential to ensure that DI has not developed.

Recommendations are listed here.



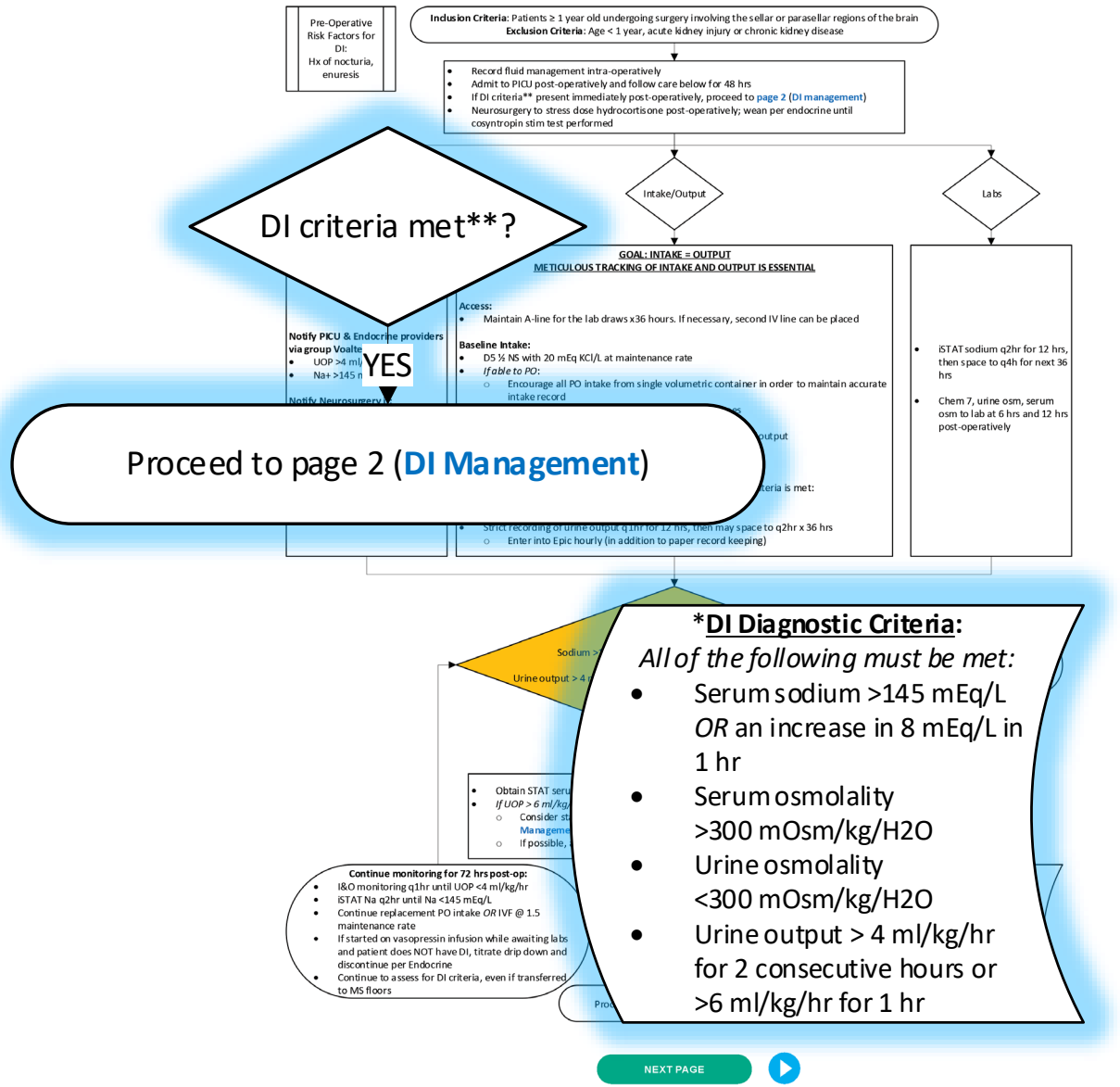
PICU Post-Operative Monitoring for DI

- If sodium is >145 mEq/L (or an increase by 8 mEq/L in 1 hr) OR there is urine output that is >4 ml/kg/hr for 2 consecutive hours (or >6 ml/kg/hr for 1 hr), you MUST obtain stat labs to evaluate if DI is present.
- If UOP or Na is concerning, you can consider starting vasopressin right away while waiting for the other confirmatory labs.
- While waiting, it is advisable to increase IVF to 1.5 M to help combat losses, or allow the patient to drink freely.



PICU Post-Operative Monitoring for DI

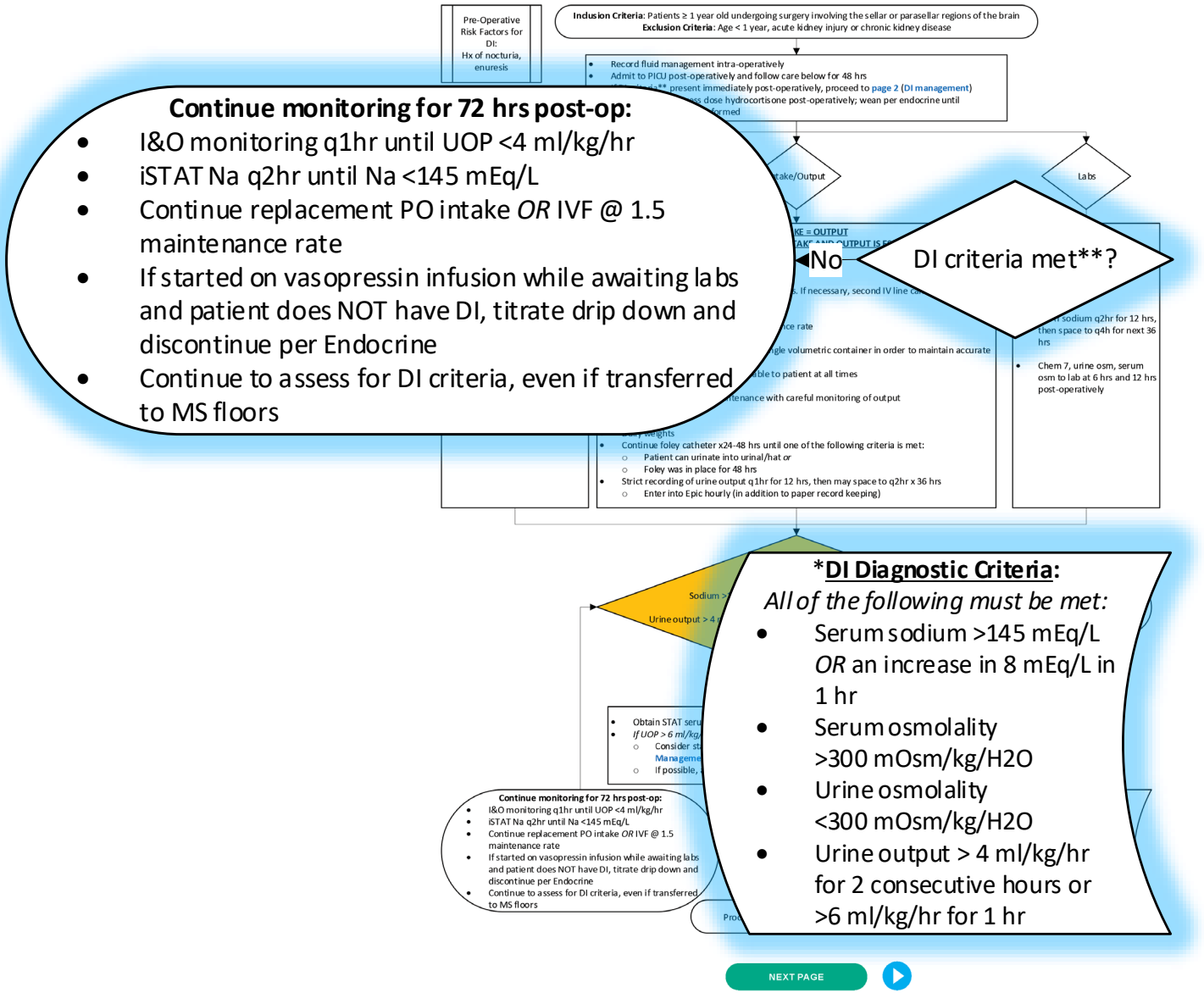
- If DI criteria is met after those STAT labs are obtained, then you will proceed to DI management on page 2.



PICU Post-Operative Monitoring for DI

If DI criteria is not met:

- Continue closer monitoring until patient is more stable
- Increase input by increasing IVF to 1.5 maintenance or replace PO to meet UOP
- Titrate vasopressin if it was started
- Continue to closely monitor for DI as previously reviewed



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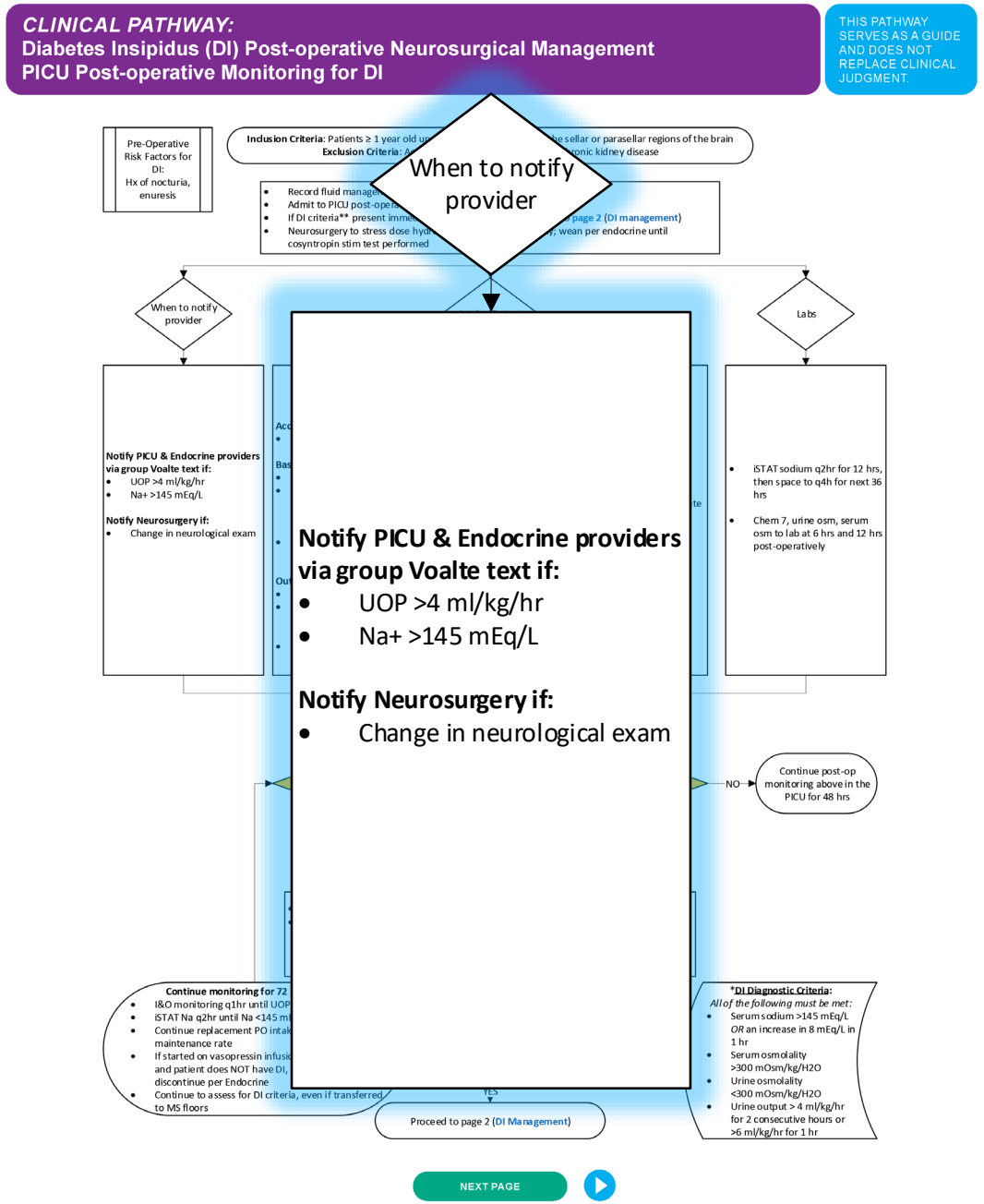
PICU Post-Operative Monitoring for DI

- Note that PICU/Endocrine providers should be notified immediately if UOP >4 ml/kg/hr or sodium is >145 mEq/L. This is to allow for immediate intervention and closer monitoring.
- Neurosurgery should be notified if there is any change in neurological examination.

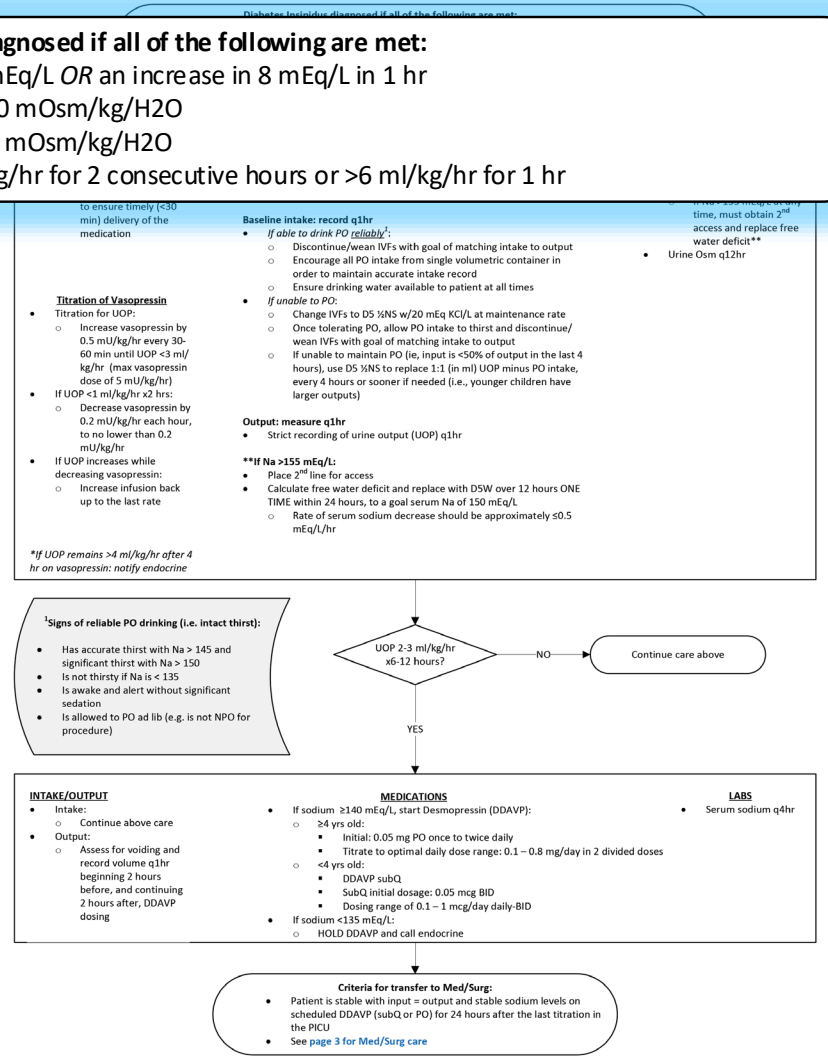


PICU Management of DI

- If DI criteria is met, follow the 2nd page of the algorithm for PICU management of DI
- Diagnostic criteria are listed here. Remember that all criteria must be met.

Diabetes Insipidus diagnosed if all of the following are met:

- Serum sodium >145 mEq/L *OR* an increase in 8 mEq/L in 1 hr
- Serum osmolality >300 mOsm/kg/H2O
- Urine osmolality <300 mOsm/kg/H2O
- Urine output > 4 ml/kg/hr for 2 consecutive hours or >6 ml/kg/hr for 1 hr



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PICU Management of DI

- Part of the initial management of DI is vasopressin.
- One role of vasopressin is to stimulate arginine vasopressin receptors (aka, antidiuretic hormone, or ADH).
- This results in decreased urine output and increased osmolality.
- Vasopressin is titrated based on UOP.
- If UOP stays >4 ml/kg/hr despite 4 hrs of vasopressin therapy, endocrine should be notified.

CLINICAL PATHWAY:
Diabetes Insipidus (DI)
PICU Management of DI

THIS PATHWAY SERVES AS A GUIDE AND DOES NOT REPLACE CLINICAL JUDGMENT.

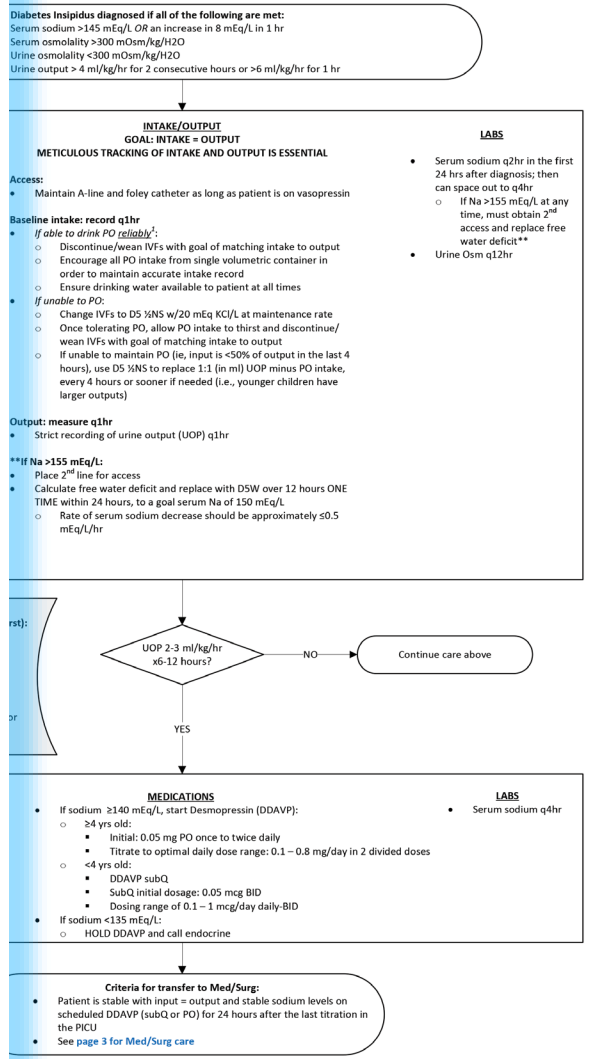
MEDICATION

- Order STAT Vasopressin IV infusion at 0.5 mU/kg/hr (max vasopressin dose of 5 mU/kg/hr)
  - Call pharmacy in order to ensure timely (<30 min) delivery of the medication

Titration of Vasopressin

- Titration for UOP:
  - Increase vasopressin by 0.5 mU/kg/hr every 30-60 min until UOP <3 ml/kg/hr (max vasopressin dose of 5 mU/kg/hr)
- If UOP <1 ml/kg/hr x2 hrs:
  - Decrease vasopressin by 0.2 mU/kg/hr each hour, to no lower than 0.2 mU/kg/hr
- If UOP increases while decreasing vasopressin:
  - Increase infusion back up to the last rate

**If UOP remains >4 ml/kg/hr after 4 hr on vasopressin: notify endocrine*



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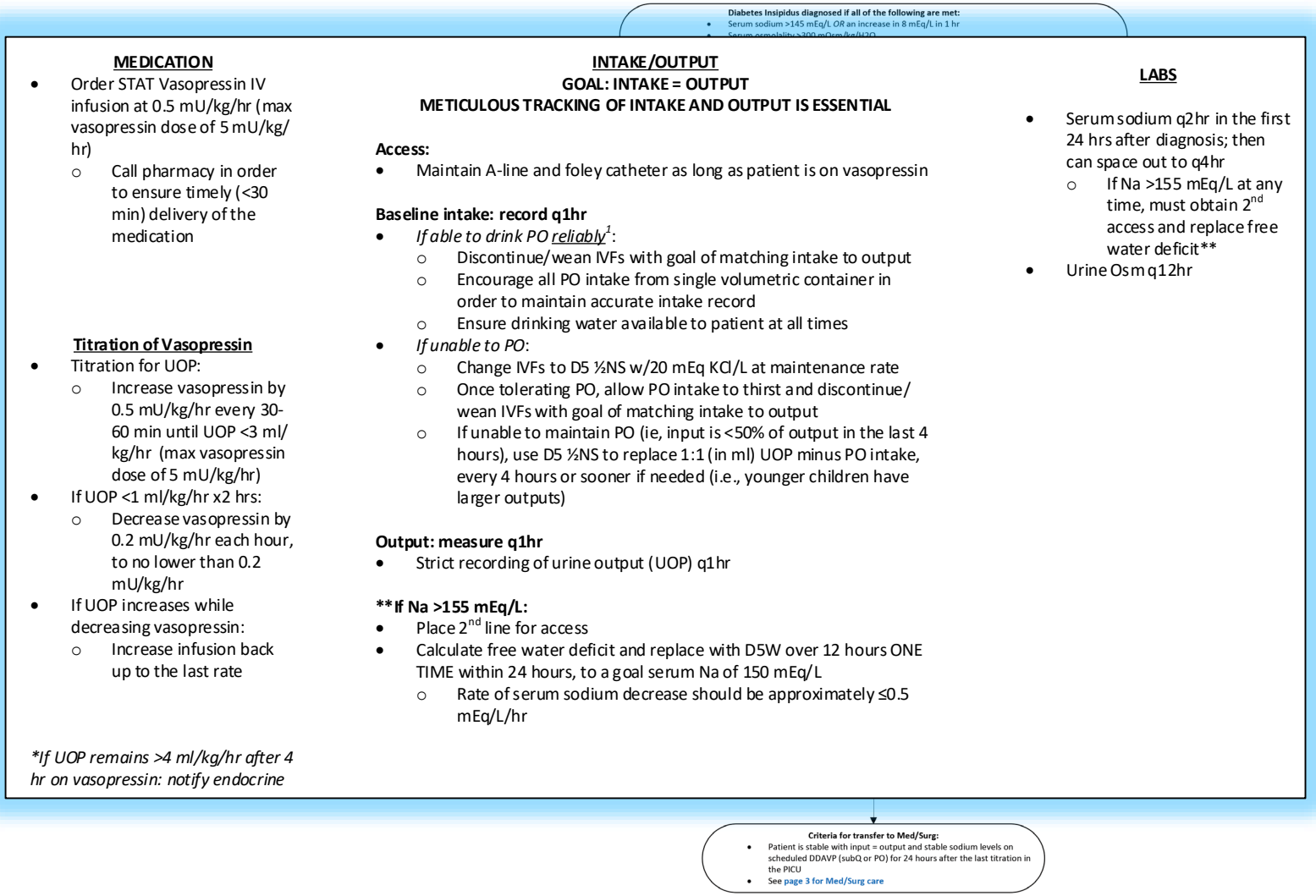
PICU Management of DI

- Again, meticulous tracking of intake and output is essential.
- The goal would be to ensure that intake = output. Careful monitoring is necessary, especially while on vasopressin.

- While the patient is on vasopressin, an A line and Foley should be maintained.
- If the patient's sodium reaches over 155 mEq/L:
  - A 2nd line should be placed to allow additional fluids
  - Free water deficit should be replaced with D5W once to get to a goal of serum Na 150 mEq/L



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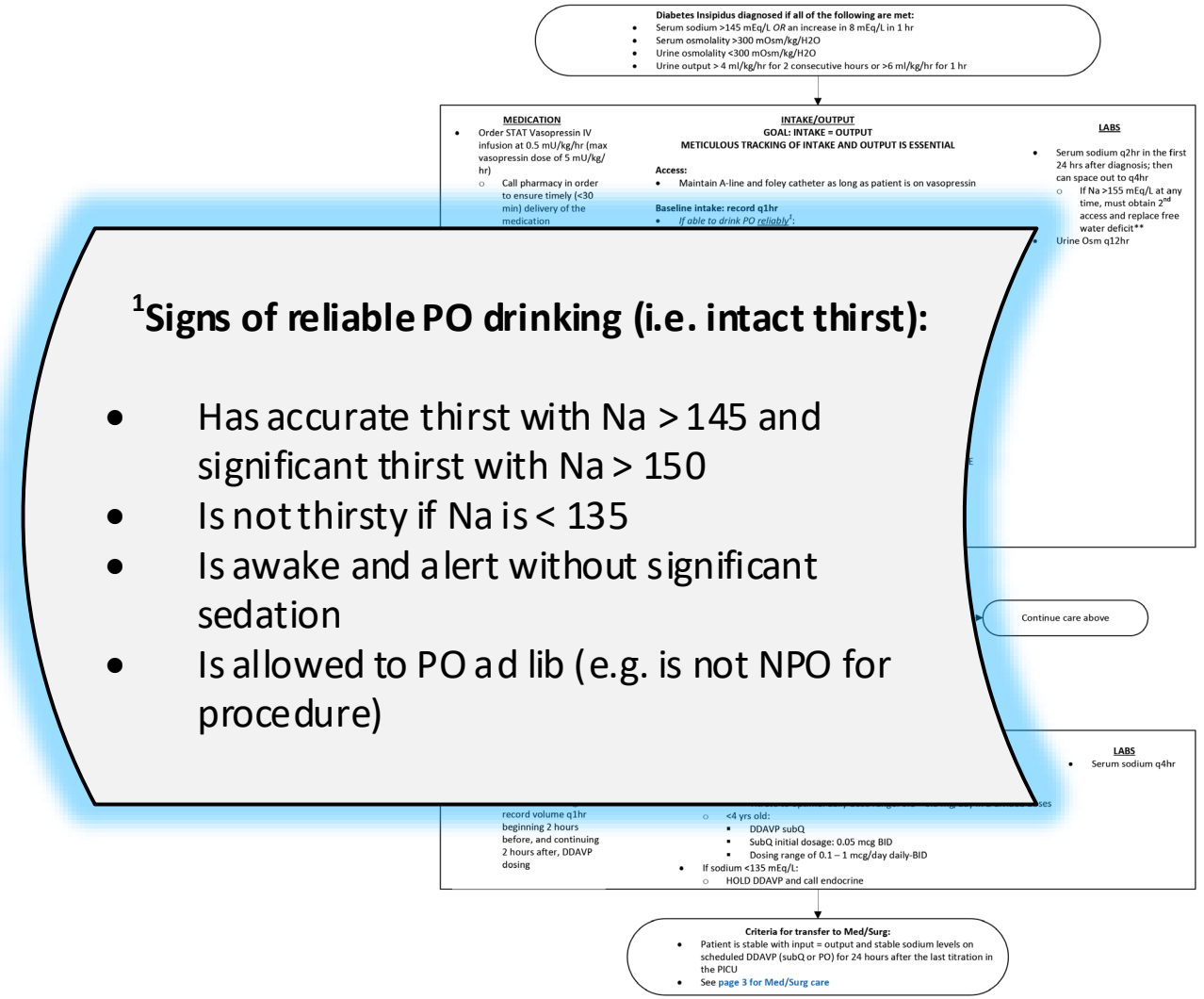
- It is vitally important to understand how to evaluate for intact thirst. Signs of reliable PO drinking are now listed on the pathway.



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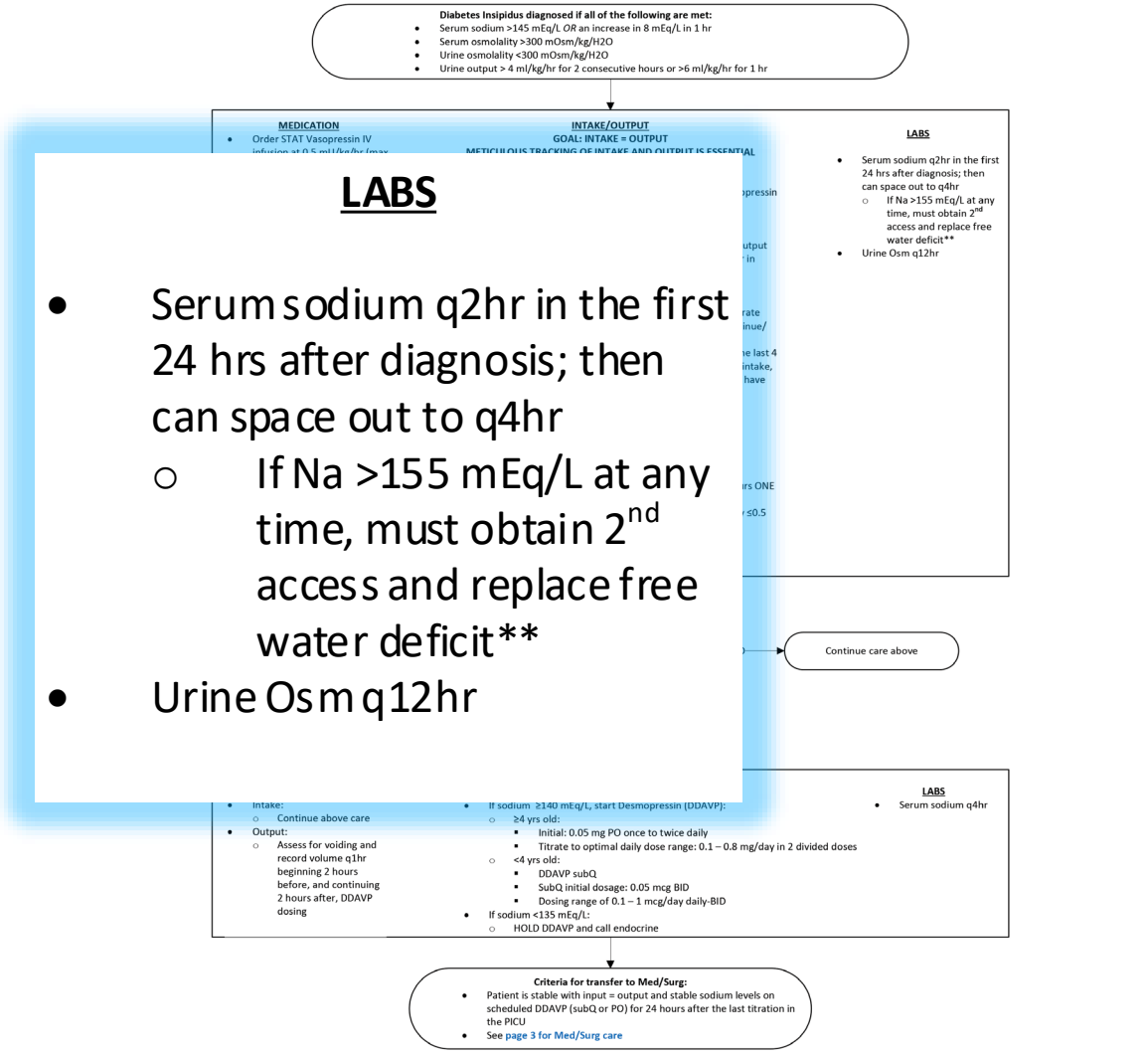
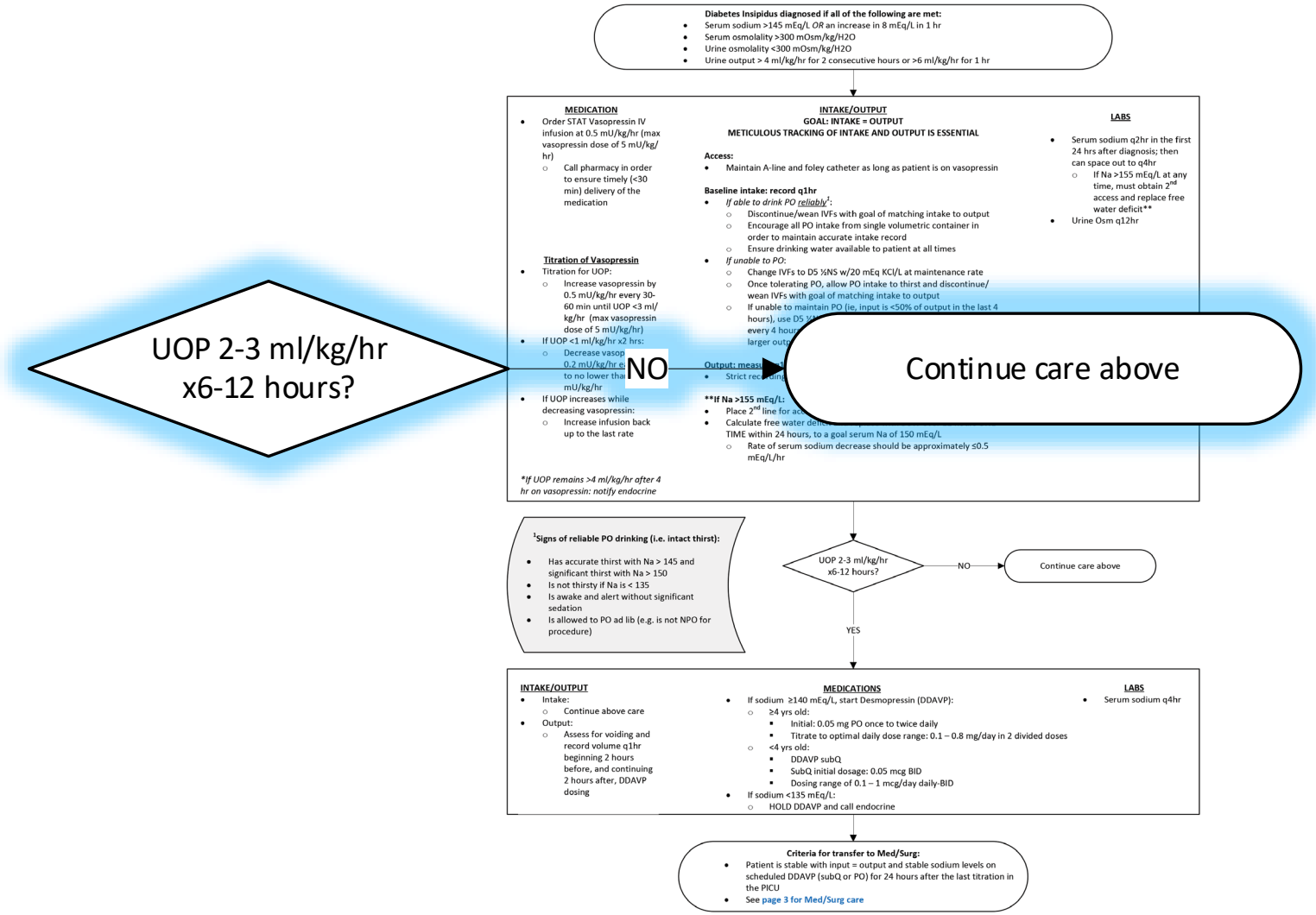
PICU Management of DI

- Labs are directed at closely monitoring serum sodium and urine osmolality
- Remember, if sodium becomes >155 mEq/L at any time, obtain a 2nd line to replace the free water deficit



PICU Management of DI

- If UOP has not stabilized to 2-3 ml/kg/hr for 6-12 hours, then the care outlined in previous slides should continue.



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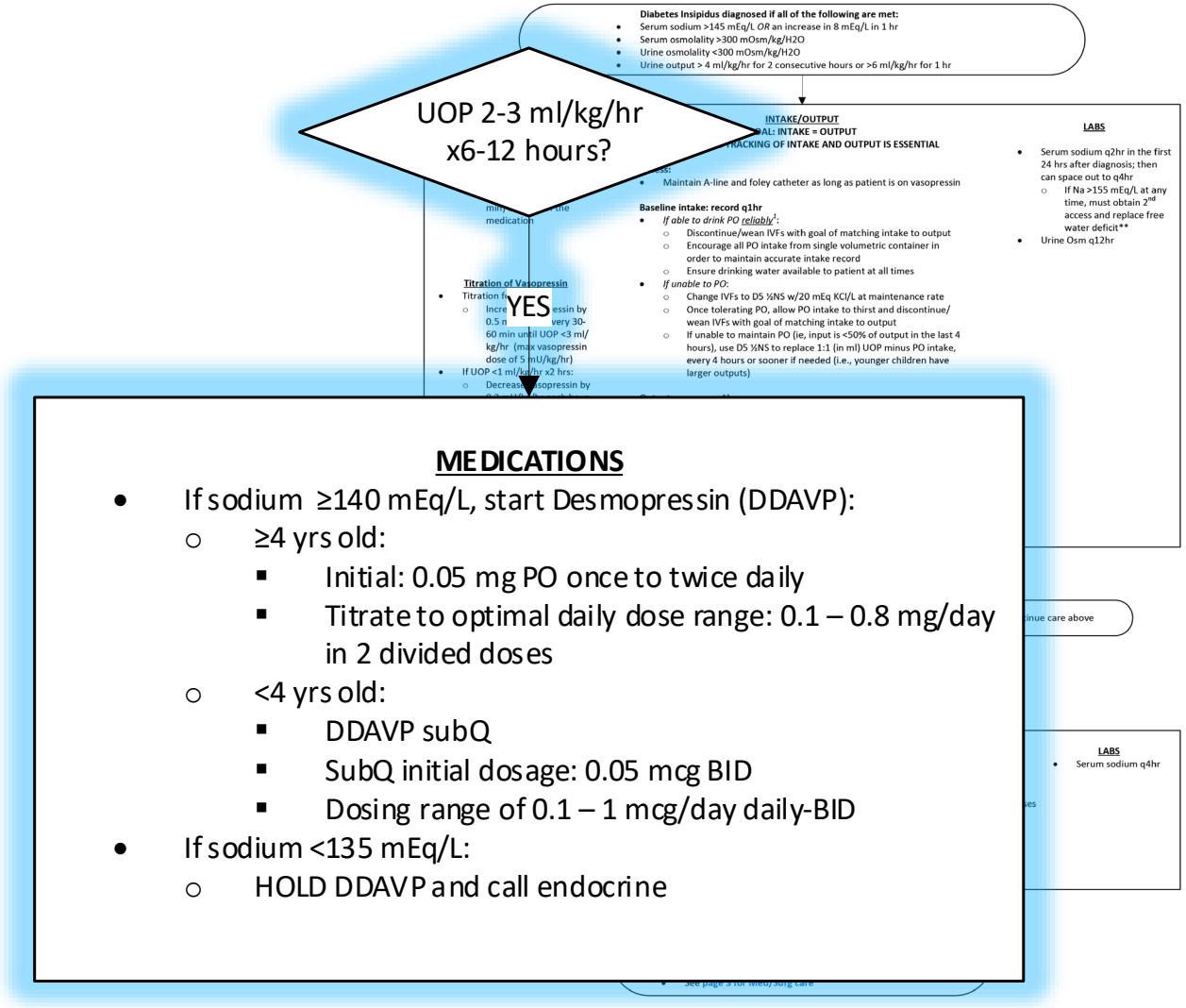
PICU Management of DI

If UOP has reached 2-3 ml/kg/hr for 6-12 hours:

- DDAVP may be started depending on sodium levels.



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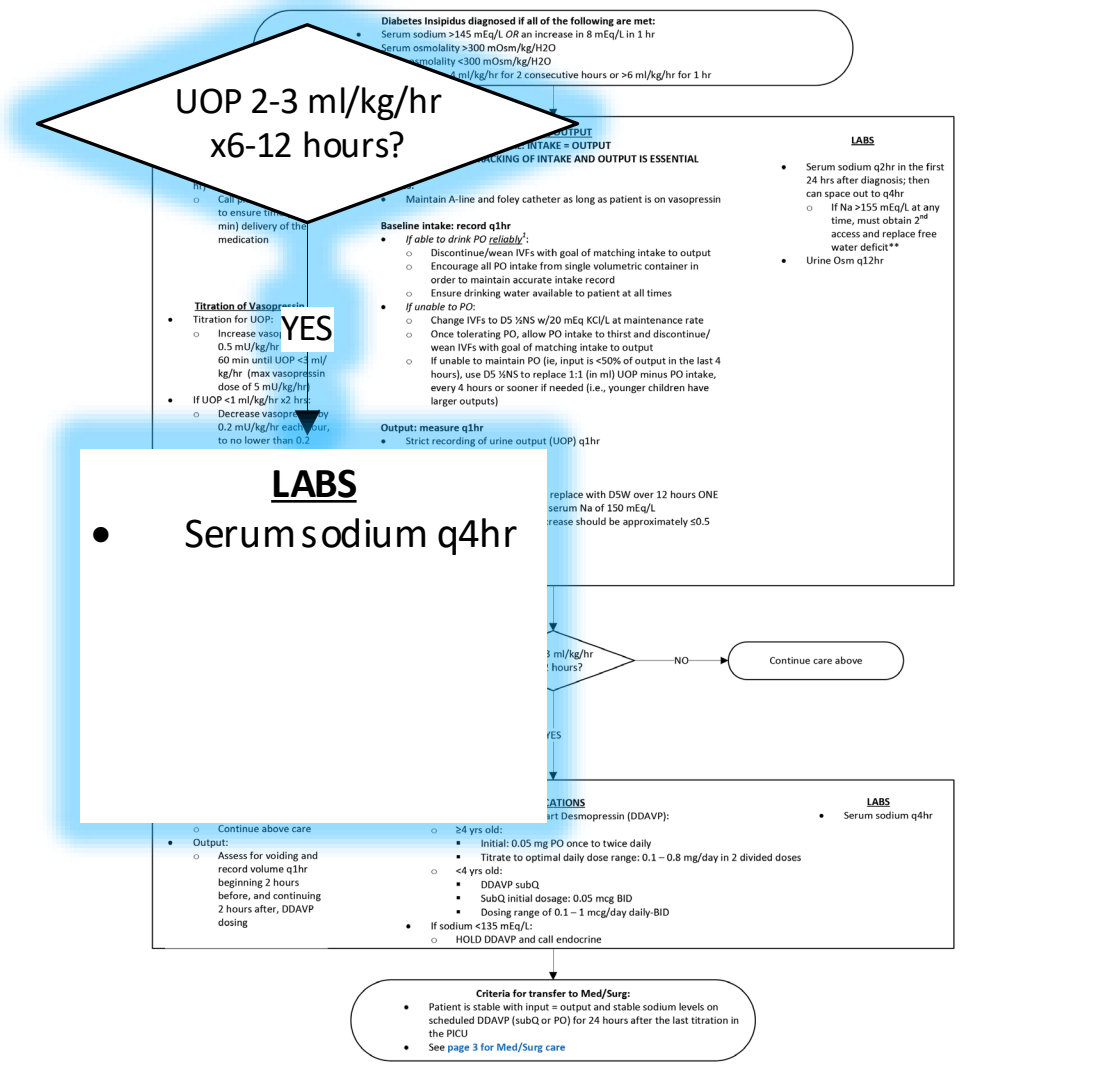
PICU Management of DI

If UOP has reached 2-3 ml/kg/hr for 6-12 hours:

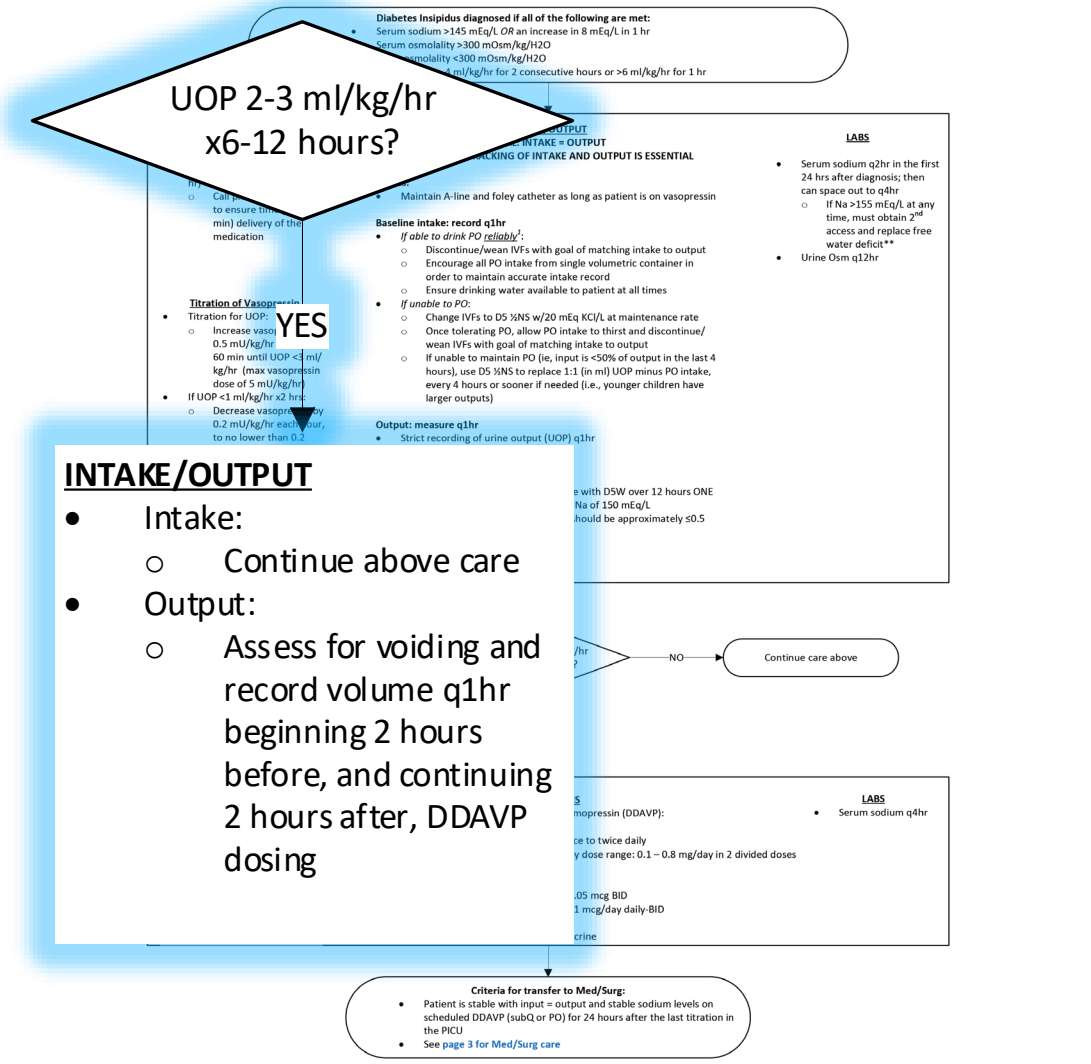
- Serum sodium monitoring can be spaced to every 4 hours if not already done



PICU Management of DI

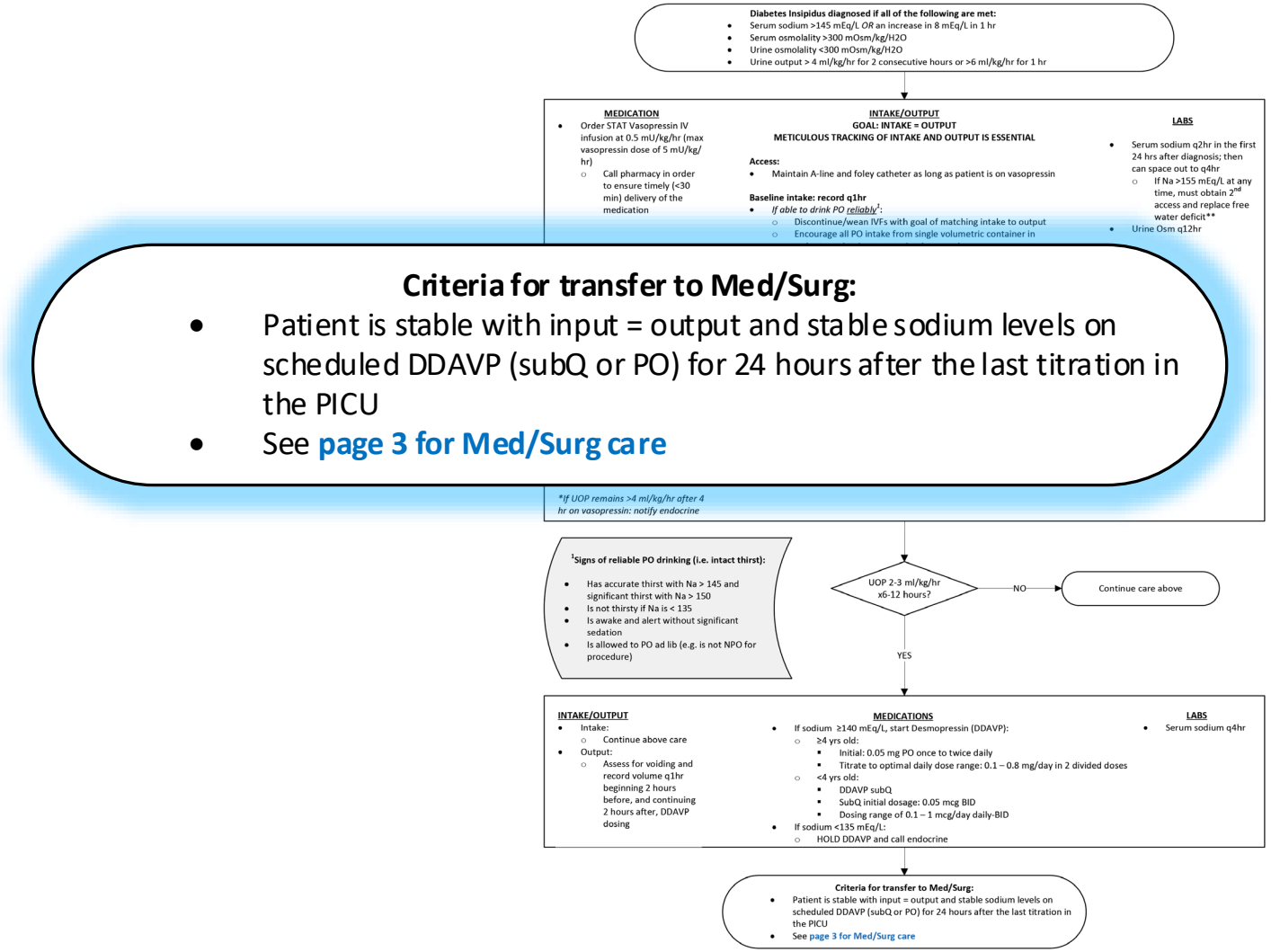
If UOP has reached 2-3 ml/kg/hr for 6-12 hours:

- Close monitoring of Intake and Output should continue
- Output assessment is important around DDAVP dosing



PICU Management of DI

- After DDAVP is titrated and the patient remains on scheduled doses for 24 hours, transfer to med/surg can be considered if intake = output and sodium levels are stable.



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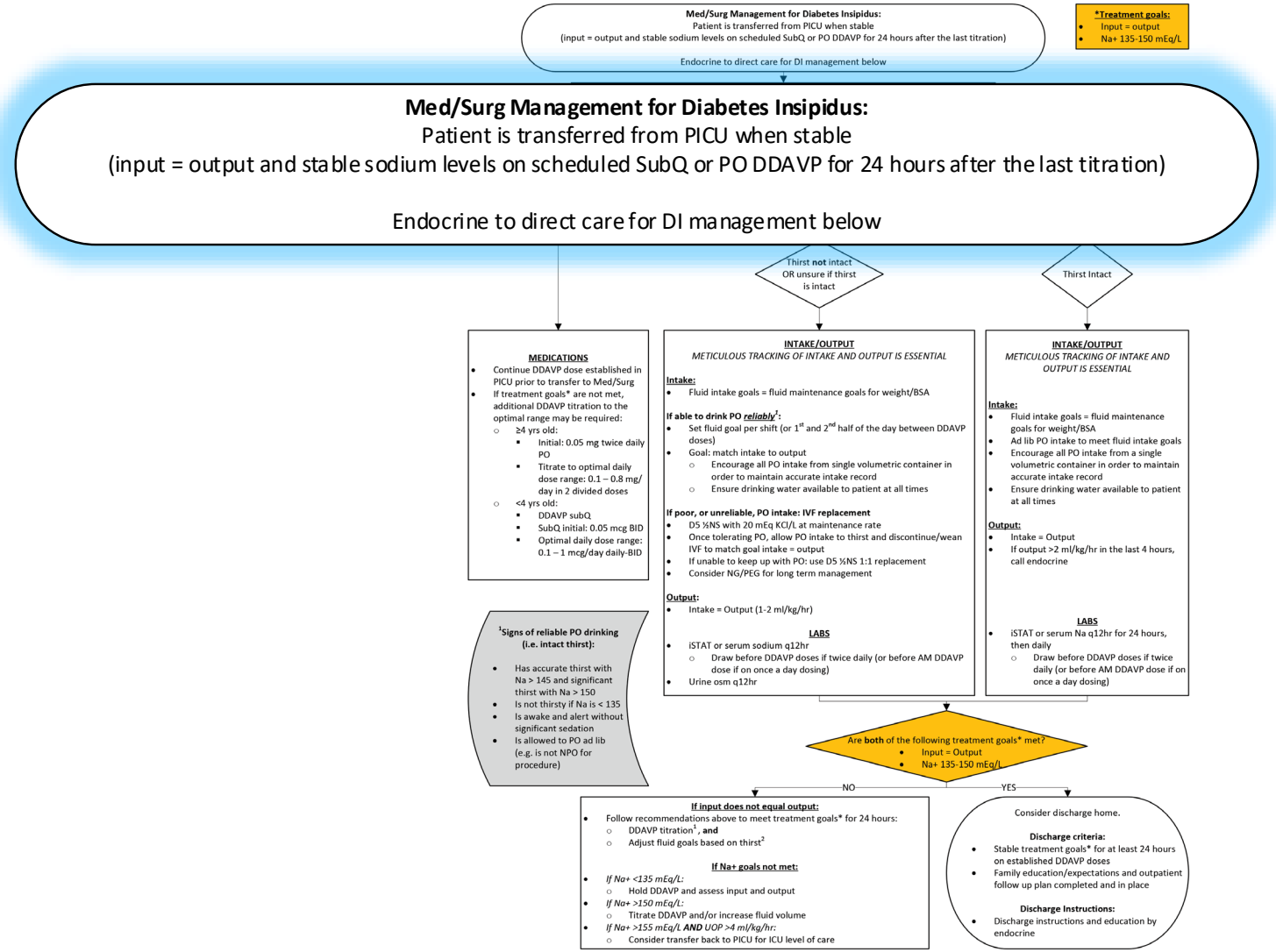
Med/Surg Management of DI

- Once criteria to transfer out of the PICU to the med/surg floors is met, follow page 3 of the pathway: Med/Surg Management of DI
- Endocrinology will direct the care for DI management.



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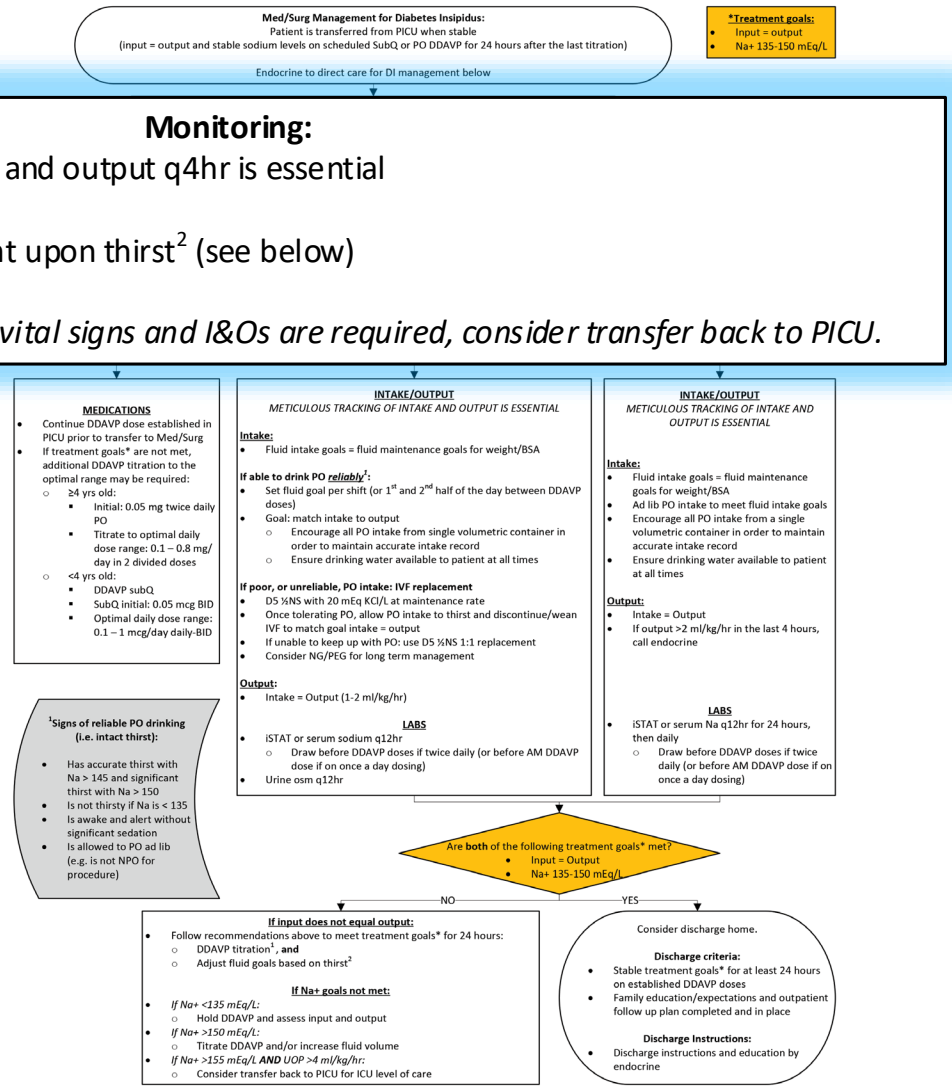
Med/Surg Management of DI

- Meticulous I&O tracking is essential. On the med/surg floors, this is done every 4 hours in conjunction with vitals. If more frequent monitoring is required, then consider transferring back to the PICU for closer monitoring.
- Labs are dependent upon thirst mechanism.



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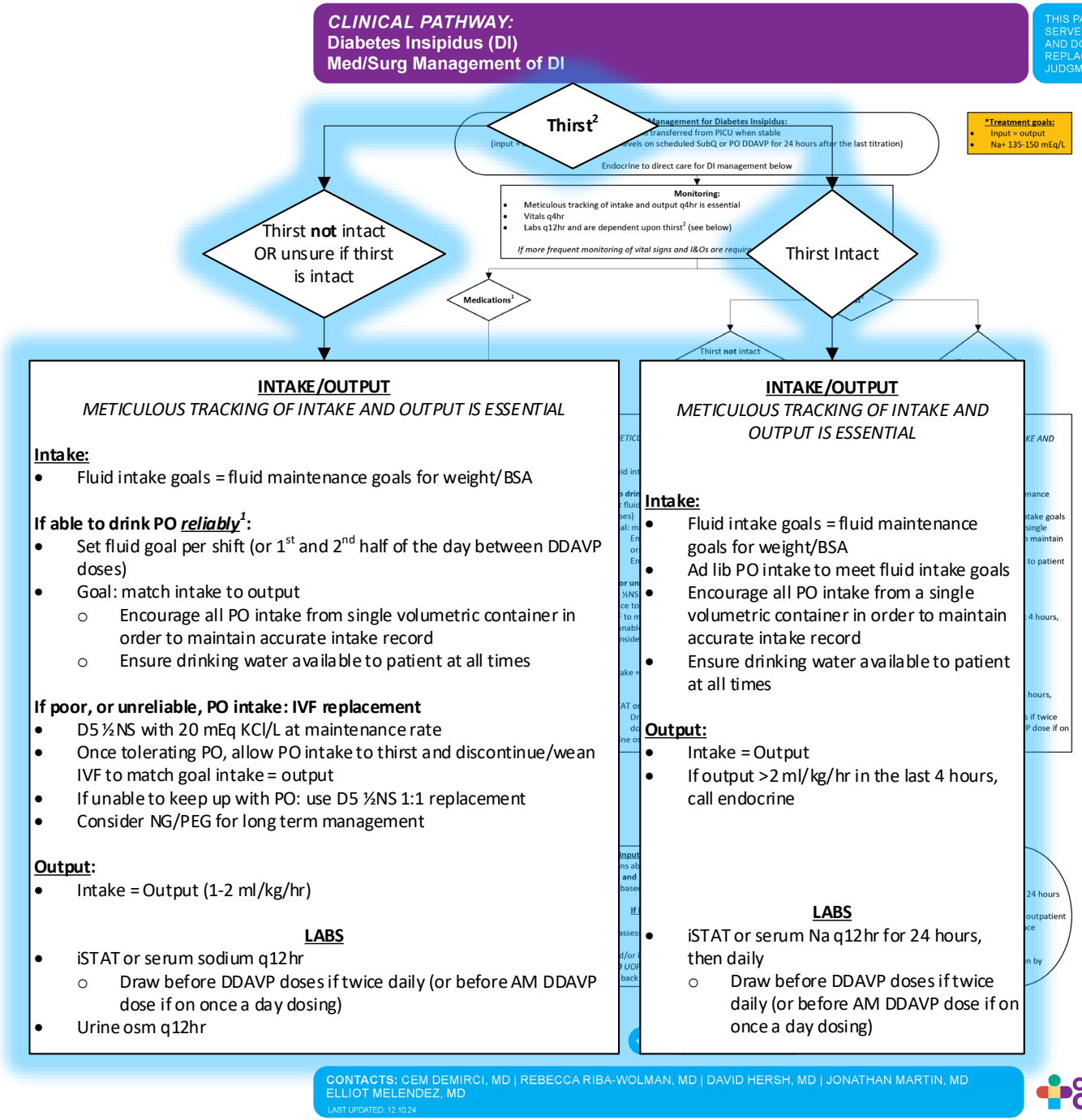
Med/Surg Management of DI

- Recommendations for I&Os and labs depend on if thirst mechanisms are intact.
- Both require:
  - Meticulous tracking of I&Os
  - Fluid intake goals to equal fluid maintenance goals for weight/BSA
  - Intake = output



Med/Surg Management of DI

CLINICAL PATHWAY:
Diabetes Insipidus (DI)
Med/Surg Management of DI

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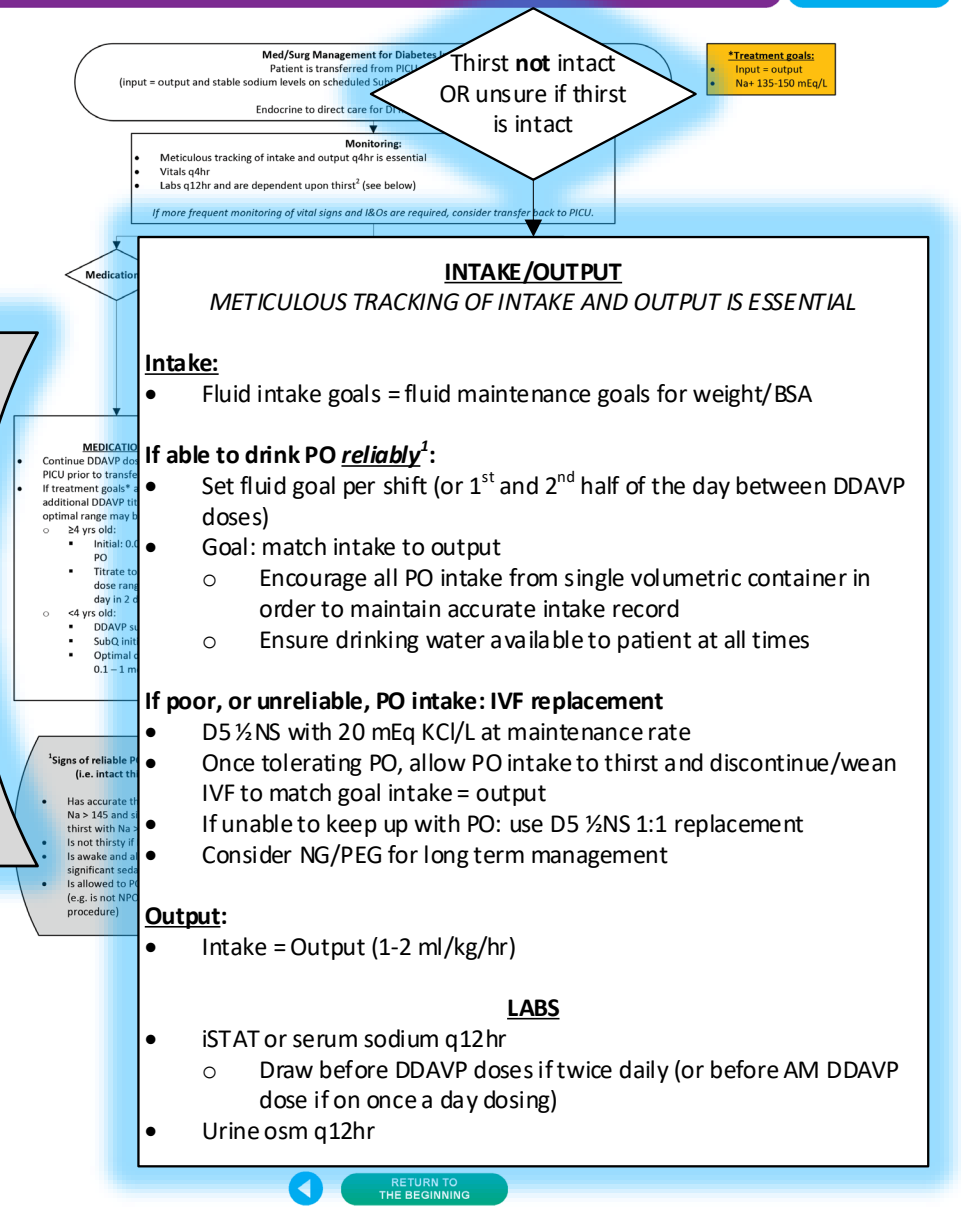
If thirst is not intact (or if there is uncertainty):

Intake:

- Should have fluid goals set and encourage all intake from one container for accurate measurements if patient is able to PO
- If PO intake is poor:
  - Start maintenance IVF
  - May need to replace 1:1
  - Consider using a NG/PEG for long term management

[1]Signs of reliable PO drinking (i.e. intact thirst):

- Has accurate thirst with Na > 145 and significant thirst with Na > 150
- Is not thirsty if Na is < 135
- Is awake and alert without significant sedation
- Is allowed to PO ad lib (e.g. is not NPO for procedure)



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Med/Surg Management of DI

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Diabetes Insipidus (DI)
Med/Surg Management of DI

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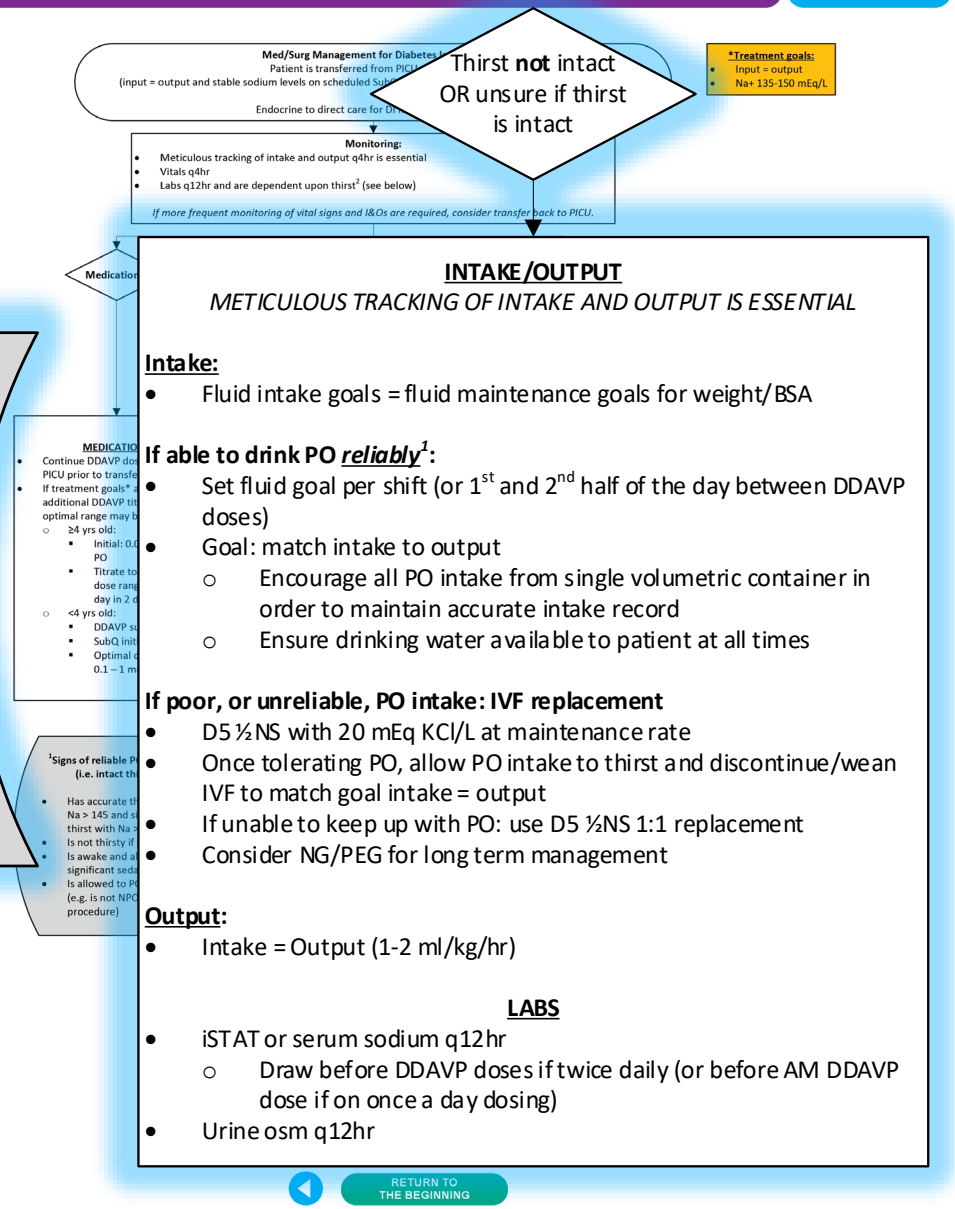
If thirst is not intact (or if there is uncertainty):

Labs:

- Sodium should be measured every 12 hours and drawn before DDAVP doses.
- Urine osm should also be monitored

[1]Signs of reliable PO drinking (i.e. intact thirst):

- Has accurate thirst with Na > 145 and significant thirst with Na > 150
- Is not thirsty if Na is < 135
- Is awake and alert without significant sedation
- Is allowed to PO ad lib (e.g. is not NPO for procedure)



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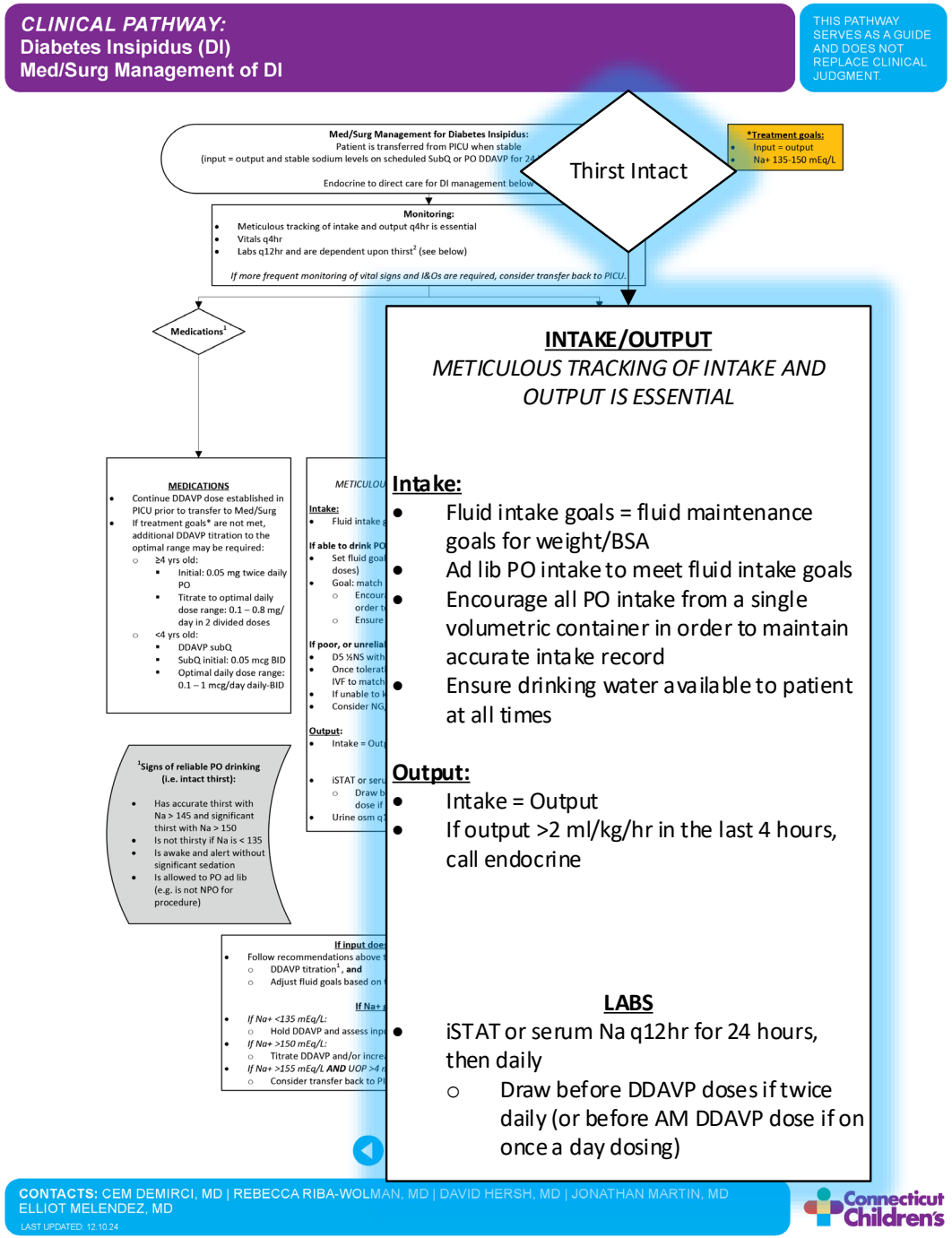
Med/Surg Management of DI

If thirst is intact

Intake:
- PO should be ad lib and monitored from one container

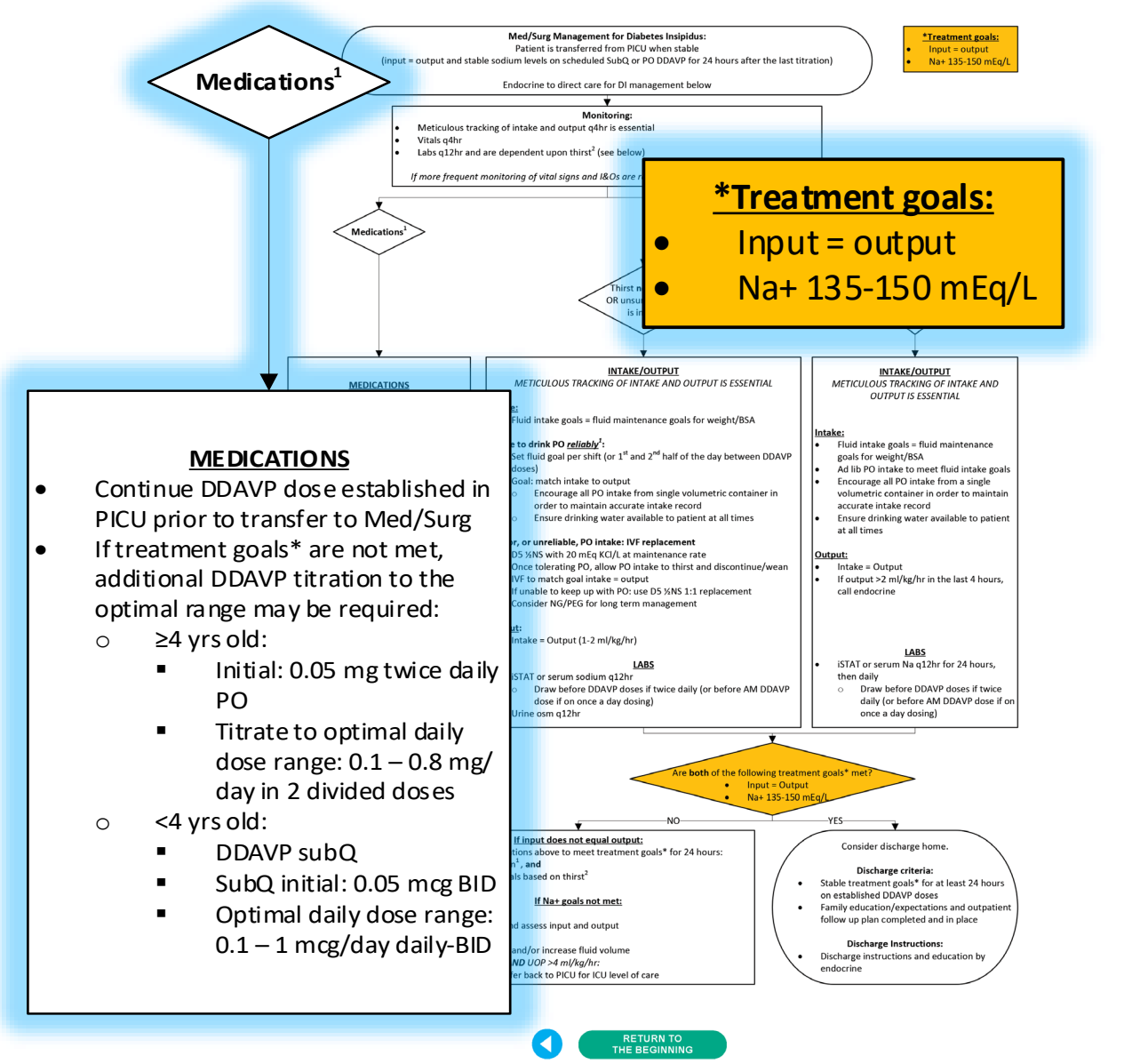
Output:
- Closely monitor output and call endocrine if output exceeds 2 ml/kg/hr in the last 4 hours

Labs:
- Only sodium will be monitored



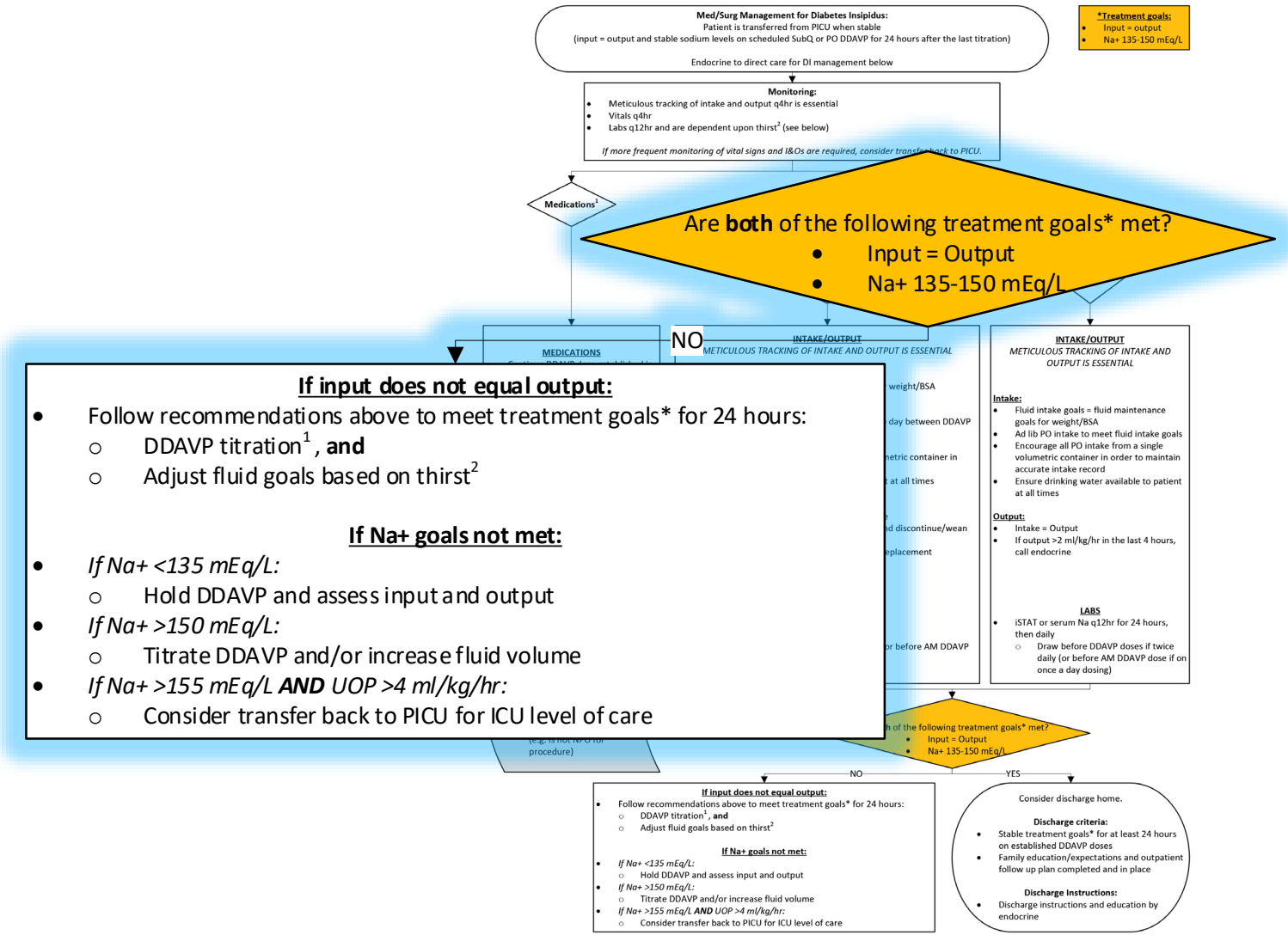
Med/Surg Management of DI

- All patients will continue their scheduled DDAVP dose that was established in the PICU.
- Treatment goals are outlined in the yellow box. DDAVP may need to be further titrated to reach these optimal ranges.



Med/Surg Management of DI

- Remember that treatment goals are input=output and sodium levels within 135-150 mEq/L
- If input does not equal output, consider DDAVP titration and adjusting fluid goals.
- If sodium goals are not met, guidelines for DDAVP and/or input adjustments are listed.
- If there is concerning Na of >155 mEq/L and UOP >4 ml/kg/hr, consider transfer back to the PICU.



If input does not equal output:

- Follow recommendations above to meet treatment goals* for 24 hours:
  - DDAVP titration[1], **and**
  - Adjust fluid goals based on thirst[2]

If Na+ goals not met:

- *If Na+ <135 mEq/L:*
  - Hold DDAVP and assess input and output
- *If Na+ >150 mEq/L:*
  - Titrate DDAVP and/or increase fluid volume
- *If Na+ >155 mEq/L **AND** UOP >4 ml/kg/hr:*
  - Consider transfer back to PICU for ICU level of care

RETURN TO THE BEGINNING

CONTACTS: CEM DEMIRCI, MD | REBECCA RIBA-WOLMAN, MD | DAVID HERSH, MD | JONATHAN MARTIN, MD
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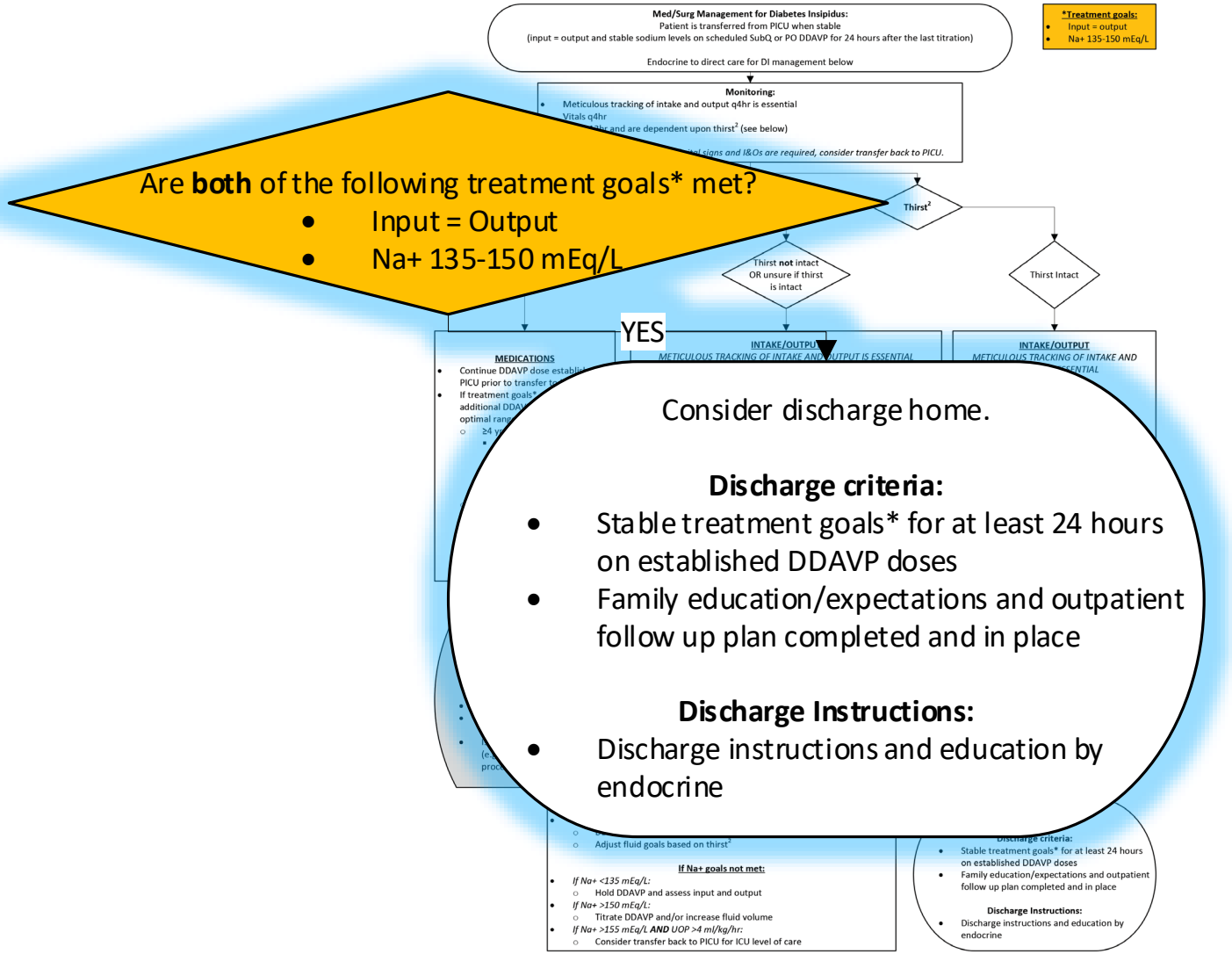
LAST UPDATED: 12.10.24

Med/Surg Management of DI

- If treatment goals are met for both input=output and Na 135-150 mEq/L while on established DDAVP for at least 24 hours, then patient can be considered for discharge.
- Discharge education and instructions will be provided by endocrinology.



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Review of Key Points

- Central DI can develop post-operatively after a neurosurgical procedure following sellar and parasellar regions
- DI diagnosis depends on serum sodium, serum osmolality, urine osmolality and urine output measures
- The main goal is for the patient to maintain intake = output, thus careful monitoring of I&Os are essential
- A second goal is to achieve desirable sodium levels. Frequency of monitoring depends on the clinical situation.

Use of Order Set

- An associated order set in Care Navigator is undergoing completion. We will make an announcement when it is available.

Quality Metrics

- Percentage of eligible patients with pathway order set usage (PICU, Med-Surg Unit)
- Average time (minutes) from arrival to PICU to administration of Vasopressin if DI suspected/confirmed
- Number of transfers from Med-Surg unit back to PICU (all cause)
- Number of patients with DI post-operatively
- Average length of stay (PICU, days)
- Average length of stay (hospital, days)

Pathway Contacts

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- David Hersh, MD
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- Jonathan Martin, MD
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Thank You!

About Connecticut Children's Pathways Program

Clinical pathways guide the management of patients to optimize consistent use of evidence-based practice. Clinical pathways have been shown to improve guideline adherence and quality outcomes, while decreasing length of stay and cost. Here at Connecticut Children's, our Clinical Pathways Program aims to deliver evidence-based, high value care to the greatest number of children in a diversity of patient settings. These pathways serve as a guide for providers and do not replace clinical judgment.