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# Current recognition and management of intra-abdominal hypertension and abdominal compartment syndrome among tertiary Chinese intensive care physicians*

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**Abstract:** This survey was designed to clarify the current understanding and clinical management of intra-abdominal hypertension (IAH)/abdominal compartment syndrome (ACS) among intensive care physicians in tertiary Chinese hospitals. A postal twenty-question questionnaire was sent to 141 physicians in different intensive care units (ICUs). A total of 108 (76.6%) questionnaires were returned. Among these, three quarters worked in combined medical-surgical ICUs and nearly 80% had primary training in internal or emergency medicine. Average ICU beds, annual admission, ICU length of stay, acute physiology and chronic health evaluation (APACHE) II score, and mortality were 18.2 beds, 764.5 cases, 8.3 d, 19.4, and 21.1%, respectively. Of the respondents, 30.6% never measured intra-abdominal pressure (IAP). Although the vast majority of the ICUs adopted the exclusively transvesicular method, the overwhelming majority (88.0%) only measured IAP when there was a clinical suspicion of IAH/ACS and only 29.3% measured either often or routinely. Moreover, 84.0% used the wrong priming saline volume while 88.0% zeroed at reference points which were not in consistence with the standard method for IAP monitoring recommended by the World Society of Abdominal Compartment Syndrome. ACS was suspected mainly when there was a distended abdomen (92%), worsening oliguria (80%), and increased ventilatory support requirement (68%). Common causes for IAH/ACS were "third-spacing from massive volume resuscitation in different settings" (88%), "intra-abdominal bleeding", and "liver failure with ascites" (52% for both). Though 60% respondents would recommend surgical decompression when the IAP exceeded 25 mmHg, accompanied by signs of organ dysfunction, nearly three quarters of respondents preferred diuresis and dialysis. A total of 68% of respondents would recommend paracentesis in the treatment for ACS. In conclusion, urgent systematic education is absolutely necessary for most intensive care physicians in China to help to establish clear diagnostic criteria and appropriate management for these common, but life-threatening, diseases.

**Key words:** Questionnaire, Intra-abdominal pressure, Intra-abdominal hypertension, Decompression laparotomy, Abdominal compartment syndrome

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## 1 Introduction

Intra-abdominal hypertension (IAH) is defined by a sustained or repeated pathologic elevation of intra-abdominal pressure (IAP) ≥12 mmHg, whereas abdominal compartment syndrome (ACS) is defined as a sustained IAP >20 mmHg (with or without an abdominal perfusion pressure <60 mmHg) associated with new organ dysfunction/failure (Malbrain *et al*., 2006b). IAH/ACS can result from multiple causes, such as abdominal or retroperitoneal bleeding, liver transplantation, massive fluid resuscitation for extra-abdominal trauma, and severe acute pancreatitis. A multicenter prevalence prospective study of IAH in 13 intensive care units (ICUs) from Belgium, Italy, Austria, Israel, Brazil, and Australia, found the prevalence of IAH to be 32.1% and the prevalence of

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ACS to be 4.2% on admission (Malbrain *et al*., 2005). The presence of IAH on admission to ICU has been associated with severe organ dysfunction during the ICU stay, and the development of IAH during an ICU stay is an independent predictor of mortality (Malbrain *et al*., 2005). Due to the possible impairment of every system and the high prevalence and incidence of IAH, some have suggested that IAP be measured in all patients after intensive care admission, with ongoing monitoring for those at high risk (Malbrain, 2004b).

Despite the ever-increasing interest and volume of publications concerning this syndrome, recent surveys have revealed a wide range in the thresholds for definition, functional indications, and management of ACS (Malbrain *et al*., 2006a; Kimball *et al*., 2007). It remains all too frequently underrecognized and underappreciated, and routine IAP monitoring has not been established in all ICUs (Malbrain *et al*., 2009). To our knowledge, few studies of IAH or ACS are being undertaken in China, and only several related articles either in Chinese or English were found on PubMed up to the end of 2009. What is worse, many physicians, including intensivists and surgeons, scarcely know or even completely lack knowledge for management of IAH/ACS, which may delay timely intervention and contribute to excessive patient resuscitation. Therefore, the primary goal of this survey was to provide a representative picture of the current awareness and management of IAH and ACS among intensive care physicians in China, as well as to explore the overall characteristics of ICUs in tertiary hospitals in China.

## 2 Materials and methods

From the participant list of the 3rd Chinese National Critical Care Conference held in July 2008, Hangzhou, China, 141 physicians from different tertiary hospitals, who would be expected to treat patients susceptible to ACS, were randomly selected. Physicians from pediatric ICUs or traditional Chinese medicine hospitals were excluded. A postal twenty-question questionnaire (see Appendix) and a prepaid addressed envelope were sent to them with the address on the participant list in early 2010. The survey assessed overall characteristics of ICU, general knowledge, causes, current methods for diagnosis, and its subsequent treatment for ACS. A reminder was sent to non-respondents within a few weeks. The total survey period was from February 2010 to April 2010. Statistical analysis was performed using SPSS Version 11.0 for Windows. Data were tested for normality using the Kolmogorov-Smirnov test and presented as mean±standard deviation (SD).

## 3 Results

Completed questionnaires were received from 108 of the 141 physicians surveyed (76.6% response rate). To our surprise, nearly one third (30.6%, $n$=33) of ICUs never measured IAP in their intensive care practice. Among which, 36.4% and 27.3% argued "Do not know how to interpret the results obtained" or "Never admit any patients with intra-abdominal hypertension" respectively as their reason not to measure the IAP.

### 3.1 Respondent demographics

Of the respondents, 75.0% ($n$=81) worked in combined medical-surgical ICUs, followed by 11.1% ($n$=12) in a medical ICU, 8.3% ($n$=9) in a surgical ICU, 2.8% ($n$=3) for neurological ICU, and 2.8% ($n$=3) for "other". When it came to their primary training, 19.4% ($n$=21) had primary training in surgery, 36.1% ($n$=39) in medicine, 38.9% ($n$=42) in emergency medicine, and 5.6% ($n$=6) in anesthesia. In terms of length of working as an intensive care physician, respondents had worked in ICUs for a median 8.0 years (range 2–23 years).

### 3.2 Overall characteristics of responded ICUs

In terms of departments referring to ICU admission, 61.1% ($n$=66) cited emergency department, followed by the respiratory department at 47.2% ($n$=51). General surgery department took the third position at 38.9% ($n$=42) and ranked fourth was the neurosurgery department, nearly 36.1% ($n$=39). Manpower, acute physiology and chronic health evaluation (APACHE) II scores, ICU length of stay, and mortality rates in the surveyed ICUs are shown in Table 1. Of the deceased patients, 42.2% were discharged for financial reasons and were expected to die within 24 h.

**Table 1 Descriptive characteristics of the surveyed ICUs and hospitals in 2009**

| Variable | Value |
|---|---|
| Hospital beds | 1432.4±655.6 |
| ICU beds | 18.2±8.6 |
| Number of doctors | 10.6±5.3 |
| Number of nurses | 36.3±19.0 |
| Number of admissions | 764.5±534.8 |
| APACHE II score | 19.4±3.8 |
| ICU length of stay (d) | 8.3±4.9 |
| ICU mortality (%) | 21.1 (95% CI: 15.6%–26.6%) |

ICU: intensive care unit; APACHE: acute physiology and chronic health evaluation; 95% CI: 95% confidence interval

### 3.3 Recognition and diagnosis of IAH/ACS

Of those ICUs that measured IAP, the overwhelming majority (88.0%, *n*=66) only measured IAP when there was a clinical suspicion of IAH and ACS. A small number of ICUs (8.0%, *n*=6) measured IAP on admitted patients after emergency laparotomy, whereas only 4.0% (*n*=3) measured IAP routinely in those who underwent massive fluid resuscitation. For those monitored IAP, the transvesicular route (100%, *n*=75) with supine position (97.3%, *n*=73) was used almost exclusively, while a fractional 6.7% mentioned inferior vena cava route.

However, there was no general consensus on the volume of saline that should be instilled, or regarding the zero reference points for the measurement. Only one sixth (16.0%, *n*=12) instilled <25 ml, nearly half (46.7%, *n*=35) instilled >50 ml, but <100 ml, whilst 21.3% (*n*=16) used >25 ml, but ≤50 ml, and 16.0% (*n*=12) for ≥100 ml. Turning to zero reference points, the story is similar, only 12.0% (*n*=9) zeroed at the midaxillary line at the level of the iliac crest, whereas the vast majority (68.0%, *n*=51) adopted the symphysis pubis and 20.0% (*n*=15) used the phlebostatic axis. Among those who measured IAP, the vast majority (70.7%, *n*=53) measured IAP occasionally, only 29.3% (*n*=22) measured either often or routinely.

When asked to quantify the number of ACS cases during 2009, 44% (*n*=33) found 1–3 cases, 16% (*n*=12) found 4–7 cases, 8% (*n*=6) found 8–10 cases, and 32% (*n*=24) found more than 10 cases. Among those who measured IAP, besides the high agreement (92%) on distended abdomen, ACS was suspected when there was a worsening oliguria (80%), increased ventilatory support requirement (68%), hypotension (60%), increased inotropic agents (48%), and worsening acidosis (44%).

### 3.4 Clinical causes of IAH/ACS

As for the reasons given for the occurrence of ACS, "third-spacing from massive volume resuscitation in different settings (post-operation, trauma, systemic inflammatory response syndrome, sepsis, pancreatitis)" was the commonest (88%) reason cited by the surveyed physicians. On the other hand, equally 52% respondents chose "intra-abdominal bleeding" and "liver failure with ascites" as the most common causes for IAH/ACS, whilst only 12% mentioned "burn" as the reason.

### 3.5 Treatment intervention

Though 60% (*n*=45) would recommend surgical decompression when the IAP exceeded 25 mmHg, accompanied by signs of organ dysfunction, there was significant variation across the respondents who measured IAP in the treatment of IAH and ACS. Nearly three quarters of respondents preferred diuresis and dialysis (72% for both), followed by paracentesis (68%) and decompression laparotomy (56%). However, 10.7% (*n*=8) stated that surgeons in their hospitals would never decompress patients with ACS. It was interesting that less than one third (28%, 28%, and 12%, respectively) mentioned "pressors/ inotropes", "fluid/ blood products", and "sedation and neuromuscular blockade agents" for the treatment of the syndrome.

## 4 Discussion

Owing to the exponentially increased interest and study in IAH and ACS over the past decade, the deleterious effect of IAH and ACS had been disclosed and recognized recently. IAH results in multiorgan dysfunction, including the cardiovascular, respiratory, renal, splanchnic, and central nervous systems, with respiratory and renal dysfunction being among the most prominent effects (Zhou *et al*., 2010). Patients with IAH have a significantly higher ICU-mortality (37.9% vs. 19.1%), 28-d (48.4% vs. 27.8%) and 90-d mortalities (53.7% vs. 35.8%), compared with the patients without the syndrome (Reintam *et al*., 2008). Moreover, hospital mortality was proportional to IAH

level: it was 6.7% when IAP was 12–15 mmHg, 25.5% at 16–20 mmHg, and the mortality rocketed to more than 75.0% if IAP reached higher than 20 mmHg (Parsak *et al*., 2008). Under this circumstance, in 2004, the World Society of Abdominal Compartment Syndrome (WSACS; http://www.wsacs.org) was founded by a group of international physicians and surgeons who recognized the need for a cohesive approach to promoting research, fostering education, early recognition, and improving the survival of patients with IAH and/or ACS (Malbrain *et al*., 2009). The WSACS advocates monitoring IAP in patients with risk factors for IAH/ACS. However, despite the ever-increasing interest and volume of publications concerning IAH/ACS, it remains all too frequently underrecognized and undertreated. Surveys from USA (Kimball *et al*., 2006) and UK (Tiwari *et al*., 2006) very recently demonstrated medical training and physicians' knowledge for IAH/ACS varied enormously, and a significant percentage of intensivists may be unaware of current approaches to management of IAH/ACS. In order to standardize the definition, clinical practice, and future research, WSACS published consensus definitions and management guidelines in 2006 and 2007 (Malbrain *et al*., 2006b; Cheatham *et al*., 2007). Nevertheless, in our 46-bed tertiary ICU, many intensivists remained unaware of the current definition of IAH/ACS, let alone the strategy to treat this syndrome. Therefore, we initiated this survey at the end of 2009. Unfortunately, our worry that this phenomenon is not a single center problem, but a national one in China, is finally confirmed by the present survey. In our survey, 30.6% of the respondents never monitored IAP with the majority unsurprisingly excusing that they "Do not know how to measure IAP" or "Do not know how to interpret the results obtained".

Early identification and appropriate staging of patients at risk are fundamental for the effective management of patients with IAH/ACS. Although direct intraperitoneal pressure measurement is the gold standard for IAP measurement, a variety of intermittent methods have been suggested, among which the transvesicular technique has achieved the most widespread adoption worldwide, due to its simplicity and minimal cost (Malbrain, 2004a). Several key principles had undergone intensive clinical validation, though the technique seems promising. With respect to the effect of instillation volume on intra-bladder pressure as an estimation of IAP, large volumes of saline, as much as 100 to 250 ml, may lead to the overestimation of IAP (Malbrain and Deeren, 2006; Vallee *et al*., 2010), while a minimal volume as low as 2 to 10 ml is sufficient for the IAP signal transduction (de Waele *et al*., 2006b; de Laet *et al*., 2008b). In terms of zero reference points for IAP measurement, various levels have been suggested such as the symphysis pubis, the phlebostatic axis, and the midaxillary line, each of which may result in different IAP measurements within the same patient. Therefore, WSACS now recommends limiting the amount of priming saline to no more than 25 ml and that the reference should zero at the level of the midaxillary line for the intermittent IAP measurement via the bladder (Malbrain *et al*., 2006b). As shown in this survey, though the vast majority of the ICUs adopted the exclusively transvesicular method to measure IAP, unfortunately, 84% used the wrong volume of priming saline, while 88% zeroed at incorrect reference points, despite the standard IAP monitoring method recommended by the WSACS in 2006.

Not surprisingly, when it comes to the causes for IAH/ACS, our survey showed results similar to those published previously (Malbrain *et al*., 2006b; Tiwari *et al*., 2006), i.e., trauma, pancreatitis with massive fluid resuscitation, and liver cirrhosis with ascites. In massive bleeding, traditional aggressive crystalloid resuscitation is the most common risk factor associated with ACS, with a net positive fluid balance of 5 L over 24 h, resulting in 85% of the patients developing IAH in a recent study (Daugherty *et al*., 2007). Shock plus massive crystalloid infusion is associated with systemic capillary leak and edema, resulting in decreased abdominal wall compliance and increased intra-abdominal and intra-luminal fluid contents, and even a vicious self-propagating cycle (Rizoli *et al*., 2010). The diagnosis of ACS needs a high index of suspicion. Fortunately, for most respondents in our survey, early signs of organ dysfunction, like worsening oliguria, increased ventilatory support requirement, distended abdomen, hypotension, and worsening acidosis, alerted physicians to measure IAP immediately and subsequently, which was prompted for the timely recognition and diagnosis of ACS.

Although WSACS has described a graded approach to the management of IAH/ACS, which can be used to avoid the need for surgical decompression in many patients, surgical abdominal decompression has long been the standard treatment for the patient who develops ACS (de Waele *et al*., 2006a; Cheatham *et al*., 2007; de Laet *et al*., 2008a). However, many things should also be taken into consideration with decompressive laparotomy, because the decompression could bring about massive intra-abdominal bleeding, persisting open abdomen, and subsequent extensive abdominal wall reconstruction. In our survey, similar to others (Ravishankar and Hunter, 2005; Tiwari *et al*., 2006), many respondents emphasized that they had very low surgical decompression rates even after the established diagnosis of ACS, because surgeons were reluctant to operate on those already very ill patients. The management of "open abdomen" and other complications including sepsis was challenging, because of a lack of awareness of the evolving management on the ACS for surgeons.

Given the fact that hospitals we recruited for the survey are teaching and tertiary centers, doctors were generally expected to have a better education background and better access to advanced medical information. This would likely result in an overrepresentation of physicians' experience of IAH/ACS management. Therefore, the actual situation in China would be even worse than that shown in our survey. Urgent systematic education is necessary for most intensive care physicians in China in order to help establish clear diagnostic criteria and appropriate management for these common, but life-threatening, diseases.

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## Appendix

Survey of current recognition and management of intra-abdominal hypertension (IAH) and abdominal compartment syndrome (ACS) among tertiary Chinese intensive care physicians is shown as follows:

1. As an intensivist, what type of intensive care unit do you work in?
   □ Medical
   □ Surgical
   □ Combination medical/surgical
   □ Neurologic
   □ Other
2. What is your primary training in?
   □ Surgery
   □ Medicine
   □ Emergency medicine
   □ Anesthesia
   □ Other
3. How many years you have worked for intensive care? _____years.
4. How many beds in your ICU and your hospital in 2009? _____ and_____.
5. How many doctors and nurses in your ICU in 2009? _____ and_____.
6. What is your total ICU admission and average APACHE II score in 2009? _____ and_____.
7. What are your top 5 departments your ICU admissions came from in 2009?
   (1)____, (2)_____, (3)_____, (4)____, (5)____.
8. What is your mortality in 2009? _____.
9. What is the percentage of patients discharged for financial reasons but expected died within 24 hours in 2009? _____.
10. Do you ever measure IAP on your ICU patients?
    □ Yes
    □ No
    **(If yes, please go to question 12)**
11. You do not measure IAP because:
    □ Do not know how to
    □ Feel that it is a waste of time
    □ Do not know how to interpret the results obtained?
    □ Never admit any patients with intra-abdominal hypertension ...**Thank you**...
12. Approximately how many cases of abdominal compartment syndrome have you seen in the last year?
    □ None
    □ 1–3
    □ 4–7
    □ 8–10
    □ >10
13. In which patients do you measure IAP?
    □ All post-operative ICU patients following emergency laparotomy

□ Patients exposed to massive fluid resuscitation
□ Only those patients thought likely to develop abdominal compartment syndrome
□ Other reasons (please specify)

14. What method do you most commonly use to measure IAP?
□ Transvesicular route
□ Gastric route
□ Femoral route
□ Inspection and palpation
□ Other

15. IAP measurements settings?
(1) Zero reference points:
□ The symphysis pubis
□ The phlebostatic axis
□ The midaxillary line at the level of the iliac crest
□ Other (please specify)
(2) Volume of instillation saline:
□ ≤25 ml
□ >25 ml but ≤50 ml
□ >50 ml
□ ≥100 ml
(3) Body positioning:
□ Supine
□ HOB 30º
□ HOB 45º
□ Other positioning

16. How often do you measure IAP?
□ Never (unaware of this procedure)
□ Never (I don't believe it has clinical correlation)
□ Seldom
□ Often
□ Routinely

17. What are the signs that make you suspicious of ACS? (multiple choices)
□ Worsening oliguria
□ Increasing ventilator pressures and/or oxygen requirements
□ Distended abdomen
□ Decreasing cardiac output and/or hypotension
□ Increasing pressor and/or inotrope requirements
□ Worsening acidosis
□ Others

18. What are the common causes of abdominal compartment syndrome in your unit? (multiple choices)
□ Third-spacing from massive volume resuscitation in different settings (post-operation, trauma, systemic inflammatory response syndrome, sepsis, pancreatitis)
□ Intra-abdominal bleeding secondary to coagulopathy
□ Liver failure with ascites
□ Burn
□ Other

19. What are your most common interventions to treat abdominal compartment syndrome in your ICU? (multiple choices)
□ Pressors/inotropes
□ Fluid/blood products
□ Diuresis
□ Dialysis
□ Paracentesis
□ Decompression laparotomy
□ Sedation and neuromuscular blockade agents
□ Others

20. When would you recommend surgical decompression?
□ IAP persistently >25 mmHg regardless of whether sign of organ dysfunction or not
□ IAP persistently >25 mmHg plus signs of organ dysfunction
□ IAP persistently >20 mmHg regardless of whether sign of organ dysfunction or not
□ IAP persistently >20 mmHg plus signs of organ dysfunction