

INTRA-ABDOMINAL PRESSURE (IAP) MONITORING IN CICU - SCH PRACTICE GUIDELINE [®]

DOCUMENT SUMMARY/KEY POINTS

- Diagnosis of Abdominal Compartment Syndrome (ACS) is dependent upon accurate and frequent measurement of IAP using consistent technique and definitions which can impact management and affect outcomes.
- The level of IAP that results in organ system dysfunction varies from patient to patient and is affected by factors such as pre-existing organ function, co-morbidities, circulatory volume status and cardiac function.
- **The development of organ dysfunction and failure associated with the elevation in IAP is of greater importance to define ACS than the absolute IAP value** ^{1, 2}
- IAP measurements should be performed **MINIMUM OF 4 HOURLY** on patients who have developed or are suspected of developing abdominal distension, e.g. trauma, abdominal surgery, ascites, intestinal obstruction ³
 - *Frequency of measurement may be adjusted by surgeon as patients' condition alters*
- **DEFINITIONS:**
 - **Normal IAP values:** approximately 4 -10 mmHg mmHg in critically ill ventilated children ³
 - **Intra-abdominal Hypertension (IAH):** sustained or repeated pathologic elevation in IAP \geq 10mmHg ³
 - **ACS:** sustained IAP $>$ 10mmHg associated with new organ dysfunction or failure in children ³
- Pain, agitation, ventilator dyssynchrony and use of accessory muscles during work of breathing may all lead to increased thoraco-abdominal muscle tone which can lead to increases in IAP. Patient sedation and analgesia can reduce muscle tone and potentially decrease IAP to less detrimental levels ^{1,4}
- Notify surgeon and CICU Consultant/Fellow if the IAP has been confirmed to be **$>$ 7 in patients $<$ 1 month age *ie neonates* or $>$ 10 in patients $>$ 1 month age** the context of poor urine output, increasing ventilation requirements and a tight abdomen clinically

This document reflects what is currently regarded as safe practice. However, as in any clinical situation, there may be factors which cannot be covered by a single set of guidelines. This document does not replace the need for the application of clinical judgement to each individual presentation.

Approved by:	SCHN Policy, Procedure and Guideline Committee	
Date Effective:	1 st September 2019	Review Period: 3 years
Team Leader:	Clinical Nurse Consultant	Area/Dept: CICU

- Management of ACS in children is dependent upon and directed toward the etiology of the underlying problem.

CHANGE SUMMARY

- Due for mandatory review
- Frequency recommendation adjusted
- Inclusion of additional information regarding IAP monitoring in neonates
- References updated

READ ACKNOWLEDGEMENT

- CICU staff are required to read and acknowledge they understand the contents of this document.

TABLE OF CONTENTS

1	Background.....	3
	Definitions.....	4
2	Risk Factors for IAH & ACS in children ^{4, 6-9, 15}	4
3	Contraindications / Limitations	5
4	Measurement of IAP	5
5	Patient body positioning.....	6
6	Special Considerations.....	7
7	Documentation	7
8	Required Equipment	7
9	Initial Set-Up and Measurement.....	8
10	Ongoing Measurement Procedure.....	9
11	Discontinuing Monitoring.....	9
12	Complications.....	10
13	References	10

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1 Background

- Compliance of abdominal wall generally limits the rise in IAP as abdominal girth ↑
However, once a critical volume is reached, compliance of the abdominal wall ↓ abruptly
- IAP is usually 0mmHg during spontaneous respiration and slightly positive in the patient on mechanical ventilation due to transmission of intrathoracic pressure across the diaphragm⁵
- Clinical presentation of IAH / ACS in children impairs the function of each organ system leading to cardiac compression; ↓ venous return; extrinsic compression of the pulmonary parenchyma and evolution of pulmonary dysfunction; renal dysfunction caused by ↑ in renal venous pressure leading to oliguria and anuria and cerebral ischemia caused by a combination of ↑ central venous pressure and ↑ intracranial pressure (ICP) in hypotensive patients
- Diagnosis of ACS is dependent upon accurate and frequent measurement of IAP using consistent technique and definitions which can impact management and affect outcomes
- The level of IAP that results in organ system dysfunction varies from patient to patient and is affected by factors such as pre-existing organ function, co-morbidities, circulatory volume status and cardiac function
- **The development of organ dysfunction and failure associated with the ↑ in IAP is of greater importance to define ACS than the absolute IAP value**^{1,2}
- Continuous bladder pressure monitoring is difficult to apply to children due to the lack of small 3-way urethral catheters subsequently, intermittent measurements are utilised⁶
- Pain, agitation, ventilator dyssynchrony and use of accessory muscles during work of breathing may all lead to ↑ thoraco-abdominal muscle tone which can lead to ↑ in IAP. Patient sedation and analgesia can ↓ muscle tone and potentially ↓ IAP to less detrimental levels^{1,4}
- Diminished abdominal wall compliance due to tight abdominal closures and third-space fluid can ↑ IAP to potentially detrimental levels^{4,8-10}
- Neuromuscular blockade has been suggested to be an effective method for ↓ IAP^{1,9}
- Management of suspected ACS in neonates can only be based on clinical and biochemical predictors for evolution of end-organ dysfunction¹¹
- Further research is needed to determine benchmark value ranges in neonates¹²

Definitions

IAP Values	Neonatal ^{13, 14}	Paediatric ³	Adult ³
Normal	5mmHg*	4-10mmHg	5-7mmHg
IAH	7mmHg*	>10mmHg (<i>sustained or repeated</i>)	>12mmHg
ACS	13mmHg*	>10mmHg (<i>associated with new organ dysfunction or failure</i>)	>20mmHg

*Based on extremely small sample size in term newborns - values absent in preterm newborns

2 Risk Factors for IAH & ACS in children ^{4, 6-9, 15}

- Diminished abdominal wall compliance:
 - Acute respiratory failure, mechanical ventilation with ↑ intra-thoracic pressure /
 - PEEP
 - Abdominal trauma or abdominal circumferential burns
 - Abdominal surgery with tight closure
 - Congenital abdominal wall defect *eg Gastrochisis, Omphalocele*
 - Diaphragmatic hernia
 - Obesity
- Increased abdominal contents:
 - Bowel obstruction/perforation/ NEC
 - Ascites
 - Intra-abdominal/Retroperitoneal bleed
 - Splenomegaly, hepatomegaly, intra-abdominal tumours
 - Post-kidney transplant from adult donor
- Increased intra-luminal contents:
 - Gastroparesis
 - Ileus, Intussusception
 - Hirschprung disease
- Capillary leak/ fluid resuscitation:
 - Cardiogenic shock / Cardiac arrest
 - Sepsis / Septic shock
 - Fluid resuscitation > 40mLs/kg in 24hrs
 - Hypothermia (*Core Temp < 33^o*)
 - Acidosis (*pH < 7.2*)

- Coagulopathy
- Massive blood transfusion

3 Contraindications / Limitations

- Although there are few true contraindications or limitations to bladder pressure measurement, the presence of bladder injury, surgical repair or bladder pathology may preclude IAP measurement.
- **A ruptured bladder is a contraindication.**
- Measurements may be inaccurate when the following are present:
 - Reduced bladder compliance and bladder spasm
 - Absence of bladder
 - Neurogenic bladder
 - Small or contracted bladder
 - Abdominal muscle contraction associated with crying or respiratory distress.
Abdominal breathing in infants makes acquisition of measurements at end-expiration challenging and may result in erroneously ↑ IAP readings

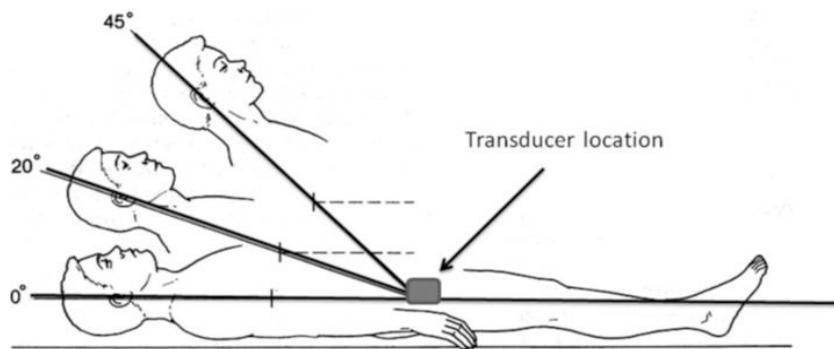
4 Measurement of IAP

- Various techniques for measuring IAP have been described in the literature but the intra-vesical technique performed via a Foley catheter is the gold standard for indirect measurement of IAP ^{2, 4, 7, 10}
- It involves the instillation of a pre-determined volume of normal saline in the bladder, allowing for equilibration of pressures and recording of the IAP using a pressure transducer.
- Because instillation of 0.9% sodium chloride into the bladder can cause a reflexive contraction of the detrusor muscles, an equilibration period of 60 seconds is recommended before measurements are performed to ensure accurate data ^{8, 16, 17}
- **Measurement is undertaken at the end of expiration, ensuring absence of abdominal contraction with transducer zeroed at the level of the mid-axillary line.**
- IAP measurements should be performed **MINIMUM OF 4 HOURLY** on patients who have developed or are suspected of developing abdominal distension e.g. trauma, abdominal surgery, ascites, intestinal obstruction ³
 - *Frequency of measurement may be adjusted by surgeon as patients' condition alters.*
- An ↑ IAP reading should be repeated to confirm there is no mechanical obstruction eg *blocked IDC*

5 Patient body positioning

- Potential contribution of body position in \uparrow IAP should be considered in patients with moderate to severe IAH or ACS.
 - Head of bed (HOB) elevation significantly \uparrow IAP compared to supine positioning, especially at higher levels of IAH ^{4, 16-18}
 - Such \uparrow in IAP become clinically significant (*increase ≥ 2 mmHg*) when the patient's HOB exceeds 20° elevation ^{18, 19}
 - Elevation of the HOB from 0° to 30° in critically ill children has been shown to \uparrow the measured IAP significantly ^{2, 20}
 - As a result **SUPINE** IAP measurements may underestimate the true IAP if the patient's HOB is being elevated between measurements.
- Subsequently, measurements should be performed in the supine position, with the transducer placed at the mid-axillary line at the level of the iliac crest (Figure 1) ⁷
 - *If clinical condition dictates HOB elevation, it should be recorded along with the IAP measurement for future comparison of values* ¹⁶⁻¹⁸

Figure 1



- **Patients < 1 month age ie NEONATES: 1mL/kg of total instillation volumes with minimum instillation volume of 3mL and maximum instillation volume not to exceed 20mL** ¹⁴
- **Patients > 1 month age: 1mL/kg of total instillation volume with a minimum instillation volume of 3mL and maximum instillation volume not to exceed 25mL** is sufficient, as higher volumes can falsely elevate IAP ^{2,3, 5, 7}
- Measurements **MINIMUM OF EVERY 4 HOURS** are to be undertaken in patients with evolving organ dysfunction until IAH has resolved ^{1, 17, 21}
- For those patients with normal IAP, further measurement should be performed if the patient shows evidence of clinical deterioration or develops other risk factors for IAH ^{9,16,17}

6 Special Considerations

- **ONLY 0.9% Sodium Chloride** should be used to fill the patient's bladder
- All transducer monitoring lines should be clearly labelled and transducer sets **treated as a closed system and changed every 72 hrs**
- All lines must be clearly labelled
- All connections should be securely luer locked
- All interventions must be carried out using an aseptic non-touch technique (ANTT)

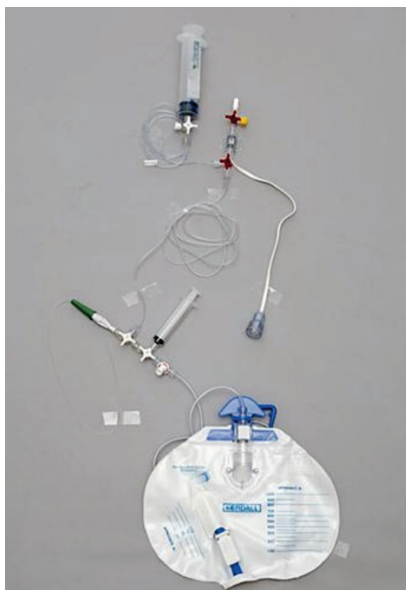
7 Documentation

- IAP measurements should be performed a **MINIMUM OF 4 HOURLY** unless otherwise prescribed and entered onto CICU flowchart along with patient position
- **Remember to subtract volume of saline instilled into bladder from patient's urine output for that hour**
- Output volumes **must not be recorded** as urine output but as additional drainage fluid loss to ensure accurate hourly urine output volumes

8 Required Equipment

** assumes IDC & drainage system in place already*

- Pressure transducer set
- Bladder kit – contains Bladder T piece
- 30mL syringe
- 500mL bag 0.9% Sodium Chloride **ALERT: NO HEPARIN**



9 Initial Set-Up and Measurement

- Ensure infection control principles are maintained and PPE is worn during the procedure.
- Organise equipment.
- Explain procedure to patient and/or family.
- Place the patient in a supine position (*if not medically contraindicated*)
- Connect bladder T-piece to a standard invasive pressure measurement circuit
- Connect pressure transducer to monitor, select ABD label with appropriate scale (*eg 0 - 15 mmHg*)
- Connect the system to 500mL 0.9% Sodium Chloride and prime pressure transducer circuit.
- Connect the bladder T-piece and place between urine drainage bag system and IDC
- Using **30mL syringe ONLY**, connect to 3-way tap in the pressure transducer circuit and draw up **1mL/kg** of sterile 0.9% sodium chloride **TOTAL INSTILLATION VOLUME**.
Minimum instillation volume of 3 mL - Maximum instillation volume of 20 mL in pts < 1 month age ie Neonates and 25 mL in pts > 1 month age ^{2,3, 5,7,14}
- To measure IAP, the urinary drainage tubing is clamped immediately distal to the spigot and below the Bladder T-piece, the stopcock is closed to the pressure transducer.
- Gently instil **1mL/kg** sterile 0.9% sodium chloride into the tubing, IDC and bladder, ensuring air does not remain in the tubing. ***Minimum instillation volume of 3 mL - Maximum of 20 mL in pts < 1 month age ie Neonates and 25 mL in pts > 1 month age should be instilled into the bladder*** ^{2,3, 5,7,14}
- Turn 3-way tap off to syringe and place transducer at iliac crest, mid-axillary line ^{7,8,16, 22} and zero the transducer
- Momentarily release clamp on the IDC tubing to allow air to be flushed from the system
- Reapply the clamp and wait 30-60 seconds before reading and recording measurement.
- **IAP IS MEASURED AT END-EXPIRATION AND EXPRESSED IN MM HG** ^{4, 7,15, 16,22}
- Unclamp IDC tubing allowing drainage of instilled 0.9% sodium chloride
- Record input and output in fluid balance section of CICU flowchart – **remember to subtract volume of saline from patient's urine output for that hour**

10 Ongoing Measurement Procedure

*** assumes Bladder T-piece is already connected in-line with the IDC, drainage bag and disposable pressure transducer primed and zeroed**

- Ensure infection control principles are maintained and PPE is worn during the procedure
- Organise equipment
- Explain procedure to patient and/or family
- Place the patient in a supine position (*if not medically contraindicated*)
- Withdraw **1mL/kg** sterile 0.9% sodium chloride into 30mL syringe **TOTAL INSTILLATION VOLUME. Minimum instillation volume of 3 mL - Maximum instillation volume of 20 mL in pts < 1 month age ie Neonates and 25 mL in pts > 1 month age** ^{2,3, 5,7,14}
- Clamp IDC drainage bag immediately distal to the spigot and below the Bladder T-piece, the stopcock is closed to the pressure transducer
- Gently instil **1mL/kg** sterile 0.9% sodium chloride into the tubing, IDC and bladder, ensuring air does not remain in the tubing. **Minimum instillation volume of 3 mL - Maximum of 25mL should be instilled into the bladder**
- Turn 3-way tap off to syringe and place transducer at iliac crest, mid-axillary line ^{7,8,16, 22}
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- Record input and output in fluid balance section of CICU flowchart – **remember to subtract volume of saline from patient's urine output for that hour**

11 Discontinuing Monitoring

- IAP monitoring is usually only required for a short period
 - *Discontinuation will be decided by the surgeon in collaboration with CICU*
- Transducer / monitoring can be disconnected prior to the removal of the patient's IDC
- Detach the transducer at the Y connector and re-attach the urinary catheter to the drainage bag using ANTT

12 Complications

- Serial measurement of IAP by the intra-vesical technique performed via a Foley catheter does not appear to lead to increased rates of catheter-associated urinary tract infections²³ Urine culture and sensitivity is the gold standard for diagnosis if an infection is suspected.
- Respiratory or haemodynamic compromise secondary to supine positioning

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