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ORIGINAL RESEARCH

Physicians' Knowledge of Abdominal Compartment Syndrome and Intra-Abdominal Hypertension in Saudi Arabia: An Online Cross-Sectional Survey Study

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Objective: To determine physicians' knowledge of abdominal compartment syndrome and intra-abdominal hypertension in Saudi Arabia.

Methods: A cross-sectional online survey study was conducted on physicians in Saudi Arabia between March and August 2022. A previously developed questionnaire was adapted and used in this study. The survey instrument investigated the knowledge and management of intra-abdominal hypertension and abdominal compartment syndrome among physicians. Logistic regression was used to identify predictors of being knowledgeable about abdominal compartment syndrome and intra-abdominal hypertension.

Results: A total of 266 physicians participated in this study. Around one-fifth (21.8%) the study participants were ICU physicians and 25.0% reported that they practice internal medicine. Intra-abdominal hypertension (IAH) and the impact of increased intra-abdominal pressure (IAP) on organ function were terms that the majority of research participants (70.3%) reported they were familiar with. A similar percentage (73.7%) reported that they are familiar with abdominal compartment syndrome (ACS). Around 43.0% of the study participants reported that they do not know how to measure IAP. The most frequently reported (13.5%) intervention in the treatment of IAH and ACS was the use of inotropes or vasopressors. The study participants showed a weak level of knowledge of ACS and IAH with a median score of 3.00 (IQR: 5.00–2.00), which represents 27.3% of the maximum attainable score. Physicians working at hospitals with 20–50 ICU beds were 41.0% (odds ratio: 0.59 (CI: 0.37–0.96)) less likely to be knowledgeable about intra-abdominal hypertension and abdominal compartment syndrome ($p \leq 0.05$).

Conclusion: Physicians demonstrated a low level of IAP and ACS knowledge. To increase the safety of medical practices and enhance clinical outcomes for patients, awareness should be raised about the proper diagnosis and management of IAP and ACS. Future research should focus on developing effective educational strategies to improve physicians' understanding of IAP and ACS.

Keywords: abdominal compartment syndrome, intra-abdominal hypertension, intra-abdominal pressure, knowledge, physicians, Saudi Arabia

Introduction

In a wide range of patient populations, abdominal compartment syndrome (ACS) and intra-abdominal hypertension (IAH) are increasingly acknowledged as risk factors for organ failure and mortality. The ACS is a serious but infrequent complication. IAH is more prevalent and can occasionally progress into ACS. Increased resource use and potential financial strain on healthcare resources are the results of these disorders.[1–8] In spite of this, intra-abdominal pressure

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(IAP) measurements are not consistently carried out, even when data or expert opinion indicate that they can affect patient care and related outcomes.[6,9]

Numerous improvements have been made recently in the management and recognition of ACS. The Abdominal Compartment Society and the "World Society of the Abdominal Compartment Syndrome" (WSACS) were founded in 2004 by a global group of clinicians with the aim of organizing and advancing research, teaching, and awareness of IAH and ACS. The most recent, scientifically supported guidelines made by the WSACS are the foundation for current ACS management.[6] A lack of medical knowledge concerning IAH and ACS was revealed by an international survey after the publication of the WSACS consensus definitions and recommendations in 2006.[9] There was a significant knowledge gap regarding IAH/ACS diagnosis and IAP monitoring in particular. The "2013 WSACS IAH/ACS Consensus Definitions and Clinical Management Guidelines on IAH/ACS" were subsequently published as an update to these recommendations.[6]

Numerous surveys have been conducted since the initial worldwide survey, the majority of them have focused on the experience or awareness of physicians in a particular region, country, or specialty.[10–13] It is still unclear how much clinical physicians are aware of the definitions and recommendations in the WSACS guidelines, which are now generally acknowledged. Furthermore, it is unknown whether physicians believe that IAH and ACS are important in the management of their patients, how and when they are utilized, and whether these definitions and recommendations are recognized as important. As a result, ACS management is still a subject of debate and varies between hospitals. Numerous studies have been conducted to determine the current level of awareness, knowledge, and usage of evidence-based medicine for IAH and ACS.[14] The fact that little was known about IAP measures and IAH and ACS therapy choices was one of these research's' most striking findings.[10,15,16] The use of different temporary abdominal closure devices and the reasons for open abdomen treatment are not universally agreed upon.[17,18] The majority of recent research has come to the conclusion that while health care practitioners are now more aware of the standards, they are still not applying them consistently or have insufficient understanding.[11,19] There are no previous studies in the Middle East region that explored the knowledge and practices of physicians related to IAH/ACS. As ACS is known as an independent predictor of death, failure to identify and promptly manage it can contribute to a poor prognosis. When treating the severely ill, high clinical suspicions should be combined with protocolized surveillance and care.[20] Therefore, the aim of this study was to determine physicians' knowledge of ACS and IAH in Saudi Arabia. Exploring physicians' knowledge of ACS and IAH is crucial since it can be used to anticipate safe and successful procedures implementation for the patients.

Methods

Study Design

This was an online cross-sectional survey study that was conducted on physicians in Saudi Arabia between March and August 2022.

Questionnaire Tool

A previously developed questionnaire by Wise et al was adapted and used in this study.[9] The survey instrument investigated the knowledge and management of ACS and IAH among physicians. The questionnaire tool comprised of three section of 52-items. Physicians' demographic and practice characteristics were covered in the first part (eight questions). The knowledge and practices of intra-abdominal hypertension by participants were examined in the second part (23 questions). Management of intra-abdominal hypertension by physicians was covered in the third part (21 questions).

The "Abdominal Compartment Society", the "European Society of Intensive Care Medicine", and the "Critical Care Society of South Africa" all accepted the original survey form. The original survey was developed by modifying one that had previously been developed and distributed to healthcare professionals in critical care in 2006.[21] Using the available research and assistance from an expert team (intensive care unit specialist, adult critical care specialist, and internal medicine specialist), the original survey questionnaire was modified to include contemporary questions relevant to the

subject. The questionnaire's clarity, ambiguity, length, and comprehensiveness were evaluated by a group of specialists made up of experienced intensivists and leaders in the WSACS and critical care societies. Ten intensive care specialists participated in a pilot test of the original instrument. They were questioned regarding the questions' clarity, comprehensibility, face validity, and whether any of them were challenging to understand. They were questioned about any questions that offended or disturbed them as well. They claimed the questionnaire was clear and easy to understand and complete.

Statistical Analysis

Statistical analysis was performed using the Statistical Package for Social Science (SPSS) software, version 27. The normality of the continuous variable in our study was checked using histogram and normality tests, which confirmed that it was non-normally distributed. Categorical data was presented as frequency (percentage). Continuous data was presented as a median interquartile range (IQR). The knowledge of the study participants was evaluated using 11 questions, with a weight of one given for each accurate response and a weight of zero for each incorrect response. The total possible score was 11, with a higher number indicating greater medical knowledge. The Mann–Whitney *U*-test and Kruskal–Wallis test were used to compare the median knowledge scores between physicians from different demographic and practice groups. Logistic regression was used to estimate odds ratios (ORs) with 95% confidence intervals (CIs) for being knowledgeable about ACS, IAH, and the WSACS consensus definitions. A logistic regression model was carried out using the median knowledge score of the study participants as the cut-off point (a score of 3.00). A two-sided $p < 0.05$ was considered as statistically significant.

Results

Demographic and Practice Characteristics of the Study Participants

A total of 266 physicians participated in this study. Around one-fifth (21.8%) the study participants were ICU physicians. Around 25.0% of the study participants reported that they practice internal medicine. Around 41.0% of them were consultants and had experience of less than 5 years. More than half of them (53.8%) reported that they manage ICU patients. Almost 50.0% of the study participants reported that they worked in both medical and surgical ICUs. A total of 7.9% of surgeons reported that they practiced general surgery. Around one-third (30.5%) of the study participants reported that they work at Ministry of Health hospitals. Most of the study participants (72.3%) reported that the number of ICU beds in their hospital is more than 20 beds. For further details on the practice characteristics of the study participants, refer to Table 1.

Table 1 Demographic and Practice Characteristics of the Study Participants

Variable	Frequency	Percentage
Occupation		
Intensive care unit physician	58	21.8%
Non-intensive care unit physician	208	78.2%
Primary area of practice (more than one answer could be chosen)		
Internal medicine	67	25.2%
Surgery / trauma	62	23.3%
Paediatrics	34	12.8%
Intensive care medicine	31	11.7%

(*Continued*)

Table 1 (Continued).

Variable	Frequency	Percentage
Family medicine	27	10.2%
Emergency medicine	25	9.4%
Anaesthesiology	18	6.8%
Cardiology	18	6.8%
Obstetrics and gynecology	16	6.0%
Level of experience?		
Consultant	110	41.4%
Resident	72	27.1%
Intern	34	12.8%
Registrar	21	7.9%
Senior Registrar	19	7.1%
Fellow	10	3.8%
Duration of experience (since first graduating as a doctor)?		
Less than 5 years	110	41.4%
5 to 10 years	53	19.9%
10 to 15 years	56	21.1%
More than 15 years	47	17.7%
Managing patients in an intensive care unit?		
No	123	46.2%
Yes	143	53.8%
Type of your intensive care unit (more than one answer could be chosen)? (n= 157)		
Medical + surgical	78	49.7%
Medical	47	29.9%
Trauma	46	29.3%
Surgical	33	21.0%
Neurosurgical	32	20.4%
Burns	27	17.2%
Cardiac	27	17.2%
Paediatric	22	14.0%
What kind of surgery do you perform most frequently (for surgeon) (More than one answer could be chosen)?		
General surgery	21	7.9%

(*Continued*)

Table 1 (Continued).

Variable	Frequency	Percentage
Urology	13	4.9%
Trauma surgery	12	4.5%
Obstetrics and gynaecology	11	4.1%
Orthopaedic surgery	9	3.4%
Cardiothoracic surgery	7	2.6%
Neurosurgery	6	2.3%
Hepatobiliary surgery	4	1.5%
Vascular surgery	3	1.1%
Colorectal surgery	1	0.4%
Not applicable	179	67.3%
Working settings		
Ministry of Health hospital	81	30.5%
University hospital	54	20.3%
Armed Forces Hospital	34	12.8%
National Guard Hospital	31	11.7%
Private sector hospitals	29	10.9%
King Fahad Medical City	17	6.4%
Security Forces Hospital	14	5.3%
King Faisal Specialist Hospital	6	2.3%
Number of ICU beds in your hospital		
Less than 10 beds	20	7.5%
10 to 20 beds	51	19.2%
20–50 beds	97	36.5%
More than 50 beds	98	36.8%

Abbreviation: ICU, intensive care unit.

Knowledge and Practices of Intra-Abdominal Hypertension

IAH and the impact of high IAP on organ function were concepts that the vast majority of study participants (70.3%) reported to be familiar with. Similar numbers (73.7%) said they were familiar with ACS. Abdominal perfusion pressure (APP) was a topic that was familiar to more than half of them (58.3%). The majority of them reported that they consider that ACS and IAH are important issues in surgical/trauma patients (93.2%) and in medical patients (86.1%). Around one-third (28.2%) of them reported that they have seen 1 to 5 ACS cases in the last year.

A total of 44.0% of the study participants reported that they believed that the typical IAP for healthy persons is between 0 and 5 mmHg. One-third (29.3%) of them reported that they consider an IAP of >12 mmHg as IAH in adults. Nearly 34.0% of them believe that patients with IAH may experience organ dysfunction at an IAP level of 20 mmHg. A similar proportion (39.8%) stated that they believe IAP at a level of 20 mmHg can cause ACS in adult patients with IAH and organ failure. Around 16.0% of them regard a 10 mmHg IAP level as signifying ACS in children. Only 4.5% of

them reported that APP = mean arterial pressure – central venous pressure. Around 29.0% of them reported that they believe that APP > 55 mmHg.

Around 43.0% of the physicians reported that they do not know how to measure IAP. A similar percentage reported that they measure IAP for patients at risk for IAH. Around 37.0% of them reported that they do not measure IAP in patients who need surgery. More than half of them (62.8%) reported that they do not routinely measure IAP. About 27.0% of them stated that they inserted the bladder before measuring IAP at 10–25 mL using the transvesical (bladder) approach. When using the trans-vesical (bladder) approach, approximately 34.0% of patients reported waiting up to 30 seconds before reading the IAP. Around 41.0% of them reported that they are familiar with the intravesicular (bladder) IAP technique. Around 12.4% reported that they measure IAP when clinically indicated. For further details on the participants' familiarity with and practices of intra-abdominal hypertension, refer to Table 2.

Table 2 Knowledge and Practices of Intra-Abdominal Hypertension

No.	Variable	Frequency	Percentage
1	"Familiar with the effect of elevated intra-abdominal pressure (IAP) on organ function or intra-abdominal hypertension (IAH)?" (Yes)	187	70.3%
2	"Familiar with abdominal compartment syndrome (ACS)?" (Yes)	196	73.7%
3	"Familiar with the concept of abdominal perfusion pressure?" (Yes)	155	58.3%
4	"Believe that ACS and IAH are important issues in surgical/trauma patients?" (Yes)	248	93.2%
5	"Believe that ACS and IAH are important problems in medical patients?" (Yes)	229	86.1%
6	Number of ACS cases seen in the last year?		
	I do not monitor for ACS	101	38.0%
	0	63	23.7%
	1–5	75	28.2%
	6–10	12	4.5%
	11–20	7	2.6%
	More than 20	8	3.0%
7	Perceived normal IAP in healthy adults:		
	0–5 mmHg	117	44.0%
	6–10 mmHg	102	38.3%
	11–15 mmHg	40	15.0%
	>16 mmHg	7	2.6%
8	Perceived IAP as IAH in adults:		
	>5 mmHg	40	15.0%
	>10 mmHg	47	17.7%
	>12 mmHg	78	29.3%
	>15 mmHg	50	18.8%
	>20 mmHg	34	12.8%
	>25 mmHg	17	6.4%

(*Continued*)

Table 2 (Continued).

No.	Variable	Frequency	Percentage
9	Perceived level of IAP at which organ dysfunction may occur in patients with IAH:		
	"Do not believe that a high IAP results in organ malfunction"	12	4.5%
	5 mmHg	11	4.1%
	10 mmHg	18	6.8%
	12 mmHg	26	9.8%
	15 mmHg	50	18.8%
	20 mmHg	90	33.8%
	25 mmHg	59	22.2%
10	Perceived IAP at which ACS occur in adult patients with IAH and organ dysfunction:		
	5 mmHg	9	3.4%
	10 mmHg	14	5.3%
	12 mmHg	14	5.3%
	15 mmHg	23	8.6%
	20 mmHg	106	39.8%
	25 mmHg	32	12.0%
11	Perceived IAP as signifying ACS:		
	5 mmHg	20	7.5%
	10 mmHg	42	15.8%
	12 mmHg	29	10.9%
	15 mmHg	72	27.1%
	20 mmHg	55	20.7%
	25 mmHg	17	6.4%
	More than 25 mmHg	31	11.7%
12	Perceived correct statements regarding abdominal perfusion pressure (APP) (More than one answer could be chosen):		
	"APP has no clinical use"	16	6.0%
	"APP = CPP (cerebral perfusion pressure)"	10	3.8%
	"APP = MAP – IAP (mean arterial pressure – intra abdominal pressure)"	140	52.6%
	"APP = MAP – CVP (mean arterial pressure – central venous pressure)"	12	4.5%
	Do not know	108	40.6%
13	Perceived best APP threshold in relation to outcome:		
	APP > 45 mmHg	64	24.1%
	APP > 55 mmHg	78	29.3%
	APP > 65 mmHg	51	19.2%
	APP > 75 mmHg	13	4.9%
	None of the above	60	22.6%

(*Continued*)

Table 2 (Continued).

No.	Variable	Frequency	Percentage
14	Measure IAP in patients? (Yes)	72	27.1%
15	Perceived reasons for not measuring IAP (More than one answer could be chosen) (n= 181)		
	"Do not know how to measure IAP"	77	42.5%
	"Do not treat any patients with IAH"	66	36.5%
	"Rely on clinical/physical examination and assessment"	46	25.4%
	"Do not know how to interpret IAP"	23	12.7%
	"There is insufficient evidence to suggest that treatment of IAH improves patient outcomes"	10	5.5%
	"Costs"	7	3.9%
	"It has no clinical relevance"	6	3.3%
16	In which medical patient population(s) do you measure IAP? (More than one answer could be chosen)		
	"Do not measure IAP in medical patients"	110	41.4%
	"Patient at risk for IAH"	115	43.2%
	"Massive fluid resuscitation"	68	25.6%
	"Acute pancreatitis"	66	24.8%
	"Organ failure"	66	24.8%
	"Sepsis"	48	18.0%
	"Obesity"	38	14.3%
	"Mechanical ventilation"	31	11.7%
	None of the above	18	6.8%
17	IAP is commonly measured for the following surgical patients: (More than one answer could be chosen)		
	"Do not measure IAP in surgical patients"	99	37.2%
	"Abdominal surgery"	109	41.0%
	"Trauma surgery"	96	36.1%
	"Abdominal vascular surgery"	76	28.6%
	"Massive fluid resuscitation during or prior to surgery"	60	22.6%
	"Obstetrics/Gynaecology surgery"	28	10.5%
	"Cardiothoracic surgery"	19	7.1%
	"Neurosurgery"	7	2.6%
	None of the above	26	9.8%
18	Methods used to measure IAP: (More than one answer could be chosen)		
	"Transvesical (bladder) measurement"	82	30.8%
	"Direct (peritoneal) measurement"	22	8.3%
	"Transgastric (stomach) measurement"	14	5.3%
	"Do not routinely measure IAP"	167	62.8%

(*Continued*)

Table 2 (Continued).

No.	Variable	Frequency	Percentage
19	Volume installed into the bladder before IAP measurement for the transvesical (bladder) technique: (n= 151)		
	0 Ml	7	4.6%
	10–25 mL	41	27.2%
	50 mL	8	5.3%
	100 mL	5	3.3%
	200 mL	28	18.5%
	Do not know	62	41.1%
20	Waiting time before reading the IAP after instillation of the fluid into the bladder: (n=143)		
	Do not wait	34	23.8%
	Up to 30 seconds	48	33.6%
	31–60 seconds	10	7.0%
	61–120 seconds	7	4.9%
	More than 120 seconds	44	30.8%
21	Aware of continuous IAP measurement techniques: (Yes)	23	16.2%
22	Familiarity with continuous IAP technique(s): (More than one answer could be chosen) (n= 84)		
	Intravesicular (bladder)	34	40.5%
	Direct peritoneal	17	20.2%
	Stomach	8	9.5%
	Solid state transducer	6	7.1%
	None of the above	31	36.9%
23	How often do you routinely measure IAP When initially setting out to monitor it?		
	Do not routinely measure IAP	145	54.5%
	Every 4 hours	24	9.0%
	Every 6 hours	18	6.8%
	Every 8 hours	10	3.8%
	Every 12 hours	11	4.1%
	Every 24 hours	10	3.8%
	"When clinically indicated"	33	12.4%
	"Continuously"	15	5.6%

Abbreviations: IAP, intra-abdominal pressure; IAH, intra-abdominal hypertension; ACS, abdominal compartment syndrome; APP, abdominal perfusion pressure.

Intra-Abdominal Hypertension Management

The use of inotropes or vasopressors was the intervention that was most frequently reported (13.5%) in the treatment of ACS and IAH. 47.0% of those who took part in the study stated that they would never request or conduct surgical decompression on a patient with ACS. Nearly 44.0% of those who conduct (or request) surgical decompression in ACS patients stated they base their choice on the severity of organ dysfunction. More over half of them (53.8%) stated that

worsening oliguria influences their decision to consult a surgeon to discuss doing a decompressive laparotomy on a patient with a known or suspected elevation in IAP or to execute a decompressive laparotomy on such a patient.

Around 11. 0% and 9.0% of them reported that they most commonly deal with open abdomen following the initial decompression and after subsequent abdominal explorations using Bogota bag or silo, respectively. Around 5.6% of them reported that they preferred the Gore-Tex temporary mesh closure. Around 13.0% of them reported that they consider polycompartment syndrome in their daily practice. Acute gastrointestinal injury (AGI) should be included as a SOFA sub score, according to about one-quarter (24.1%) of the study participants. 7.0% of those who took part in the survey said they regularly test IAP in patients with an open abdomen. 16.0% of them claimed to be familiar with the idea of the lateralization of the abdominal musculature.

Around 18.0% of respondents said they had heard of the Abdominal Compartment Society (WSACS) prior to completing the questionnaire. Similar numbers (15.4%) claimed to be aware of the WSACS consensus guidelines' publication in 2006 and 2007 as well as the 2013 revision to the WSACS definitions and criteria (15.0%). According to Table 3, 43.0% of them believe that the 2013 IAH/ACS guidelines should also be released in their local language.

Predictors of Knowledge of Abdominal Compartment Syndrome and Intra-Abdominal Hypertension

The study participants showed a weak level of knowledge of ACS and IAH with a median score of 3.00 (IQR: 5.00–2.00), which represents 27.3% of the maximum attainable score. The median knowledge score showed a significant difference between participants based on their duration of experience in their profession ($p \leq 0.05$), Table 4.

Table 3 Intra-Abdominal Hypertension Management

No.	Frequency of Using Interventions in Managing IAH and ACS.	Never	Rarely	Sometimes	Usually	Frequently	Not Applicable
1	Inotropes/vasopressors	19.5%	7.3%	21.8%	13.5%	9.0%	28.9%
2	Diuretics	13.5%	6.4%	27.4%	13.2%	13.9%	25.6%
3	Fluid/Blood products	15.8%	9.4%	30.1%	9.4%	10.2%	25.2%
4	Abdominal paracentesis	16.5%	9.4%	34.2%	9.0%	6.5%	24.4%
5	Decompressive laparotomy	20.3%	14.3%	25.9%	6.7%	6.9%	25.9%
	Variable			Frequency		Percentage	
6	"In a patient with ACS, perform (or request) surgical decompression":						
	Never			125		47.0%	
	Yes, but in selected patients			33		40.6%	
	Yes, always			108		12.4%	
7	"Decision to perform (or request) surgical decompression on a patient with ACS depends on": (More than one answer could be chosen) (n= 160)						
	IAP			32		20.0%	
	"Degree of organ dysfunction"			70		43.8%	
	"Cause of ACS"			40		25.0%	
	"Evolution of IAP"			33		20.6%	
	"Evolution of organ dysfunction"			53		33.1%	
	"Do not surgically decompress patients with ACS"			30		18.8%	

(*Continued*)

Table 3 (Continued).

8	"Factors affect decision to consult a surgeon to discuss decompressive laparotomy or perform a decompressive laparotomy on a patient with a known or suspected elevation in IAP": (More than one answer could be chosen) (n= 160)		
	Worsening oliguria	86	53.8%
	Increasing pressure or inotrope doses	74	46.3%
	Abdominal distension	71	44.4%
	Decreasing cardiac output	69	43.1%
	Increasing ventilator pressures	65	40.6%
	Worsening acidosis	61	38.1%
	Increasing oxygen requirement	40	25.0%
	None of the above	13	8.1%
9	"Dealing with the open abdomen after the initial decompression through":		
	Not applicable	156	58.6%
	"Bogota bag or silo"	30	11.3%
	"Barker's vacuum pack technique"	16	6.0%
	"Commercial negative pressure wound therapy"	15	5.6%
	"Temporary mesh closure (eg Dacron)"	10	3.8%
	"Skin-only closure"	9	3.4%
	"Immediate primary fascial closure"	7	2.6%
	None of the above	23	8.6%
10	"Dealing with the open abdomen after subsequent abdominal explorations through":		
	Not applicable	165	62.0%
	"Bogota bag or silo"	25	9.4%
	"Temporary mesh closure (eg Dacron)"	16	6.0%
	"Barker's vacuum pack technique"	15	5.6%
	"Commercial negative pressure wound therapy"	12	4.5%
	"Skin-only closure"	11	4.1%
	"Immediate primary fascial closure"	0	0.0%
	None of the above	22	8.3%
11	"Preferred type of temporary mesh closure":		
	Not applicable	210	78.9%
	"Gore-Tex"	15	5.6%
	"Prolene/Marlex mesh"	13	4.9%
	"Vicryl/Dexon mesh"	12	4.5%
	"Vypro mesh"	11	4.1%
	"Dermal template (Alloderm, Xenmatrix)"	5	1.9%

(*Continued*)

Table 3 (Continued).

12	"Do you consider polycompartment syndrome in daily practice"?		
	No	84	31.6%
	Yes	34	12.8%
	It does not exist	8	3.0%
	I have not yet heard of it	140	52.6%
13	"Acute gastrointestinal injury (AGI) should be included as a Sequential Organ Failure Assessment (SOFA) sub score"?		
	No	42	15.8%
	Yes	64	24.1%
	I have not heard of AGI	160	60.2%
14	"Do you measure IAP in open abdomen patients"?		
	I do not measure IAP	119	44.7%
	"When the abdomen is open there is no need since IAP cannot increase"	20	7.5%
	Yes	19	7.1%
	Sometimes	35	13.2%
	No	73	27.4%
15	"Aware of the concept of lateralization of the abdominal musculature"? (Yes)	43	16.2%
16	Classification of the open abdomen is …		
	"Important to facilitate comparison of patient groups"	81	30.5%
	"Important to highlight challenges these patients face and for comparative reasons"	84	31.6%
	"Only important for research"	29	10.9%
	Not important	72	27.1%
17	Which of the following sentence are true for you?		
	"Aware of this and use it in clinical practice"	56	21.1%
	"Aware of but do not understand the clinical relevance"	30	11.3%
	"Only aware of the concept"	53	19.9%
	"Not aware of the concept"	127	47.7%
18	Before taking this survey, were you aware of the "Abdominal Compartment Society (WSACS)?" (Yes)	48	18.0%
19	"Before taking this survey, were you aware of the publications of the WSACS consensus guidelines in 2006 and 2007?" (Yes)	41	15.4%
20	"Before taking this survey, were you aware that the WSACS definitions and guidelines were revised in 2013 and are available at www.wsacs.org?" (Yes)	40	15.0%
21	"Do you think the 2013 guidelines for IAH/ACS should be launched in your own native language"? (Yes)	115	43.2%

Abbreviations: IAP, intra-abdominal pressure; IAH, intra-abdominal hypertension; ACS, abdominal compartment syndrome; APP, abdominal perfusion pressure; AGI, Acute gastrointestinal injury; SOFA, Sequential Organ Failure Assessment.

Table 4 Median Knowledge Score Stratified by Participants Characteristics

Variable	Median Knowledge Score	p-value
Occupation		
Non-intensive care unit physician	3.00 (3.00)	0.883
Intensive care unit physician	3.00 (3.25)	
Primary area of practice		
Internal medicine	3.00 (2.00)	0.064
Surgery / trauma	3.00 (3.00)	
Paediatrics	2.50 (1.00)	
Intensive care medicine	3.00 (2.00)	
Family medicine	3.00 (2.00)	
Emergency medicine	3.00 (2.50)	
Anaesthesiology	3.00 (2.25)	
Cardiology	5.00 (2.50)	
Obstetrics and gynecology	5.00 (3.00)	
Level of experience		
Consultant	3.00 (3.00)	0.738
Resident	3.00 (2.00)	
Intern	3.00 (1.75)	
Registrar	3.00 (3.00)	
Senior registrar	3.00 (2.75)	
Fellow	2.00 (5.00)	
Years of experience		
Less than 5 years	3.00 (2.00)	0.026*
5 to 10 years	4.00 (4.00)	
10 to 15 years	3.00 (2.00)	
More than 15 years	3.00 (3.00)	
Managing ICU patients		
No	3.00 (3.00)	0.844
Yes	3.00 (3.00)	
Number of ICU beds in your hospital		
Less than 10 beds	3.00 (1.75)	0.984
10 to 20 beds	3.00 (3.00)	
20–50 beds	3.00 (3.00)	
More than 50 beds	3.00 (3.00)	

Note: *p≤0.05.

Binary logistic regression analysis identified that physicians working at hospitals with 20–50 ICU beds were 41.0% (odds ratio: 0.59 (CI: 0.37–0.96)) less likely to be knowledgeable about intra-abdominal hypertension and abdominal compartment syndrome (p≤0.05), Table 5.

Table 5 Binary Logistic Regression Analysis

Variable	Odds Ratio (95% Confidence Interval)	P-value
Occupation		
Non-intensive care unit physician (Reference group)	1.00	
Intensive care unit physician	0.40 (0.21–0.76)	0.005
Primary area of practice		
Internal Medicine (Reference group)	1.00	
Surgery / Trauma	1.08 (0.62–1.91)	0.780
Paediatrics	0.77 (0.35–1.65)	0.497
Intensive Care Medicine	0.21 (0.07–0.64)	0.006
Family Medicine	0.66 (0.35–1.27)	0.214
Emergency Medicine	1.70 (0.59–4.88)	0.324
Anaesthesiology	1.41 (0.54–3.66)	0.480
Cardiology	4.61 (0.96–22.02)	0.056
Obstetrics and Gynecology	2.28 (0.67–7.711)	
Level of experience?		
Consultant (Reference group)	1.00	
Resident	0.60 (0.35–1.02)	0.060
Intern	0.86 (0.42–1.76)	0.684
Registrar	0.54 (0.21–1.36)	0.188
Senior Registrar	1.25 (0.49–3.15)	0.641
Fellow	0.47 (0.12–1.83)	0.274
Years of experience		
Less than 5 years (Reference group)	1.00	
5 to 10 years	0.99 (0.55–1.77)	0.967
10 to 15 years	1.13 (0.64–2.00)	0.674
More than 15 years	0.80 (0.43–1.48)	0.473
Managing ICU patients		
No (Reference group)	1.00	
Yes	0.89 (0.55–1.45)	0.638

(*Continued*)

Table 5 (Continued).

Variable	Odds Ratio (95% Confidence Interval)	P-value
Number of ICU beds in your hospital		
Less than 10 beds (Reference group)	1.00	
10 to 20 beds	0.68 (0.37–1.24)	0.206
20–50 beds	0.59 (0.37–0.96)	0.032*
More than 50 beds	1.09 (0.68–1.74)	0.717

Note: *p≤0.05.

Discussion

This study examined physicians' knowledge of ACS and IAH in Saudi Arabia. Our key findings are: 1) physicians showed a weak level of knowledge of IAH and ACS, 2) physicians working at hospitals with 20–50 ICU beds were less likely to be knowledgeable about IAH and ACS, 3) the majority of the study participants reported that they are familiar with IAH or the effect of elevated IAP on organ function as well as ACS, 4) the majority of them reported that they believe that ACS and IAH are important issues in surgical/trauma patients and in regular patients, 5) more than half of them reported that they do not routinely measure IAP and around one-tenth of the study participants reported that they measure IAP when clinically indicated, and 6) the most frequently reported intervention in the management of ACS and IAH was the use of inotropes or vasopressors.

Our participating physicians showed a weak level of knowledge of IAH and ACS with a median score of 3.00 (IQR: 5.00–2.00), which represents 27.3% of the maximum attainable score. Physicians working at hospitals with 20–50 ICU beds were 41.0% (odds ratio: 0.59 (CI: 0.37–0.96)) less likely to be knowledgeable about IAH and ACS (p≤0.05). A previous multinational survey study that was conducted on physicians reported a higher level of knowledge across a study that was conducted at two time points, ranging from 42.7–48.0%.[9,21] This is dangerous as a weak level of knowledge of IAH and ACS is associated with improper clinical practices in real life settings. Lack of knowledge about IAP could affect how cases with IAH or ACS are classified and diagnosed.[22] This indicates that physicians may not be aware of the negative effects of increased IAP on end-organ function, which may manifest at relatively low IAPs of 10 mmHg.[21]

The majority of the physicians (70.3%) stated that they were familiar with IAH or the effect of elevated IAP on organ function. A similar percentage (73.7%) reported that they are familiar with ACS. This was lower than the findings of a previous multinational study by Wise et al, which reported that around 96.0% of the physicians were familiar with IAH and ACS.[9] More than half of them (62.8%) reported that they do not routinely measure IAP and 12.4% reported that they measure IAP when clinically indicated. A similar percentage (12.5%) of the physicians in Wise et al's study reported that they measure IAP when clinically indicated.[9] In spite of evidence that clinical examination is a poor predictor of abdominal pressures and that clinical examination is unable to effectively predict IAP to replace intravesicular IAP measures, the majority of physicians still rely on physical examination, according to previous literature.[23,24] In addition, there is yet no solid proof that treating IAH early leads to better patient outcomes.[9] IAH/ACS should be diagnosed by physicians using both clinical and IAP findings.[21]

Some individuals may experience an increase in IAP due to anthropometric measures, body positioning, the use of positive pressure ventilation, or perhaps small fluid or blood accumulations.[25] Elevated IAP causes IAH in mild cases and ACS in advanced cases.[26] IAP evaluation is necessary for all patients who are critically ill, edematous, or who have abdominal distension for any other reason. Important risk factors include inflammatory conditions and intraabdominal diseases.[27] In addition to patient-related factors like age and body mass index, IAH and ACS both have a number of risk factors, such as decreased abdominal wall compliance, increased intra-luminal contents, increased intra-abdominal contents, capillary leak, or fluid resuscitation.[26,27]

The majority of them reported that they believe that ACS and IAH are important issues in surgical/trauma patients (93.2%) and in medical patients (86.1%). This was consistent with the findings of Wise et al's study where the majority of the physicians considered ACS to be important both in medical patients (86.4%) and in trauma (98.2%).[9] Both surgical and medical patients should get an IAP measurement. Abdominal and trauma surgery, major fluid resuscitation, severe pancreatitis, sepsis, and organ failure are indications for IAP monitoring.[21,28] Patients with ACS should be monitored for oliguria from renal ischemia, increased airway resistance or reduced lung compliance, decreased tidal volumes, hypoxemia, hypercarbia, hypotension and decreased cardiac output, gastrointestinal bleeding, bloody diarrhea, rising lactate from ischemia of the bowel, increased creatinine, bilirubin, liver function tests, and impaired distal extremity circulation as a result of pressure on the aorta.[27,29,30]

The most frequently reported (13.5%) intervention in the management of IAH and ACS was the use of inotropes or vasopressors. A previous multinational study by Wise et al reported that physicians diuretics were used more frequently (49.2%), compared to inotropes (38.6%), decompressive laparotomy (37.0%), paracentesis (36.5%), and fluids/blood products (24.2%) for the management of IAH and ACS.[9] Another study by Kimball et al reported similar results, with vasopressors being the third most commonly used approach.[31] Wise et al confirmed that for the management of IAH and ACS, when possible, decompressive laparotomies should be avoided in favor of non-surgical therapies.[21] At the same time, Pearson et al endorsed early decompressive laparotomy in paediatric patients.[32] Reducing abdominal wall tension, positioning the patient to lower intra-abdominal pressures, reducing intra-luminal gastrointestinal contents, evacuating intra-abdominal contents, optimizing fluid balance, maintaining an adequate abdominal perfusion pressure, and using goal-directed resuscitation are all important elements of successful management of IAP and ACS.[6,27,33,34]

In our study, a total of 18.0% reported that they were aware of the existence of the WSACS before participating in our study. A similar percentage (15.4%) reported that they were aware of the publications of the WSACS consensus guidelines in 2006 and 2007 and that the WSACS definitions and guidelines were revised in 2013 (15.0%). This was much lower than the findings of a previous study by Wise et al, which reported that the majority of physicians (73.2%) were aware of WSACS and the WSACS guidelines (60.2%).[9] The definitions and recommendations were updated in accordance with evidence-based medicine and the GRADE system (Grading of Recommendations Assessment, Development, and Evaluation).[25]

This study has multiple strengths. To the best of our knowledge, this is the first study in the Middle East region to examine physicians' knowledge of ACS and IAH and in Saudi Arabia specifically. The study population was not restricted to physicians from specific speciality or settings, which increase the generalisability of our findings. The study was conducted using a previously validated assessment tool, which increase the validity of our assessment and enable us to compare our study findings to other study populations. At the same time, this study has limitations. Our ability to establish a causal relationship between study variables was constrained by the cross-sectional survey design of the study itself. This study may be subject to selection bias because only interested physicians may participate due to the length of the survey tool. Finally, because we were unable to determine how well the sample was recruited from the population of interest, we were unable to estimate the response rate for our questionnaire study, which could have resulted in non-response bias. As a result, the results should be cautiously evaluated.

It is necessary to conduct more research into the attitudes, practices, and knowledge of physicians about ACS and IAH. It is crucial to have more solid data supporting current practices since this will aid in healthcare planning and the development of educational initiatives aimed at raising healthcare workers' knowledge of the value of performing IAP in order to avoid any potential complications. It is necessary to do more research to strengthen the existing evidence about the value of performing IAP among patients with various complications that indicated it. This will raise the physicians' confidence about utilizing this type of measurement in their practices.

Conclusion

Physicians demonstrated a low level of IAP and ACS knowledge. To increase the safety of medical practices and enhance clinical outcomes for patients, awareness should be raised about the proper diagnosis and management of IAP and ACS.

Future research should focus on developing effective educational strategies to improve physicians' understanding of IAP and ACS.

Data Sharing Statement

All data associated with this study are present in the paper.

Ethical Approval

The study was approved by the Institutional Review Board at Al- Imam Mohammad Ibn Saud Islamic University gave their clearance with IRB No.186/2022. Informed consent was obtained from the study participants prior to study commencement. This study was conducted in accordance with the World Medical Association (WMA) Declaration of Helsinki.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Disclosure

The authors declare that there are no conflicts of interests.

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