



# Intra-abdominal hypertension and abdominal compartment syndrome in pediatrics. A review



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## ABSTRACT

**Purpose:** To consolidate pediatric intensivists' understanding of the pathophysiology, definition, incidence, monitoring, and management of intra-abdominal hypertension (IAH) and abdominal compartment syndrome (ACS); and to highlight the characteristics related to the pediatric population.

**Methods:** This is a narrative review article that utilized a systematic search of the medical literature published in the English language between January 1990 and August 2016. Studies were identified by conducting a comprehensive search of Pub Med databases. Search terms included "intra-abdominal hypertension and child", "intra-abdominal hypertension and pediatrics", "abdominal compartment syndrome and child", and "abdominal compartment syndrome and pediatrics".

**Results:** Intra-abdominal hypertension and ACS are associated with a number of pathophysiological disturbances and increased morbidity and mortality. These conditions have been well described in critically ill adults. In children, the IAH and the ACS have a reported incidence of 13% and 0.6 to 10% respectively; they carry similar prognostic impact but are still under-diagnosed and under-recognized by pediatric health care providers.

**Conclusions:** Intra-abdominal hypertension and ACS are conditions that are regularly encountered in critically ill children. They are associated with an increased morbidity and mortality. Early recognition, prevention and timely management of this critical condition are necessary to improve its outcome.

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## Contents

1.	Introduction . . . . .	276
2.	Material and methods . . . . .	276
3.	Results and discussion . . . . .	276
3.1.	Definitions . . . . .	276
3.2.	Intra-abdominal pressure measurement . . . . .	276
3.3.	Pathogenesis of IAH . . . . .	277
3.4.	Pathophysiological implications of IAH . . . . .	278
3.4.1.	Gastrointestinal system. . . . .	278
3.4.2.	Respiratory system. . . . .	278
3.4.3.	Cardiovascular system . . . . .	278
3.4.4.	Central nervous system. . . . .	278
3.4.5.	Renal system . . . . .	278
3.5.	Incidence and risk factors for IAH and ACS . . . . .	278
3.6.	Prognosis of IAH and ACS . . . . .	279
3.7.	Management of intra-abdominal hypertension . . . . .	279
3.7.1.	Evacuation of intra-luminal content . . . . .	279
3.7.2.	Evacuation of extra-luminal content . . . . .	280
3.7.3.	Optimize fluid administration and correction of positive fluid balance: . . . . .	280

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3.7.4. Improve abdominal wall compliance . . . . .	280
Conflict of interest . . . . .	281
Funding . . . . .	281
References. . . . .	281

## 1. Introduction

There has been an increased interest in intra-abdominal hypertension (IAH) during the past decade, and the World Society of the Abdominal Compartment (WSACS, [www.wsacs.org](http://www.wsacs.org)) has published consensus definitions, guidelines statements and recommendations for the screening and management of IAH and abdominal compartment syndrome (ACS) in critically ill adult patients [1,2], with some specific considerations for children in the last revised guidelines [3]. Due to increased awareness and better defined intervention strategies, mortality due to ACS in adults has decreased from 80 to 37% [4–6]. However, the mortality rate due to ACS in children has remained stable at 40–60% [7–9]. This high mortality is in part attributable to poor recognition of ACS among pediatric health care providers as demonstrated by different surveys conducted [10–12].

In this article, we provide a narrative review of the latest reported data on definition, incidence, monitoring, and management of IAH and ACS in children to increase awareness among pediatric intensivists.

## 2. Material and methods

In this narrative review article we utilized a systematic search of Clinical trials and review papers, published in peer reviewed journals in the English language between January 1990 and August 2016. Given the lack of large multicenter studies in the literature, the authors did not restrict studies based on size or particular patient cohorts, only case reports were excluded.

Studies were identified by conducting a comprehensive search of Pub Med databases. Search terms included “intra-abdominal hypertension and child”, “intra-abdominal hypertension and pediatrics”, “abdominal compartment syndrome and child”, and “abdominal compartment syndrome and pediatrics”. In order to identify additional citations, we also used the Pub Med ‘related articles’ feature, and manually searched bibliographies of the relevant studies. These searches yielded a total of 164 articles. Thirty articles were case reports and were excluded from the study, and 88 were not selected because they were irrelevant or exclusively related to adults. Hence, 44 articles pertinent to IAH and ACS in children were included for review.

## 3. Results and discussion

### 3.1. Definitions

Normal IAP in spontaneously breathing persons is close to zero mmHg, and in mechanically ventilated children it is  $7 \pm 3$  mmHg regardless of the child's weight [13]. Children have lower mean arterial pressures than adults; therefore multiorgan failure may occur in children at lower IAP thresholds than those defined for adults. Evidence of organ dysfunction has been reported to occur at IAPs as low as 10–15 mmHg in critically ill children [8,14]. The pediatric sub-committee of the WSACS recently developed specific definitions and diagnostic criteria for IAH and ACS for infants and children (Table 1). They define IAH in children as a sustained or repeated pathological elevation in IAP > 10 mmHg. Abdominal compartment syndrome in children is defined as a sustained elevation in IAP > 10 mmHg associated with new or worsening organ dysfunction that can be attributed to elevated IAP. As in adults, primary IAH or ACS is defined as a condition associated with injury or disease within the abdomino-pelvic region; secondary

IAH or ACS refers to conditions that do not originate from the abdomino-pelvic region and, recurrent IAH or ACS refers to the condition in which IAH or ACS redevelops following previous surgical or medical treatment of primary or secondary IAH or ACS [3].

Abdominal perfusion pressure (APP) is the difference between the mean arterial pressure and the IAP, it may be thought of as the abdominal analogue to cerebral perfusion pressure. As APP may correlate with visceral perfusion, this measure has been previously proposed to be used as a resuscitation endpoint in patients with IAH [2,15]. Although APP may have some merits, to date it is still unclear if increasing APP improves outcomes. Furthermore, aiming for higher blood pressures carries the inherent risk of excessive fluid administration, which might ironically increase the incidence and severity of IAH and ACS. Therefore, there is currently insufficient evidence to recommend use of APP as a resuscitation endpoint in patients with IAH [3]. In children, the optimum APP level is not well identified.

### 3.2. Intra-abdominal pressure measurement

The gold standard for IAP measurement is through a peritoneal catheter, but this method is invasive and can be associated with severe complications such as peritonitis and bowel perforation [16]. The recommended method by the WSACS guidelines for indirectly measuring IAP is the bladder method [3]. Indeed, the intravesical pressure closely correlates with IAP [17], and this method was found to be the most accurate indirect method of measuring IAP in children [18]. Several setups and even IAP measuring kits exist, but the following is an example of a simple system [19]. The aspiration port of the Foley catheter is attached to a short 18-gauge catheter under sterile conditions, with 3 stopcocks

**Table 1**  
Proposed pediatric specific definitions by the WSACS.

Terminology	Proposed definition in children
IAP	The steady-state pressure concealed within the abdominal cavity (should be expressed in mmHg and measured at end-expiration in the supine position after ensuring that abdominal muscle contractions are absent and with the transducer zeroed at the level of the mid-axillary line)
IAP measurement	The reference standard for intermittent IAP measurement in children is via the bladder using 1 mL/kg as an instillation volume, with a minimal instillation volume of 3 mL and a maximum installation volume of 25 mL of sterile saline
Normal IAP	4–10 mmHg in critically ill children
APP	The difference between MAP and IAP
IAH	A sustained or repeated pathological elevation in IAP > 10 mmHg
IAH grade I	IAP 10–12 mmHg
IAH grade II	IAP 13–15 mmHg
IAH grade III	IAP 16–19 mmHg
IAH grade IV	IAP ≥ 20 mmHg
ACS	A sustained elevation in IAP > 10 mmHg associated with new or worsening organ dysfunction that can be attributed to elevated IAP
Primary IAH/ACS	A condition associated with injury or disease in the abdomino-pelvic region that frequently requires early surgical or interventional radiological intervention
Secondary IAH/ACS	Refers to conditions that do not originate from the abdomino-pelvic region
Recurrent IAH/ACS	Refers to the condition in which IAH or ACS redevelops following previous surgical or medical treatment of primary or secondary IAH or ACS

WSACS, world society of abdominal compartment syndrome; IAP, intra-abdominal pressure; APP, abdominal perfusion pressure; MAP, mean arterial pressure; IAH, intra-abdominal hypertension; ACS, abdominal compartment syndrome.

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