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ORIGINAL

Prevalence of intra-abdominal hypertension in critically ill patients: a multicentre epidemiological study

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Abstract *Objective:* Although intra-abdominal hypertension (IAH) can cause dysfunction of several organs and raise mortality, little information is available on the incidence and risk factors for IAH in critically ill patients. This study assessed the prevalence of IAH and its risk factors in a mixed population of intensive care patients. *Design:* A multicentre, prospective 1-day point-prevalence epidemiological study conducted in 13 ICUs of six countries. *Interventions:* None. *Patients:* Ninety-seven patients admitted for more than 24 h to one of the ICUs during the 1-day study period. *Methods:* Intra-abdominal pressure (IAP) was measured four times (every 6 h) by the bladder pressure method. Data included the demographics, medical or surgical type of admission, SOFA score, etiological factors such as abdominal surgery, haemoperitoneum, abdominal infection, massive fluid resuscitation, and ileus and predisposing conditions such as hypothermia, acidosis, polytransfusion, coagulopathy, sepsis, liver dysfunction, pneumonia and

bacteraemia. *Results:* We enrolled 97 patients, mean age 64±15 years, 57 (59%) medical and 40 (41%) surgical admission, SOFA score of 6.5±4.0. Mean IAP was 9.8±4.7 mmHg. The prevalence of IAH (defined as IAP 12 mmHg or more) was 50.5 and 8.2% had abdominal compartment syndrome (defined as IAP 20 mmHg or more). The only risk factor significantly associated with IAH was the body mass index, while massive fluid resuscitation, renal and coagulation impairment were at limit of significance. *Conclusion:* Although we found a quite high prevalence of IAH, no risk factors were reliably associated with IAH; consequently, to get valid information about IAH, IAP needs to be measured.

Keywords Intra-abdominal pressure · Intra-abdominal hypertension · Abdominal compartment syndrome · Surgery · Trauma · Critically ill patients · Intensive care

Introduction

The abdomen can be considered as a closed box, partially rigid (spine, pelvis, costal arch) and partially flexible (abdomen wall, viscera and diaphragm) acting as a fluid compartment, so that the pressure within follows Pascal's hydrostatic laws [1, 2, 3]. Intra-abdominal pressure (IAP) may vary with the individual's anatomical characteristics, body size, muscles tone, etc., or because of abdominal disease (ascites, peritonitis, haemoperitoneum, trauma) [1]. The IAP can easily be measured directly or indirectly through the stomach or bladder. Over the years the bladder technique has been increasingly employed as the gold standard with an indwelling Foley catheter, using the bladder as a passive conduct [1, 2, 3, 4, 5].

The different methods lead more or less to the same IAP value [1, 6, 7]. A pathological increase in IAP has negative effects on the splanchnic, respiratory, cardiovascular renal and neurological function [1, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15]. The cut-off used to define IAH in surgical patients varies from 12 to 25 mmHg [1, 2, 3]. The extreme form of IAH is the abdominal compartment syndrome (ACS) which involves an acute increase in IAP above 20–25 mmHg with organ dysfunction [1, 2, 16].

The IAH and ACS are significantly associated with increased mortality in surgical patients [6, 8, 10, 17, 18]. In critically ill patients, IAH may range from moderate increase up to the ACS [1, 2]. Since IAH not only has harmful consequences on different organ systems, but is also associated with mortality, it is a substantial clinical problem.

Despite anecdotal reports, animal studies and retrospective or small prospective studies, to date no large prospective multicentre data on IAH are available [1].

The aims of this study were therefore to establish in a mixed population of intensive care patients (a) the prevalence of IAH and ACS, and (b) etiological and predisposing factors, if any, associated with intra-abdominal hypertension.

Materials and methods

Patients

This was a 1-day snapshot study on the prevalence of IAH in 13 intensive care units (ICU) from six countries (Belgium, Italy, Austria, Israel, Brazil and Australia), in all patients hospitalised for more than 24 h on 21 December 2000. The study was performed from 12:00 noon on the stated day until 12:00 noon the next day. The study was conducted in accordance with the study protocol, the Declaration of Helsinki, and applicable regulatory requirements.

The institutional review board (IRB) and the local institutional ethics committee (IEC) of each participating centre approved the protocol before data collection. In view of the nature of the study, informed consent from the patient or next of kin was not essential, and the decision was left to the local IRB/IEC.

For an ICU to be included in the study, it had to have six or more beds and the physicians had to have previous experience in measuring IAP. General and specialised ICUs for adults were included, but paediatric ones were excluded.

Data collection

Data were collected on a questionnaire by a clinician nominated as principal investigator for each centre. The record forms were collected centrally in Belgium and entered twice in a computer program specifically designated for this study to identify inconsistencies. The coordination centre was accessible throughout the study to answer queries and to give feedback. The following information was collected for each patient admitted to the ICU during the study.

Intra-abdominal pressure

The IAP was measured through a Foley bladder catheter, according to the modified Kron technique described by Cheatham and Safcsak [18]. In brief, a standard intravenous infusion set was connected to normal saline, two stop-cocks, a 60-ml Luer lock syringe and a disposable pressure transducer. The transducer was connected to an 18-G plastic intravenous infusion catheter inserted into the culture aspiration port of the Foley catheter. The infusion catheter was flushed with saline and then attached to the first stop-cock by arterial pressure tubing. The pressure transducer was zeroed at the level of the symphysis pubis. With the patient in the supine position and the Foley catheter clamped, 50 ml of saline were injected into the bladder and IAP was measured during end expiration. To check that the pressure signal was correctly transduced, gentle compressions of the abdomen should cause instant oscillation in the IAP tracing. If the signal was damped, the Foley catheter was opened to flush out air bubbles and the procedure was repeated.

The IAP was measured four times, at 6-h intervals during the study, at 12:00, 18:00, 24:00 and 6:00, in stable measurement conditions, and for each acquisition time point one IAP measurement was done.

Demographic data

Age, height, weight, body mass index (BMI), date and reason for ICU admission (surgical or medical) and the total prestudy stay in the ICU were recorded. The type of hospital (university or community) and ICU (general or specialised) as well the number of ICU beds were noted.

Organ dysfunction

Respiratory, cardiovascular, renal, coagulation, liver and neurological dysfunctions were evaluated by the Sepsis-related Organ Failure Assessment (SOFA) score, using the worst values of the day [20]. The SOFA score for each organ ranges from 0 (normal) to 4 (most abnormal). Organ failure was defined as a SOFA organ subscore equal to or above 3.

Etiological factors and predisposing conditions

Clinical etiological factors and predisposing conditions for increased IAP at the moment of the study were recorded for each patient.

We defined the following clinical etiological factors:

1. Abdominal surgery (with or without laparoscopy, reduction of hernia, tight closure or abdominal banding with postoperative Velcro belt to prevent incisional hernia).
2. Massive fluid resuscitation was arbitrarily defined as more than 3.5 l of colloids or crystalloids in the 24 h before the study.
3. Ileus, whether paralytic, mechanical or pseudo-obstructive, was defined as abdominal distension or absence of bowel sounds or failure of enteral feeding; evidenced by gastric dilatation or massive gastroparesis with a gastric residual of more than 1000 ml in the 24 h before the study.
4. Abdominal infection (pancreatitis, peritonitis, abscess, etc.).
5. Pneumoperitoneum.
6. Haemoperitoneum either caused by an intra- or retroperitoneal bleeding.

We established the following associated conditions:

1. Acidosis was defined as an arterial pH below 7.2.
2. Hypothermia was defined as a core temperature below 33°C.
3. Polytransfusion was defined as the transfusion of more than six units of packed red cells in the 24 h before the study.
4. Coagulopathy was defined as a platelet count below 55,000/mm^3 or an activated partial thromboplastin time (APTT) more than two times normal or a prothrombin time (PTT) below 50% or an international standardised ratio (INR) more than 1.5.
5. Sepsis was defined according to the American—European Consensus Conference definitions [21].
6. Liver dysfunction was defined as decompensated or compensated cirrhosis or other liver failure with ascites (paraneoplastic, cardiac failure, portal vein thrombosis, ischaemic hepatitis).
7. Mechanical ventilation was defined as use of invasive positive pressure ventilation with or without positive end-expiratory pressure (PEEP).
8. Bacteraemia was defined as the presence of bacteria in the bloodstream determined by blood cultures.
9. Pneumonia was defined when at least one of the major criteria were present (decision to treat, a new or progressive infiltrate or pleural infusion on chest X-ray, new onset of purulent sputum or change in character of sputum) and two of the minor criteria were present (rales, dullness, temp above 38.3°C, WBC above 10,000/mm^3, blood culture with same organism as in tracheal aspiration, semi-quantitative isolation with broncho-alveolar lavage or protected brush or distal protected aspirate, or quantitative isolation in endotracheal aspirate).

Definitions

The IAH was defined as a maximal IAP value of 12 mmHg or more in at least one measurement [1, 22], whereas the ACS was defined as an IAP of 20 mmHg or more in at least one measurement with failure of one or more organs [1, 18, 22, 23]. Organ failure was defined as a SOFA organ subscore equal to or above 3 (see "Organ dysfunction").

Statistical analysis

Results are expressed as mean±standard deviation (SD). The coefficient of variation (CV) for repeated measurements of IAP in single patients was calculated as the SD divided by the mean and expressed as a percentage. The global bias was calculated as the difference between the highest and lowest IAP value during the study day (ΔIAP). Comparison of variables between patients with and without IAH were analysed using univariate analysis with unpaired Student's *t* test for continuous variables and Fisher's exact test for non-continuous variables. To assess the independent predictors of IAH all the variables that differed significantly in patients with and without IAH in the univariate analysis were entered in a backward logistic regression model [24]. A p value less than 0.05 was considered statistically significant.

Results

In total, 97 patients were enrolled by the 13 participating ICUs. Eight (61.5%) of these ICUs were situated in a university hospital, 4 (30.8%) in university-affiliated hospitals and 1 (7.7%) in a community hospital. On average the hospitals being part of the study had 838±441 hospital beds, 10.9±2.8 ICU beds, 640±334 admission in 1999 and 7.5±2.7 patients per centre.

Prevalence of intra-abdominal hypertension and abdominal compartment syndrome

Table 1 summarizes the IAP at 6-h intervals, with the mean of the four measurements, the lowest and highest IAP, the difference between them and the coefficient of variation. The distribution of the maximal IAP is presented in Fig. 1. Forty patients (41.2%) had a normal IAP (<12 mmHg), 57 (58.8%) had IAH above 12 mmHg, 28 (28.9%) had IAH above 15 mmHg and 8 (8.2%) presented with ACS (IAP >20 mmHg). As shown in Table 2 the prevalence of IAH differs in relation to the cut-offs used and whether mean or maximal IAP values were used. From the 8 patients with

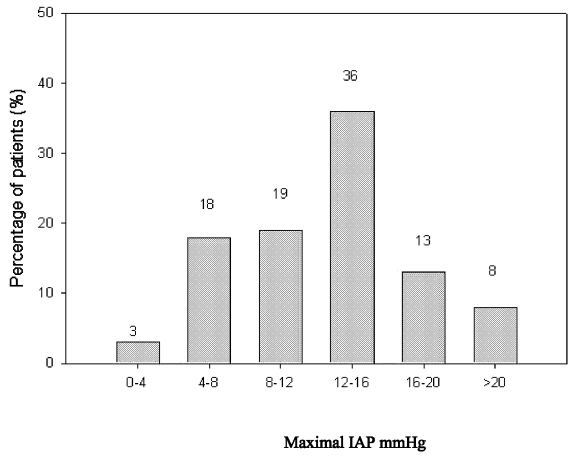

Fig. 1 Gaussian distribution of maximal intra-abdominal pressure (*IAP*) during the study day

Table 1 Intra-abdominal pressure values (in mmHg) on study day. *IAP* intra-abdominal pressure, *IAP 12 h* mean IAP value at 12 h, *IAP 18 h* mean IAP value at 18 h, *IAP 24 h*: mean IAP value at 24 h, *IAP 6 h* mean IAP value at 6 h, IAP_{mean} mean IAP values (four measurements, i.e. at 12, 18, 24 and 6 h), IAP_{min} minimal IAP value (of the four measurements), IAP_{max} maximal IAP value (of the four measurements), Δ*IAP* (global bias) IAP_{max}—IAP_{min}, *CV* coefficient of variation, defined as the standard deviation (SD) divided by IAPmean

	Total group (*n*=97)	IAP <12 mmHg (*n*=40)	IAP ≥12 mmHg (*n*=57)
IAP 12 h	9.5±5.2	5.5±2.4	12.3±4.7*
IAP 18 h	10±5.9	5.4±2.4	13.2±5.4*
IAP 24 h	9.8±4.8	6.1±2.7	12.3±4.3*
IAP 6 h	9.7±5.5	5.5±2.5	12.7±5*
IAP_{mean}	9.8±4.7	5.6±2	12.7±3.8*
IAP_{min}	7.2±4	3.9±1.9	9.6±3.4*
IAP_{max}	12.2±5.8	7.1±2.4	15.8±4.7*
ΔIAP	5±3.7	3.2±2.0	6.2±4.2*
CV	0.25±0.14	0.28±0.15	0.23±0.13

*$p<0.05$ compared with patients without intra-abdominal hypertension

Table 2 Prevalence of intra-abdominal hypertension in different patient groups and according to different cut-offs for IAP_{max} and IAP_{mean}. IAP_{mean} mean IAP values (four measurements, i.e. at 12, 18, 24 and 6 h), IAP_{max} maximal IAP value (of the four measurements)

Cut-off (in mmHg)	Total (*n*=97)	Medical (*n*=57)	Surgery (*n*=40)
IAP_{max} ≥12	57 (58.8%)	31 (54.4%)	26 (65%)
IAP_{max} ≥15	28 (28.9%)	17 (29.8%)	11 (27.5%)
IAP_{max} ≥20	8 (8.2%)	6 (10.5%)	2 (5%)
IAP_{mean} ≥12	23 (23.7%)	14 (24.6%)	9 (22.5%)
IAP_{mean} ≥15	9 (9.3%)	7 (12.3%)	2 (5%)
IAP_{mean} ≥20	4 (4.1%)	2 (3.5%)	2 (5%)

p not significant for all comparisons

Table 3 Patients' demographics and characteristics on study day. *IAP* intra-abdominal pressure, *BMI* body mass index, *SOFA* Sequential Organ Failure Assessment

	Total group (*n*=97)	IAP <12 mmHg (*n*=40; 41.2%)	IAP ≥12 mmHg (*n*=57; 58.8%)
IAP (mmHg)	9.7±4.7	5.6±2.1	12.7±3.8*
Age (years)	64.4±15.5	62.3±14.2	65.8±16.4
BMI (kg/m^2)	25.8±5.5	23.8±3.3	27.3±6.2*
Medical	57 (58.8%)	26 (65%)	31 (54.4%)
Surgery	40 (41.3%)	14 (35%)	26 (45.6%)
Total SOFA score	6.5±4	5.5±3.4	7.2±4.2*
Respiratory	2.1±1.1	1.8±1.2	2.3±1*
Cardiovascular	1.1±1.5	1±1.5	1.2±1.5
Renal	0.9±1.2	0.5±0.7	1.2±1.4*
Coagulation	0.5±0.8	0.3±0.6	0.7±1*
Liver	0.7±1.1	0.6±1.1	0.7±1
Neurological	1.3±1.5	1.4±1.6	1.2±1.5
Organ failure (n)	1.1±1.1	0.9±0.9	1.3±1.2
Prestudy ICU stay (days)	11.6±12.7	13.4±15.6	10.4±10.3

*$p<0.05$ vs patients without intra-abdominal hypertension

ACS, most had respiratory (*n*=4), cardiovascular (*n*=2) or neurological (*n*=2) organ failure. There was only 1 patient with either liver, haematological or renal dysfunction as defined by the SOFA subscores. In 6 patients with ACS there was only 1 organ failure, whereas 1 patient had two and the last had three organs failing.

Determinants of intra-abdominal hypertension

Table 3 summarizes the demographic data, SOFA score and length of prestudy ICU stay for patients with normal and abnormal IAP. Surprisingly, we did not find any difference in IAP in patients with a medical or a surgical admission; however, the patients with IAH (maximal IAP 12 mmHg or more) had a significantly greater BMI and overall severity as indicated by SOFA score. With regard to the organ failure used to compute the SOFA score, the respiratory, renal and coagulation systems were significantly more impaired in patients with IAH.

Clinical etiological factors and predisposing conditions

Although we considered several clinical etiological factors and predisposing conditions possibly correlated with IAH (Table 4), only two were significantly associated with it. Patients with IAH had a higher rate of fluid resuscitation and were more frequently transfused. The odds ratio for IAH was 3.3 (95%CI 1.2–9.2) for fluid resuscitation and 7.3 (95%CI 0.9–60.3) for polytransfusion. Most of these conditions, with the exception of acidosis, mechanical ventilation and sepsis were more frequent in IAH, although not significantly.

Table 4 Prevalence of clinical etiological factors and predisposing conditions for intra-abdominal hypertension. *PEEP* positive end-expiratory pressure

	Total group (n=97)	IAP <12 mmHg (n=40)	IAP ≥12 mmHg (n=57)
Etiological factors			
Abdominal surgery	23 (23.7%)	6 (15)	17 (29.8)
Pneumoperitoneum	0	0	0
Haemoperitoneum	4 (4.1%)	0	4 (7)
Abdominal infection	10 (10.3%)	2 (5)	8 (14)
Fluid resuscitation	27 (27.8%)	6 (15)	21 (36.8)*
Ileus	18 (18.6%)	6 (15)	12 (21.1)
More than 1	21 (21.7%)	5 (12.5)	16 (28.1)
Predisposing conditions			
Acidosis	9 (9.3%)	4 (10)	5 (8.8)
Hypothermia	0	0	0
Polytransfusion	10 (10.3%)	1 (2.5)	9 (15.8)*
Coagulopathy	16 (16.5%)	5 (12.5)	11 (19.3)
Sepsis	22 (22.7%)	10 (25)	12 (21.1)
Liver dysfunction	20 (20.6%)	8 (20)	12 (21.1)
Mechanical ventilation	64 (66%)	28 (70)	36 (63.2)
PEEP (cm H_2O)	7±2.9	7.2±3.5	6.9±2.6
Bacteraemia	17 (17.5%)	5 (12.5)	12 (21.1)
Pneumonia	29 (29.9%)	12 (30)	17 (29.8)
More than 1	20 (20.6%)	6 (15)	14 (24.6)

Mechanical ventilation: any form of mechanical ventilation whether invasive or non-invasive
Numbers in parentheses are percentages

Table 5 Univariate and multivariate analysis of intra-abdominal hypertension predictive factors. *BMI* body mass index, *SOFA* Sequential Organ Failure Assessment

Variable	IAP <12 mmHg	IAP >12 mmHg	Univariate p value	Multivariate p value
BMI (kg/m^2)	23.8±3.3	27.3±6.2	0.001	0.013
Total SOFA score	5.5±3.4	7.2±4.2	0.004	0.310
Respiratory	1.8±1.2	2.3±1.0	0.005	0.212
Renal	0.5±0.7	1.2±1.4	0.002	0.079
Coagulation	0.3±0.6	0.7±1.0	0.020	0.054
Fluid resuscitation	6 (15%)	21 (36.8%)	0.020	0.071
Polytransfusion	1 (2.5%)	9 (15.8%)	0.040	0.111

Multivariate analysis

The variables significantly associated with IAH on univariate analysis were entered in a backward multiple regression model. Only the BMI was significantly associated with IAH, whereas fluid resuscitation, the coagulation and renal SOFA subscores were at limit of statistical significance (Table 5).

Discussion

The main findings of this study were (a) the high prevalence of IAH in a mixed general adult ICU population, and (b) that only the BMI, besides a number of clinical etiological and predisposing factors analysed, was significantly associated with IAH.

Measurement of intra-abdominal pressure

Recent prospective studies that evaluated the physician's accuracy in establishing the presence of IAH by physical examination alone compared with indirect measurement through the bladder found that physicians had less than a 50% chance of correctly identifying IAH (sensitivity around 40%). Consequently, it is now recommended that if you want to make a diagnosis of IAH or ACS, you have to measure the IAP in the clinical practice [25, 26, 27].

The IAP that is generated by the relationship between abdominal wall and its content can be measured directly by an intraperitoneal catheter or indirectly by the gastric or the urinary bladder pressure [1, 6]. Kron et al. proposed to use the bladder pressure as the method of choice or gold standard, assuming that the bladder wall behaves as a passive diaphragm when the bladder volume is between 50 and 100 ml [28]. Subsequently, Iberti et al. demonstrated that the bladder pressure and IAP are nearly identical in humans [4]; however, the bladder pressure can be unreliable in case of low intrinsic bladder

compliance, bladder trauma or pelvic haematoma which may compress the bladder [1]. Despite these limitations, we chose to use the bladder pressure technique for the current study, since it is a relatively simple method and the one most commonly used at the bedside. Unlike the technique proposed by Kron et al. [28], which may increase the risk of urinary infections on account of the disconnection and reconnection of the urinary catheter, we measured the bladder pressure through the aspiration port of the urinary catheter [5, 19].

The method appeared reasonably reproducible in most participating centres. Comparing the measurements taken every 6 h in each patient, we found an average coefficient of variation of 0.25±0.13 (or thus 25%) which is comparable to daily fluctuations in other pressures like central venous pressure or pulmonary artery occlusion pressure; however, the literature offers no data on 24-h continuous IAP measurement in the ICU to confirm or not whether these variations or fluctuations in IAP during one study day were normal or related to the measurement technique used.

Prevalence of intra-abdominal hypertension

The values used to define IAH in the literature range from 12 to 25 mmHg [6, 7, 8, 9, 10, 18, 22, 29, 30, 31] and from 20 to 25 mmHg for ACS (Table 6) [16, 17, 18, 22, 31, 32, 33, 34]; furthermore, the latter is defined not only on the basis of the IAP, but also the presence of haemodynamic impairment and organ dysfunction. We found that the prevalence of IAH closely reflected the cut-off criteria used to define IAH, being higher with a lower cut-off and lower with higher cut-off and the number of measurements in each patient (see Table 2). We used a cut-off of 12 mmHg, considerably lower than in previous reports, that mainly studied surgical patients where in this study data were obtained from a mixed sample of mainly medical ICU patients. This choice was based more on physiopathology than on clinical derangements [1]. The gastrointestinal system is affected at levels of IAH as low as 10 mmHg, and for IAH between 10 and 15 mmHg there is reduction in chest wall compliance; however, only at IAP above 20 mmHg is there a marked reduction in cardiac output and oliguria [1, 2, 11, 12]. In addition, using a cut-off of 12 mmHg IAP was quite accurate in predicting morbidity and mortality in a sample of mainly medical ICU patients [22].

Indeed, using a physiology based cut-off it appears that more than 50% of a mixed population admitted to general specialised adult ICU present with various degree of IAH up to the ACS. The prevalence of IAH was lower using the mean IAP instead of the maximum; thus, the number of measurements per day can influence the prevalence of IAH.

In most articles published, the maximal IAP value is used instead of the mean or median. It would not make any sense to withhold surgery because the mean IAP value for that given day did not reach the cut-off value to initiate surgical decompression. On the contrary, surgery is most often based on the maximal IAP value or an IAP trend together with the presence of end-organ failure. In analogy, it would make no sense to withhold fluid therapy or diuretics because the mean value for an intracardiac filling pressure did not reach a therapeutic cut-off; therefore, the maximal IAP value on the study day was withheld in the definition of IAH.

As the IAP is a physiological parameter as any other "body pressure", it substantially fluctuates during the day. Since the inception of IAP monitoring, measurements obtained every 4–12 h have been assumed to accurately portray a patient's IAP state during the intervening time. It is now recognized, however, that these intermittent measurements are only "snapshots" that poorly illustrate the

Table 6 Previously reported IAH and ACS cut-offs. For the cut-offs, IAP was used (expressed in mmHg)

	Reference	Number	Type	Cut-off	Incidence (%)	Population
IAH	[9]	88	P	20	33	Abdominal surgical patients (laparotomy)
	[6]	73	P	20	38	Abdominal surgical patients
	[29]	49	P	18	81	Abdominal surgical patients
	[8]	70	R	18	32	Penetrating abdominal trauma
	[10]	263	P	18	40	Abdominal surgical patients
	[22]	405	P	12	18	Medical patients
	[30]	108	P	25	32	Orthotopic liver transplantation
	[31]	156	P	20	39	Severely injured patients
ACS	[33]	104	P	25	4	Surgical
	[34]	107	R	25	15	Staged abdominal repair
	[23]	145	P	20	14	Abdominal trauma patients
	[22]	405	P	20	2	Medical patients
	[17]	311	P	25	5	Trauma patients
	[19]	77	P	20	36	Surgical patients
	[31]	188	P	25	14	Torso trauma patients
	[31]	156	P	25	15	Severely injured patients

"moving picture" of the patient's response to injury and subsequent resuscitation. A fully automated technique would have a lot of advantages since many factors that may alter the accuracy and reproducibility of intermittent IAP measurements (such as volume instilled, zero reference level, air bubbles, over- or underdamping, etc.) do not play a role; however, in the absence of a general availability of such a technique and in order to limit the medical staff's workload we believe that at least two to four measurements of IAP should be scheduled during the day.

In the literature most of the time maximal IAP but sometimes also mean IAP values are used for diagnosis and prognostication, making it difficult to compare these data. As was done in this study, we suggest to use maximal IAP values for diagnosis of IAH and ACS and prognostic implication, in correlation with the worst value used for a variable within a 24-h period for computation of severity scores.

Etiological and predisposing factors for increase in the abdominal pressure

The negative effects of high IAP have been widely investigated [1]. Depending on its level and the overall haemodynamic condition IAH has been associated with bowel ischaemia [1, 6, 8, 12], bacterial translocation [1, 12], acute renal failure [1, 9, 10], respiratory failure [1, 13] and central nervous impairment [1, 14]; thus, early identification of those factors that might increase the risk of IAH development could be useful to improve the clinical management and outcome [35, 36].

In a previous study Ivatury et al. found that in surgical patients the increase in lactate levels, mesh closure and abdominal trauma were the best predictors for IAH [8]. Balogh et al. reported high crystalloid volume and low systemic blood pressure as independent factors for IAH in surgical and trauma patients [32]. The same group reported that an increase in the net fluid balance, plateau airway pressure and CO_2 gap were reported as independent risk factors for ACS [31].

In the present study, which was not limited to surgical patients, but investigated a mixed ICU population, the only variable significantly associated with IAH was the BMI, although the transfusion rate and the fluid resuscitation (probably associated with a positive net balance) were close to the limit of statistical significance; however, the bulk of our data suggest that neither a single factor nor a group of factors can predict with sufficient accuracy which patients are likely to develop IAH.

Conclusion

The IAH is a substantial clinical problem in intensive care patients. Its prevalence is high but differs depending on whether mean or maximal IAP values are used, and which cut-offs are selected. Our study suggests that there is no specific type of patient or disease or treatment that reliable indicates when IAP needs to be measured, or when the measurement is not necessary in a mixed ICU population. Indeed, it seems that, at least for the initial overall characterization of ICU patients, IAP should be routinely measured. The bladder method seems accurate for screening purposes. Since IAP is a physiological variable that substantially fluctuates during the day it should be measured as often as possible. Since this is often not feasible at the bedside with the current available techniques, at least two to four measurements a day should be done, the more being the better.

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