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Is the ASA Classification Universal?

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Abstract

Objective: The physical status classification of the American Society of Anaesthesiology (ASA) is the most used score in the preoperative evaluation, but inconsistent evaluations and low reliability have been reported. The aim of this study is to evaluate the variability in the evaluation of ASA physical status classification among Portuguese anaesthesiologists.

Methods: Cross-sectional study, in which an electronic questionnaire, was distributed to Portuguese anaesthesiologists with questions regarding their demographic characteristics, professional experience, place of work and how they would categorise 15 clinical cases regarding ASA classification. Three anaesthesiologists and a medicine student wrote the cases. Data analyses were done using R suite version 1.0.143 and IBM SPSS Statistics. The agreement among participants was evaluated through intraclass correlation coefficient (ICC). A value of $P < .05$ was assumed as statistically significant.

Results: 1,850 e-mails were sent, and 259 answers were obtained. Median age of participants was 47 years. 172 were female and 87 males. Ninety percent of work is in the public sector, and 99.6% use this classification on their daily practice. Participants' agreement ranged from 3 to 15 responses, with a mean of 9.2 (SD ± 2.4). In none of the cases was observed a total agreement with the author's classification. The ICC among the participants was 0.726 (0.585; 0.869; $P < .001$), showing a moderate degree of agreement.

Conclusion: The results of this sample revealed that the agreement among Portuguese anaesthetists is satisfactory and similar to the values observed in other countries where there were no significant differences between trainees and specialists.

Keywords: ASA physical status classification, prospective studies, reliability

Introduction

The evaluation of the patients undergoing surgery is an anaesthesiologist's fundamental competence and has always been one of the greatest challenges they face.[1]

In 1941, the American Society of Anaesthetists (ASA) published the first version of a 'physical status' classification for patients who undergo surgery. This first ASA physical classification suffered modifications, making it a scale from 1 to 6 in present days.[2]

The ASA physical classification's intent is to quantify the amount of physiological reserve that a patient possesses at the time they are assessed for a surgical procedure.

One of the main criticisms directed to the ASA classification application is its dependence from high inter-observer variability. In 2014, the ASA re-published the classification scale, adding some examples, in the attempt to reduce this variability.[3]

The aim of this study was to evaluate the Portuguese anaesthesiologists agreement concerning the ASA physical status (ASA-PS) classification.

As a secondary goal, this study aimed to access the agreement on the ASA-PS evaluation between the Portuguese anaesthesiologists, attending to it's demographics, professional level of differentiation and sector in which they mostly work (public or private).

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Table 1. Description of the ASA Physical Status Classification[3]

ASA grade	Description
ASA 1	A normal healthy patient
ASA 2	A patient with mild systemic disease
ASA 3	A patient with severe systemic disease
ASA 4	A patient with severe systemic disease that is a constant threat to life
ASA 5	A moribund patient who is not expected to survive without operation
ASA 6	A declared brain-dead patient whose organs are being removed for donation

ASA, American Society of Anesthesiology.

Methods

Cross-sectional study conducted from May 2017 to January 2018 and the population consisted in anaesthesiology specialists and trainees included in the mailing list of Portuguese Society of Anaesthesiology. 1,850 e-mails asking for participation were sent from December 2017 to January 2018. When no answer was obtained, no further way of communication was attempted. Additional participants were recruited from 'Anestesia', a wide Portuguese anaesthetist's Facebook group. Participants working outside the country were rejected. As no patient information is used, there was no need to obtain consent. Ethical clearance was also not required, as it is the policy of the institution in which the work was carried on, that questionnaire based studies do not need to be submitted to the ethical committee.

The clinical cases used in this study were adapted and translated to Portuguese by two anaesthesiology trainees and one medicine student from the examples given in the works of Hurwitz et al.[2] and Mak et al.,[4] and later reviewed by one anaesthesiology specialist. The cases represent common daily cases and are displayed in the Appendix section. Participant's demographic data such as age, gender, years of experience, professional differentiation, area of the country and sector (public or private) they work were collected.

Main Points

- ASA classification is a tool used to quantify patient's physiological reserve before a surgical procedure.
- This cross-sectional study, based on 15 clinical cases, assessed the variability in the evaluation of ASA physical status classification among Portuguese anaesthetists.
- ASA agreement among Portuguese anaesthetists is satisfactory (including between trainees and specialists) and similar to other published data.

Statistical Analysis

The agreement among participants was evaluated through intraclass correlation coefficient (ICC). To estimate ICC with precision and assurance, the sample size (number of clinical cases needed) was determined using the formula indicated by Zou .[5] A minimum sample size of 15 subjects (clinical cases) were then required to ensure, with 80% assurance probability, that the lower limit of the one-sided 95% confidence interval is no less than 0.6 for a desirable reliability coefficient of 0.8.

An e-mail containing a link to access the questionnaire and a brief study description was sent by the Portuguese Society of Anaesthesiology. Apart from this, participation was promoted through direct contact with different department chiefs. The questionnaire was available in an online platform (Google Forms) during 40 days. The form included 15 non-emergent clinical cases. The participants were asked to rank each case according to ASA-PS classification, displayed in Table 1.[3]

Data analyses were done using R suite version1.0.143 (Vienna, Austria) and Statistical Package for the Social-Sciences (SPSS) version 24.0 (IBM SPSS Corp.; Armonk, NY, USA), and analysis was performed in two steps. First, we provided the correct answer for the cases and calculated the proportion of respondents rating identically. Second, the ASA grade reliability was assessed using the ICC (two-way random model single measure) with 95% confidence intervals (95% CI) for the overall data and for each of the demographic subgroups.[6]

An ICC of 0.80 or higher was considered high, 0.60-0.79 moderate and less than 0.60 was considered to be poor regarding the reliability.[7]

Results

Demographic characteristics of the respondents are listed in Table 2. No participants were excluded based on the exclusion criteria. Though out the country, 99.6% of the participants said they use the ASA-PS classification on their daily practice.

The mean number of cases classified identically to the reference values was 9.2 out of 15 (SD = 2.4). The distribution of the number of identical responses with reference values ranging from 3 to 15 is described in Figure 1. Out of the 259 participants, only three classified correctly all the 15 cases, while four misclassified only one case. 75.6% of the participants classified correctly more than half of the cases.

Table 2. Participant's Characteristics

		Count	Percentage of total participants	Average	Standard deviation
Gender	Female	172	66.4		
	Male	87	33.6		
Age (years old)				47	19
Professional differentiation	Specialist	203	82.5		
	Trainee	43	17.5		
Years of experience (categorized)	≤10	121	46.7		
	11-15	32	12.4		
	16+	88	34.0		
Years of experience (categorized), without considering trainees	≤10	79	38.9		
	11-15	31	15.3		
	16+	88	43.3		
Location of the hospital of work	Centre	61	24.7		
	Islands	12	4.9		
	North	98	39.7		
	South	76	30.8		
Type of hospital	Private	23	9.5		
	Public	218	90.5		
Differentiation level of the hospital	Level 1	57	23.9		
	Level 2	79	33.2		
	Level 3	102	42.9		
Frequent use of ASA-PS classification	No	1	0.4		
	Yes	245	99.6		

ASA-PS, American Society of Anesthesiology physical status.

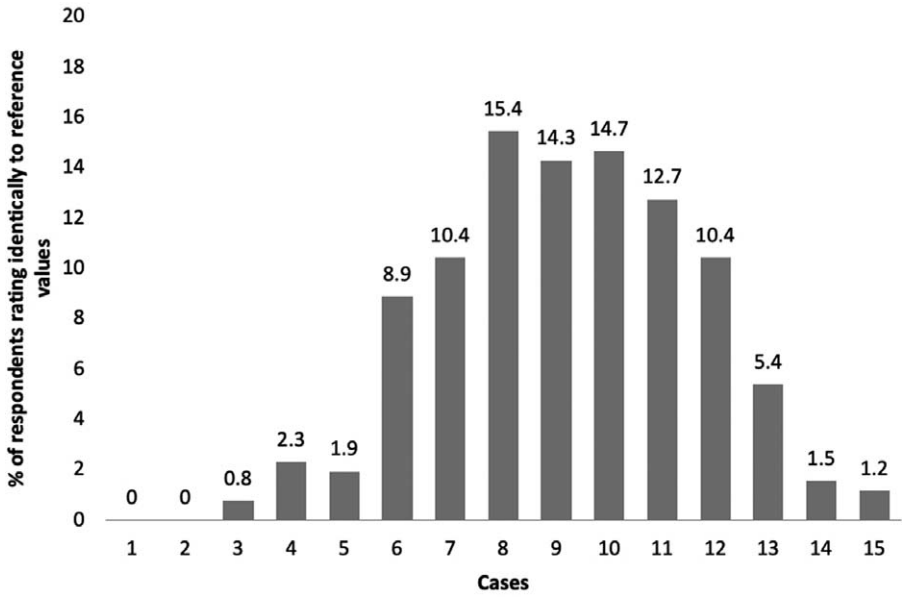

Figure 1. Distribution of the number of identical responses when compared with reference values.

Table 3. Distribution of ASA Grades According to Participant's Classifications

	ASA level distribution					
Case no.	**I**	**II**	**III**	**IV**	**V**	**VI**
1	**164 (63.3)**	95 (36.7)	0	0	0	0
2	0	103 (39.8)	**154 (59.5)**	2 (0.8)	0	0
3	0	121 (46.7)	**138 (53.3)**	0	0	0
4	33 (12.7)	**213 (82.2)**	12 (4.6)	1 (0.4)	0	0
5	0	0	5 (1.9)	**129 (49.8)**	123 (47.5)	2 (0.8)
6	0	0	88 (24.0)	**168 (64.9)**	3 (1.2)	0
7	57 (22.0)	**125 (48.3)**	63 (24.3)	11 (4.2)	2 (0.8)	1 (0.4)
8	0	3 (1.2)	70 (27.0)	**175 (67.6)**	11 (4.2)	0
9	27 (10.4)	**140 (54.1)**	92 (35.5)	0	0	0
10	**160 (61.8)**	99 (38.2)	0	0	0	0
11	0	**192 (74.1)**	64 (24.7)	3 (1.2)	0	0
12	3 (1.2)	**152 (58.7)**	102 (39.4)	2 (0.8)	0	0
13	17 (6.6)	**239 (92.3)**	3 (1.2)	0	0	0
14	2 (0.8)	95 (36.7)	**151 (58.3)**	11 (4.2)	0	0
15	0	19 (7.3)	**189 (73.0)**	50 (19.3)	1 (0.4)	0

ASA, American Society of Anesthesiology.
Note: The most rated ASA class for each case is the one marked in bold.

Table 4. ASA Grade Reliability

Characteristics	**N**	**ICC**	**95% CI**
Overall	259	0.732	0.583-0.867
Experience			
Trainee	42	0.748	0.610-0.882
<6	33	0.796	0.671-0.907
6-10	46	0.747	0.608-0.881
<10	120	0.707	0.563-0.858
Hospital differentiation level	218	0.727	0.587-0.869
Level 1	33	0.721	0.574-0.867
Level 2	79	0.727	0.586-0.870
Level 3	102	0.726	0.585-0.869
University hospital			
No	102	0.700	0.552-0.853
Yes	142	0.742	0.605-0.878

ASA: American Society of Anesthesiology.

The ASA ratings distribution for the 15 cases is shown in Table 3. In none of the 15 cases was observed a total agreement in ASA grades allocation (all participants answering the same). However, a majority (more than 50%) was obtained in almost all cases (with agreement rates ranging from 92.3% on case 13 to 53.3% on case 3). Exceptions are observed in cases 5 and 7 with agreement rates of 49.8% and 48.3% respectively.

On cases 5, 9 and 12, however, the most allocated grade did not correspond to the author's reference grade. In all these three cases, the most allocated grade was one level below the reference value for each one of the cases (grade 4 instead of grade 5 on case 5; and grade 2 instead of 3 on cases 9 and 12).

Overall the inter-rater reliability between the 259 respondents as expressed by ICC was 0.732 (95% CI: 0.583-0.867) as shown in Table 4. The ICC amongst trainees was 0.748 (95% CI: 0.610-0.882) versus 0.727 (95% CI: 0.587-0.869) for specialists with over 10 years of experience. The highest ICC, though, was obtained in the group of specialists with less than 6 years of experience—0.796 (95% CI: 0.671-0.907). According to the hospital differentiation level, the ICC was 0.721 (95% CI: 0.583-0.867) for lever 1, 0.727 (95% CI: 0.586-0.870) for level 2 and 0.726 (95% CI: 0.585-0.869) for level 3. Finally, we obtained an ICC of 0.700 (95% CI: 0.552-0.853) between participants working in a non-university hospital and of 0.742 (95% CI: 0.605-0.878) amongst those working in a university hospital. Therefore, we found that the relative reliability was moderate for all these subgroups and that there were some

differences in ICCs between them. The ICC difference between levels of hospital differentiation was only 0.006, but the difference between being and not a university hospital was 0.042. Having less than 6 or more than 10 years of experience represented a difference in the ICC of 0.089. Despite this, all these differences were not statistically significant.

The distinction between public and private sector was not taken into account, because the private sector had few participants (9.5%).

Discussion

The original idea behind the creation of a classification for patients undergoing surgery was to evaluate their physical status and not their perioperative risk of complications as it has been commonly misused.[8] This scale should be reproducible and easy to use allowing a standardised evaluation of patients by all anaesthesiologists. However, previous studies such as the works of Riley et al.[9] and Mak et al.[4] suggested low agreement between anaesthetists when classifying same patients, recognising it as a severe limitation to an instrument that should be universal and transversal to all anaesthetists. In the latest version of ASA guidelines in 2014, examples were added to the ASA classification. These examples describe clinical cases and were introduced to each ASA grade in order to guide anaesthesiologists towards a more accurate and better classification. After this, an improvement in this variability was expected. However, the systematic review of Parenti et al.[10] in 2016 didn't show that. They obtained a wide inter-rater agreement range among all studies included, ranging from fair to good agreement; however, the most prevalent agreement was only moderate. Seven of their nine reviewed studies reported a k inter-rater value higher than 0.4. In Portugal, apart from one poster reposting a study with fewer participants and in which the sample size (number of clinical cases needed) wasn't previously determined using the formula indicated by Zou, there were no major studies on this topic.[5,11]

Our results demonstrate that variation in ASA classification is still considerable after many years and attempts to improve its use. There were disagreements in all 15 clinical cases and in only three of the cases was this restricted to two grades (cases 1, 3 and 10). In cases 1 and 10, the correct classification was ASA 1 and some participants misclassified it with as an ASA 2. This might have been due to the doubt if an inguinal hernia and gonalgia (respectively) would be considered a mild systemic disease or not systemic at all. On case 3, the correct grade would have been ASA 3 and some participants misclassified it as ASA 2, showing the difficulty to decide if a previous heart stroke imposes or not severe functional limitation. Despite this, the reliability on these cases was the best found in the study.

Case 7 was even assigned all the six grades. This huge classification dispersion might result from the uncertainty if a vaginal bleeding is or is not systemic disease (ASA 1) or if it makes the patient moribund and unable to survive more 24 hours without that procedure (ASA 5), giving that a prolonged haemorrhage could cause the patient to bleed out. Most of the participants classified it as being an ASA 2 grade, considering therefore that the patient presented a mild systemic disease.

Case 5, on the other hand, not only didn't record a majority on the most assigned grade (ASA 4), but also did not correspond to the correct one (ASA 5). This confusion might have been due to the doubt if this patient was moribund and was going to die without the surgery to fix the digestive bleeding (given his hemodynamic status) or if he just presented a severe systemic disease. Definition of moribund should therefore be clarified.

This study also found that the number of years of experience, the hospital differentiation level and working in a university hospital did not have a significant impact the inter-rater reliability. Nevertheless, some differences were found among the ICCs of these subgroups. Contrary to what could be expected, trainees did not misclassify more than professionals with a lot of years of experience. In fact we found that the highest agreement was found in the group of specialists with less than 6 years of experience, followed by the trainees and in the last position the specialist with more than 10 years of experience. This might be explained by the fact that young specialists are more aware of the information updates of the anaesthesiology society. Also, it would be expected that doctors that work in less differentiated hospitals such as levels 1 or 2, could misclassify more than others that work in level three hospitals, as a consequence of receiving less complex patients but, only slight differences were found. Regarding the differences between university-hospitals and non-university-hospitals, as it would be expected, being integrated in a university gives advantage in terms of the inter-rater agreement with the professionals working in that hospital.

The overall inter-rater reliability expressed by ICC was 0.732, a moderate one (ICC 0.60-0.80). This value is similar to the values observed in other countries' literature for studies with similar drawings.[9,12,13] The results of this sample revealed that the agreement among Portuguese anaesthetists is quite satisfactory even though when it comes to clinical decisions, it would be important to have an even higher reliability grade (ICC 0.80-1).

There are a number of reasons that may explain why there is still some discrepancy between professionals in such a well documented, universally used grading system. For example, different interpretations of 'functional limitation', 'constant threat to life' and 'moribund' might explain some of these differences in the ASA classification.

However, this study had some limitations such as the unknown number viewers on the group 'Anestesia', making us unable to determine our response rate. We also decided not to include the grade 'E' of the ASA-PS scale (corresponding to emergent cases) and therefore we didn't study the full length of the scale, representing all the potential scenarios.

In the future, it would be interesting to conduct further studies to find out exactly what are the major confounding factors when attributing an ASA grade to a patient as well as studies to determine effective strategies to standardise even more this practice.

Conclusion

The results of this study revealed that the agreement among Portuguese anaesthetists is satisfactory and similar with the values observed in the literature for other countries. There was neither significant difference between trainees and specialists nor between different hospital differentiation levels.

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References

1. Sweitzer B. Three wise men (×2) and the ASA-physical status classification system. *Anesthesiology*. 2017;126(4):577-578. [CrossRef]
2. Hurwitz EE, Simon M, Vinta SR, et al. Adding examples to the ASA-physical status classification improves correct assignment to patients. *Anesthesiology*. 2017;126(4):614-622. [CrossRef]
3. Doyle DG. *American Society of Anesthesiologists Classification (ASA Class)*. Treausre Island, FL: StatPears Publishing, 2017.
4. Mak PH, Campbell RC, Irwin MG. The ASA physical status classification: Inter-observer consistency. *Anaesth Intensive Care*. 2002;30(5):633-640. [CrossRef]
5. Zou GY. Sample size formulas for estimating intraclass correlation coefficients with precision and assurance. *Statist Med*. 2012;31(29):3972-3981. [CrossRef]
6. Hallgren KA. Computing inter-rater reliability for observational data: An overview and tutorial. *TQMP*. 2012;8(1):23-34. [CrossRef]
7. Dg A. *Practical Statistics for Medical Research*. London: Chapman & Hall, 1991.
8. Keats AS. The ASA classification of physical status-A recapitulation. *Anesthesiology*. 1978;49(4):233-236. [CrossRef]
9. Riley R, Holman C, Fletcher D. Inter-rater reliability of the ASA physical status classification in a sample of anaesthetists in Western Australia. *Anaesth Intensive Care*. 2014;42(5):614-618. [CrossRef]
10. Parenti N, Reggiani MLB, Percudani D, et al. Reliability of American Society of Anesthesiologists physical status classification. *Indian J Anaesth*. 2016;60(3):208-214. [CrossRef]
11. Godinho P, Gonçalves L, Lavado J, Dixe MA, Mjendane P, Valente E, Classificação ASA-Concordância a nível nacional. *Rev Soc Port Anestesiol*. 2016;25(Suplemento):74(P0117).
12. Sankar A, Johnson SR, Beattie WS, et al. Reliability of the American Society of Anesthesiologists physical status scale in clinical practice. *Br J Anaesth*. 2014;113(3):424-432. [CrossRef]
13. Aronson WL, McAuliffe MS, Miller K. Variability in the American Society of Anesthesiologists physical status classification scale. *AANA J*. 2003;71(4):265-274.

Appendix: Clinical Cases

Case 1

A 75-year-old Caucasian male farmer, weighing 85 kg, is scheduled for an elective inguinal herniorrhaphy. He operates a 120-ha farm with help only during harvest. Ten years ago he was ill with hepatitis with no known residual complication. The rest of his history is non-contributory. On physical examination, he appears younger than his stated age. Vital signs are normal. The right inguinal hernia is the only abnormality found.

Case 2

A 56-year-old woman presents for vaginal hysterectomy for uterine fibroids. She is 162 cm and weighs 73 kg (body mass index [BMI]: 28). She has hypertension controlled with metoprolol. She has a 20 pack-years smoking history but quit smoking 5 years ago and denies any recent respiratory infections. She was recently diagnosed with noninsulin-dependent diabetes mellitus. Her most recent haemoglobin A1c is 10.5%, and her fasting blood glucose the day of surgery is 250 mg dL^{-1}.

Case 3

A 56-year-old Caucasian man is scheduled for an elective haemorrhoidectomy. Past history reveals a myocardial infarction 9 months ago, uncomplicated by arrhythmias or heart failure. Review of systems is non-contributory. Physical examination shows no abnormality except prolapsed haemorrhoids. ECG demonstrates an old anterior infarct and a normal sinus rhythm.

Case 4

A 42-year-old Negro man is scheduled for a lumbar laminectomy for a herniated disk at L2-3. Past history and review of systems reveal a previous diagnosis of sickle-cell trait. The rest of the history is non-contributory. Physical examination shows no abnormality except neurologic findings compatible with the herniated lumbar disc. Haemoglobin: 11.8 g dL^{-1} and haematocrit: 36.4%.

Case 5

A 50-year-old Caucasian man was hospitalised 6 days prior to operation with the complaint of substernal pain. During the next 3 days enzymatic and electrocardiographic changes compatible with myocardial infarction were found.

During the first day, noradrenaline infusion was necessary to maintain blood pressure in the normal range. From the second day on, mental confusion was noticed. On the fourth day, the patient passed tarry stools and had two episodes of haematemesis. Transfusion of six units of blood was necessary to maintain blood pressure.

Past history includes a childhood infectious disease, a daily consumption of 12 ounces (half bottle) of 84-proof whisky for 25 years, and 90 pack-years of cigarette smoking. The patient has had a productive cough and exertional dyspnoea.

An hour preceding operation the patient vomits a litre of bright red blood; blood pressure is 70/40 mmHg and pulse rate, 120 per minute. An immediate exploratory laparotomy is proposed.

On physical examination the patient is cold, sweaty and dyspnoeic. He is unresponsive to verbal commands. Blood pressure is 60/40 mmHg, pulse rate is 130 per minute, haemoglobin is 8.5 gdL^{-1} and haematocrit is 24%.

Case 6

A 55-year-old Caucasian man is scheduled for a transurethral resection of prostate to relieve obstructive uropathy. He has an accompanying diagnosis of aortic stenosis. Past history is non-contributory. Review of systems reveals frequent, severe pain, which is angina in nature and is relieved by nitroglycerine. The patient has had two episodes of congestive heart failure necessitating hospitalisation, the most recent being 3 months ago. Medications prescribed were nitroglycerine, digoxin, and furosemide. He has been advised to quit his job as an accountant and to restrict his work at home. On physical examination, the patient, who was thin, was resting in bed using three pillows. Blood pressure is 115/90 mmHg. There is a systolic murmur at the aortic area with radiation to the neck, accompanied by a systolic thrill. The second heart sound in the aortic area is decreased in intensity. The lungs are clear to auscultation. The balance of the physical examination is non-contributory.

Blood studies reveal serum glutamic oxaloacetic transaminase (SGOT) 55 mU mL^{-1} (normal 10-40 mU mL^{-1}); potassium, 3.2 mequiv. L^{-1} (normal 3.5-5 mequiv. L^{-1}). Chest X-ray shows left ventricular enlargement. The ECG shows changes characteristic of left ventricular hypertrophy and a normal sinus rhythm, with a rate of 66 per minute.

Case 7

A 24-year-old Caucasian housewife, weighing 60 kg, is scheduled for dilatation and curettage. Seven weeks following her last menstrual period, vaginal bleeding developed. Three days following the onset of bleeding an abortion is passed. The bleeding has continued and has saturated five napkins over the past 24 hours. This was the patient's first pregnancy. She has been fasted for 8 hours and had only clear liquids for the preceding 6 hours. Past history and review of systems are non-contributory. Physical examination reveals a normal blood pressure, 100/60 mmHg and a pulse rate of 64 per minute. Vaginal bleeding is evident, and skin pallor is recorded. The haemoglobin: 9.5 mg dL^{-1} and the haematocrit: 26%.

Case 8

A 67-year-old Caucasian man is scheduled for gastric resection to remove a mass in the greater curvature of the stomach. Past history reveals previous anaesthetic 2 years ago for right colectomy, which was complicated by respiratory failure, necessitating 5 days of mechanical ventilation. The patient has smoked two packs of cigarettes per day for 47 years. He becomes short of breath after six steps, has had a chronic cough for 20 years and produces half a cup of sputum each morning. On physical examination, the patient is obviously short of breath and is sitting up in bed. He exhales with pursed lips, cannot blow a match at 4 in. and becomes dyspnoeic after 20 ft. Examination of the chest reveals increased anteroposterior (A-P) diameter, use of accessory respiratory muscles and basilar rhonchi, which clear with a cough. Clubbing of the fingers is observed. The rest of the physical examination is normal. Haemoglobin is 15 g dL^{-1}, with haematocrit 49%. Chest X-ray reveals increased A-P diameter but no acute process. ECG reveals right ventricular hypertrophy. Results of pulmonary function tests include FEV1 25%, maximum mid-expiratory flow 0.28 L s^{-1} and FRC 120% of predicted.

Case 9

A Caucasian woman is scheduled for an elective procedure for urinary incontinence. Review of systems and past history are otherwise non-contributory. Physical examination reveals that the patient is 1.60 m and weighs 120 kg, and has signs and systems consistent with a cystocele. The balance of the examination is non-contributory.

Case 10

An 81 year-old woman comes in for cataract surgery. She is an active volunteer in the library for 4 h day^{-1}. She says she has no medical problems, but she has not seen a doctor in 20 years. The last time she

saw a doctor was for knee pain, but it eventually got better. She has never had surgery. She does not take any medications. She lives alone and is able to go grocery shopping once a week and does take care of her daily activities on her own. The rest of her history, review of symptoms and physical exam are within normal limits.

Case 11

An 82 year-old man presents for cataract surgery. He has a history of asthma for which he uses salbutamol approximately three times per year. He has benign prostatic hypertrophy and controlled insulin-dependent diabetes with a haemoglobin A1c of 5%. He takes sildenafil for erectile dysfunction, citalopram for depression and hydrocodone twice per day for chronic low back pain. He reports that he can walk three blocks before getting short of breath.

Case 12

A 32-year-old man presents for gastric banding weight loss surgery. He is currently 1.68 m and weighs 118 kg (BMI: 42 kg m^{-2}), after an intentional weight loss of 15 kg during the past 6 months. He has gastroesophageal reflux disease that is controlled on omeprazole. He currently walks 40 min day^{-1} on a treadmill without chest pain or shortness of breath. Preoperative blood pressure is 118/70 mmHg, heart rate 84 beats min^{-1}.

Case 13

A 56-year-old man presents for carpal tunnel release surgery. He denies any past medical history. He has never had surgery and is not on any medications. He does smoke one pack of cigarettes a day for the past 38 years. He says he used to smoke marijuana as a college student and drinks two to three beers every night. Physical exam and vital signs are within normal limits on the day of surgery.

Case 14

A 45-year-old Caucasian female anaesthesiologist is scheduled for a staging laparotomy for lymphoma. Her weight is 52 kg and represents a loss of 8 kg in the past 3 months. She has been treated with prednisolone, 50 mg per day and chlorambucil for the past 2 months. Past history includes infectious childhood diseases and an appendectomy at age 17, performed with an unidentified general anaesthetic, with good recovery. Had 2 labours, both with spinal anaesthesia without squeal.

An inguinal biopsy was done during uneventful balanced anaesthesia 2 months ago. Physical examination reveals that the patient is thin, with the following abnormal findings: the spleen and liver are enlarged. A mass is palpable in the lower abdomen. Inguinal nodes are present on the right, and a healed left inguinal scar is present.

Laboratory values include haematocrit, 30%; haemoglobin 10 g dL^{-1}; white cell count 5.0 L^{-1}; platelet count 125,000 L^{-1}; alkaline phosphatase 250 mU mL^{-1} (normal 35-95 mU mL^{-1}); lactate dehydrogenase (LDH) 300 mU mL^{-1} (normal 100-250 mU mL^{-1}); creatine phosphokinase (CPK) 150 mU mL^{-1} (normal 25-145 mU mL^{-1}); SGOT 80 mU mL^{-1} (normal 10-40 mU mL^{-1}).

Case 15

A 42-year-old woman presents for umbilical hernia repair. She has a history of uncontrolled hypertension in the past leading to end-stage renal disease. She is currently compliant with her haemodialysis three times per week. Her last dialysis session was yesterday. She denies any other end-organ damage related to her hypertension. For the past 6 months, her blood pressure has been controlled on lisinopril and atenolol. She denies chest pain or shortness of breath while doing yard work. Her blood pressure is 122/84 mmHg, and potassium is 4.1 mequiv. L^{-1} on the day of surgery.