Anaesthesiology Intensive Therapy
2013, vol. 45, no 1, 25–29
ISSN 1642–5758
DOI: 10.5603/AIT.2013.0005
www.ait.viamedica.pl

Perioperative prognostic factors in patients with ruptured abdominal aortic aneurysms treated in the intensive care unit

Danuta Gierek, Tomasz Cyzowski, Adrianna Kaczmarska, Anna Janowska-Rodak, Barbara Budziarz, Tomasz Koczur

Department of Anaesthesiology and Intensive Therapy, University Hospital No 7, Medical University of Silesia in Katowice, Poland

Abstract

Background. The incidence of abdominal aortic aneurysm (AAA) has been estimated at 20–40 cases per 100,000 per annum. The disease is often asymptomatic; in many cases, its first symptom is shock caused by a ruptured aneurysm. The aim of the present study was to assess retrospectively the selected perioperative factors in patients hospitalised in the intensive care unit (ICU) after repair of ruptured abdominal aortic aneurysm.

Methods. Analysis involved medical records of patients after repair of ruptured abdominal aortic aneurysm treated in ICU in the years 2009–2010. Patients were divided into two groups: group I — survivors who were discharged from ICU and group II — non-survivors. Demographic factors, intraoperative data, vital parameters, laboratory results and severity of patient's state on admission to ICU were analysed.

Results. Analysis of laboratory results on admission to ICU showed lower values of pH and HCO_3^- concentrations as well as higher international normalised ratio (INR) and activated partial thromboplastin time (APTT) in group II. Mean intraoperative diuresis differed between the groups; in group I — 303 mL and in group II — 155 mL. Mean diuresis on ICU day 1 was higher in group I compared to group II, i.e. 20.87 and 11.27 mL kg b.w.-1, respectively. APACHE II, SAPS II, MODS and SOFA point values were higher in group I than in group II.

Conclusions. Markers of impaired homeostasis, such as pH, HCO_3^- concentration, INR and APTT assessed on admission to ICU can be relevant prognostic factors in patients after repair of ruptured abdominal aortic aneurysm. Monitoring of diuresis during surgery and on day 1 of ICU treatment was a sensitive risk marker for acute kidney injury. Multiple organ failure scales such as APACHE II, MODS, SOFA and SAPS II were reliable prognostic tools to be used In the early period of ICU treatment.

Key-words: abdominal aortic aneurysm, ruptured; intensive therapy, prognosis; intensive therapy, prognostic scales

Anaesthesiology Intensive Therapy 2013, vol. 45, no 1, 25–29

The incidence of abdominal aortic aneurysm has been estimated at 20–40 cases per 100,000 per annum [1, 2, 3]. The disease is often asymptomatic; in many cases, its first symptom is shock caused by a ruptured aneurysm.

In many cases, patients with ruptured abdominal aortic aneurysms (RAAAs) have severe concomitant diseases significantly affecting the risk of repair as well as the number and types of complications. Despite advances in surgery, anaesthesiology and intensive therapy, the mortality rates in this group remain extremely high reaching 100% in patients left surgically untreated although RAAA repairs are also associated with high mortality rates, ranging from 40 to 94% [4, 5].

Postoperative RAAA-associated mortality is divided into early (first 24 postoperative hours) and late (successive treatment days) [1].

The leading cause of death during the first postoperative day is haemorrhagic shock and its consequences [1]. The major cause of postoperative complications and resultant mortality is the systemic inflammatory response syndrome (SIRS). The factors markedly involved in its development include surgical insult, intraoperative hypotension, massive transfusion of blood preparations, aorta clamping, ischaemia of the lower body part, reperfusion syndrome, and responses to prosthetic materials. Ultimately, multiple organ failure (MOF) and death are likely to occur [1].

The aim of this study was to evaluate retrospectively the selected perioperative factors in patients hospitalized in ICU after RAAA repair.

METHODS

Analysis involved medical records of patients after ruptured abdominal aortic aneurysm repairs treated at the Department of Anaesthesiology and Intensive Therapy, University Hospital No. 7 of the Upper Silesia Medical Centre in Katowice between 2009 and 2010.

Patients were divided into two groups according to case records and anaesthesia charts. Group I consisted of survivors who were discharged from ICU whereas group II included non-survivors.

The following factors were analysed:

- demographic: age, gender;
- intraoperative: surgery duration, intraoperative blood loss, types and volumes of
- blood preparations transfused, types of vasoactive drugs used, kinds of procedures;
- vital parameters on admission to ICU: mean arterial pressure (MAP), heart rate, central venous pressure (CVP);
- laboratory results on admission: blood tests (haemoglobin concentration, haematocrit, red blood cell count, white blood cell count and platelet count), arterial blood acid-base balance (pH, partial oxygen pressure [PaO_2] and carbon dioxide pressure [$PaCO_2$], bicarbonate concentration [HCO_3^-]), clotting parameters (INR and APTT), ionograms (K^+, Na^+), biochemical tests (creatinine, bilirubin, ALT, AST);
- severity of patient states on admission to ICU evaluated according to the acute physiology, age and chronic health evaluation II (APACHE II), multiple organ dysfunction score (MODS), sepsis-related organ failure assessment (SOFA), simplified acute physiology score (SAPS II);
- type and number of transfused units of blood preparations, volume of transfused fluids;
- diuresis on ICU day 1;

length of ICU hospitalization.

The gathered data were entered into the Microsoft Excel 2007 calculation sheet. Statistical analysis was carried out using Statistica for Windows 8.0 PL software (StatSoft, Tulsa, USA). The distribution of quantitative variables was checked by the Shapiro-Wilk *W* test. Inter-group comparisons of quantitative variables were carried out using the Student's *t*-test and Mann-Whitney *U* test; for qualitative variables, the Fisher's test was applied. $P \leq 0.05$ was considered as statistically significant.

RESULTS

In the population of 754 patients treated in ICU of the Upper Silesia Medical Centre in the years 2009–2010, 52 (6.9%) underwent RAAA repairs. Group I included 21 (40.5%) and group II 31 (59.5%) patients.

The mean age was 66.8 years in group I and 72.8 years in group II ($P = 0.03$). In both groups, there were individuals aged over 80 years of age: in group I — 3 and in group II — 9. The percentage of female patients was significantly lower in group I compared to group II ($P = 0.02$), i.e. 9.5% and 22%, respectively.

The mean length of procedures was comparable in both groups — 163 min in group I and 171 min in group II. The intraoperative blood losses were 2490 mL (group I) and 2909 mL (group II). On average, 7.8 units of blood preparations were transfused in group I and 9.7 units in group II ($P = 0.17$). Intraoperative diuresis differed between the groups ($P = 0.02$) — 302 mL in group I and 155 mL in group II.

The vasoactive drugs used intraoperatively were listed in Table 1.

No significant inter-group differences in surgical procedures were demonstrated (Tab. 2).

Vital parameters and laboratory results on ICU admission were presented in Table 3.

APACHE II, SAPS II, MODS and SOFA point values were found to be higher in group I than in group II (Tab. 4).

The mean number of units of blood preparations transfused on ICU day 1 was 4.4 in group I and 5.1 in group II. The mean volumes of transfused fluids on ICU day 1 were 5017 mL and 4767 mL, respectively.

The mean diuresis on ICU day 1 was higher in group I compared to group II, i.e. 20.9 mL kg b.w.$^{-1}$ and 11.3 mL kg b.w.$^{-1}$, respectively.

The mean ICU hospitalisation length was 10.7 days in group I and was longer than that in group II, 6.7 days ($P = 0.03$).

DISCUSSION

The mortality in the group of patients admitted to ICU after ruptured abdominal aortic aneurysm repairs was almost 60%, which is comparable with the literature data [6, 7] and results of large-scale studies published in recent years [8, 9, 10]. In the Mayo Clinic study carried out in 413 patients (USA), the mortality was 45% [8]. According to the study conducted in the group of 406 patients in 2005, the mortality was 48.3% [9]. The retrospective analysis performed in 2011 demonstrated the postoperative mortality of 51.2% [10]. The differences in survival in the above analyses may result from different inclusion criteria. Not all the patients survive the transport to hospital and some diagnoses are still established intraoperatively — during an exploratory laparotomy carried out in individuals suspected of acute abdomen in non-reference centres. According to some es-

Table 1. Vasoactive drugs used during RAAA

	Group I (n)	Group II (n)
Nitroglycerine	3	7
Noradrenalin	10	13
Dopamine	3	1
Noradrenalin i dopamine	5	5
Noradrenalin i adrenalin	0	5

$P = 0.2$

Table 2. Types of surgery

	Group I (n)	Group II (n)
Aorto-aortic bypass	7	13
Aorto-femoral bypass	1	2
Aorto-bifemoral bypass	13	16

$P = 0.76$

Table 3. Vital parameters and laboratory results on ICU admission ($\bar{x} \pm SD$)

	Group I	Group II	*P*
Vital parameters			
MAP (mm Hg)	82.5 ± 28.6	80.4 ± 37.5	> 0.05
Heart rate (min^{-1})	101.2 ± 21.3	102.7 ± 20.9	> 0.05
CVP (cm H_2O)	11.8 ± 6.1	14.1 ± 6.9	> 0.05
Laboratory results			
Haemoglobin (g dL^{-1})	10.0 ± 2.1	9.0 ± 2.2	> 0.05
Haematocrit (%)	30.3 ± 6.1	27.3 ± 6.5	> 0.05
Erythrocytes (T L^{-1})	3.3 ± 0.69	3.9 ± 5.63	> 0.05
Leucocytes (G L^{-1})	11.5 ± 5.5	12.31 ± 5.8	> 0.05
Platelets (G L^{-1})	116.5 ± 81.8	104.2 ± 50.9	> 0.05
pH	7.29 ± 0.08	7.19 ± 0.12	< 0.01
PaO_2 (mm Hg)	155.0 ± 102.1	125.1 ± 72.1	> 0.05
$PaCO_2$ (mm Hg)	43.3 ± 8.0	44.2 ± 10.9	> 0.05
HCO_3^- (mmol L^{-1})	21.2 ± 4.3	17.0 ± 5.6	< 0.01
INR	1.3 ± 0.2	1.8 ± 0.7	< 0.01
APTT	1.4 ± 0.7	2.1 ± 0.95	< 0.02
K^+ (mmol L^{-1})	4.8 ± 1.1	5.3 ± 1.0	> 0.05
Na^+ (mmol L^{-1})	140.1 ± 3.3	142.4 ± 6.0	> 0.05
Creatinine (mg L^{-1})	1.7 ± 1.7	1.7 ± 0.9	> 0.05
Bilirubin (mg L^{-1})	0.73 ± 0.4	0.99 ± 0.9	> 0.05
ALAT (IU L^{-1})	29.3 ± 22.4	29.3 ± 19.2	> 0.05
AspAT (IU L^{-1})	32.3 ± 18.8	29.2 ± 16.3	> 0.05

Abbreviations in the text

Table 4. Mean scores of patients state evaluation according to APACHE II, MODS, SAPS II, and SOFA on ICU admission (x ± SD)

	Group I	Group II	*P*
APACHE II	23 ± 3	35 ± 4	< 0.01
MODS	9 ± 2	12 ± 2	< 0.01
SAPS II	68 ± 10	85 ± 12	< 0.01
SOFA	10 ± 2	13 ± 2	< 0.01

Abbreviations in the text

timates, the actual total mortality due to RAAA can reach 80–90% [11]. In our study, the mortality regarded only patients admitted to ICU after surgery, excluding those who died before or during RAAA repairs and patients transferred postoperatively to the department of surgery.

The patient's age is considered a relevant prognostic factor yet the age limit for RAAA repairs has not been determined [10]. Some authors do not consider age a risk factor [6, 10]. It has been demonstrated that the length of life is comparable in 80-year-old survivors and age-matched patients without RAAA [12, 13]. This evidences that the certificate age does not coincide with the biological age and disqualification of patients based only on this criterion is essentially wrong.

High mortality rates in female RAAA patients in our study population, despite a markedly smaller size of the group, can indicate that gender should be considered a risk factor of perioperative death. Our findings are consistent with the literature data [10, 14, 15]. RAAAs are more common in male patients yet in females they are accompanied by more advanced atherosclerotic process and more severe cardiovascular disorders.

According to the available literature findings, the survival of RAAA patients is highly correlated with MAP [7, 10]. The anaesthetic management applied to maintain intraoperative normovolaemia and normotension can partially explain the discrepancies between our observations and those reported by other authors.

Moreover, low haemoglobin concentrations (< 9 g dL^{-1}) and haematocrit (< 35%) are further independent risk factors of death in RAAA patients [10], which result from severe haemorrhaging and high intraoperative blood loss. However, when sudden active haemorrhage occurs accompanied by hypovolaemia, results of blood tests, which are initially normal, can distort the actual clinical picture. Therefore, it is believed that the most reliable parameter of haemorrhagic shock in RAAA patients is absolute blood loss in relation to body weight, which correlates with the severity of multiple organ consequences of ischaemia. The blood loss above 2000 mL is considered an independent factor increasing the risk of perioperative death due to haemorrhagic shock and its sequels [16].

One of the most frequent complications of RAAA repairs is acute kidney injury whose incidence reaches 48% [16]. Its causes include perioperative haemorrhagic shock, intraoperative suprarenal aortic clamping, ischaemic injuries and SIRS. We believe that monitoring of diuresis during surgery and on the first ICU day is crucial. Diuresis during surgical repair and on the first ICU day was found to be lower in patients with poor treatment outcomes. However, this did not pertain to the concentration of creatinine in the early postoperative period. This parameter appears to be insufficiently sensitive during the first ICU day.

Based on strict control of diuresis and monitoring of the risk of acute kidney injury according to the RIFLE criteria, the early institution of renal replacement therapy should be considered [17]. Veno-venous haemofiltration used for stabilising the patient's state and normalising renal parameters is likely to improve substantially the survival of RAAA patients [1, 17].

The mean scores of multiple organ failure evaluation according to APACHE II, SAPS II, MODS and SOFA were higher in non-survivors, which is consistent with the literature data [18, 19]. The most significant correlation was demonstrated for APACHE II. Its prognostic value is particularly important at the beginning of therapeutic management [19]. Amongst the parameters required to calculate APACHE II scores, levels of pH and HCO_3 in arterial blood gasometry, serum concentrations of creatinine and potassium and age were pivotal to therapy outcomes in the study population. The above parameters reached extreme values in the group with negative outcomes. According to the literature data, abnormalities in gas exchange, acid-base imbalance and low arterial blood pressure are the key risk factors in RAAA patients [7]. The predicted APACHE II-based mortality was 70%, which is higher than the actual mortality calculated for the study group.

Retrospective evaluation of patients` states in the study groups according to SOFA and MODS was also found reliable for prognosis of survival in ICU patients. According to the literature findings [10, 20], the two scales should not be used only as a one-time prognostic index on admission to ITU. Their use during therapeutic management is beneficial for assessment of the dynamics of changes in patients` states. Their prognostic value markedly increases during the period longer than 48 h after admission, when the mortality is not directly associated with the surgical procedure and severity of clinical condition on admission but also with the development of multiple organ failure [20].

CONCLUSIONS

1. Indices of impaired homeostasis, such as pH, HCO_3^- concentration, INR APTT assessed on ICU admission can be relevant prognostic factors in patients after ruptured abdominal aortic aneurysm repairs.
2. Monitoring of diuresis during the surgical procedure and on the first ICU day is a sensitive marker of the risk of acute kidney injury.
3. The multiple organ failure scales such as APACHE II, MODS, SOFA and SAPS II are found to be reliable prognostic tools in patients during the early period of ICU treatment.

References:

1. *Gelzinis T, Subramaniam K:* Anesthesia for open abdominal aortic aneurysm repair. In: *Subramaniam K (ed.):* Anesthesia and perioperative care for aortic surgery. Springer 2011; 301–327.
2. *Gloviczki P, Pairolero P, Mucha P:* Ruptured abdominal aortic aneurysm: the Harborview experience. J Vasc Surg 1991; 13: 240–247.
3. *Katz D, Stahley J, Zelenock G:* Operative mortality rates for intact and ruptured abdominal aortic aneurysms in Michigan. J Vasc Surg 1994; 19: 804–815.
4. *Szulc R:* Znieczulenie i intensywna terapia w chirurgii naczyń. α-Medipress, Bielsko-Biała 1999.
5. *Mackiewicz Z, Molski S, Jundziłł W, Lichota W:* Pęknięty tętniak aorty brzusznej. Wiad Lek 1997; 50 (Suppl 1): 5–9.
6. *Helpern V, Kline R, D`Angelo A:* Factors that effect the survival rate of patients with ruptured abdominal aneurysms. J Vasc Surg 1997; 26: 939–948.
7. *Witkiewicz W, Czarnecki K, Maszkowski M:* Are we supposed to operate every ruptured aneurysm of the abdominal aorta? Acta Angiol 2002; 8: 127–136.
8. *Noel A, Gloviczki P, Cherry K:* Ruptured abdominal aortic aneurysm: the excessive mortality rate of conventional repair. J Vasc Surg 2001; 34: 41–46.
9. *Davidovic L, Marcovic M, Kostic D:* Ruptured abdominal aortic aneurysm: factors influencing early survival. Ann Vasc Surg 2005; 19: 29–34.
10. *Janusauskas T, Vaitkeviciute L, Triponis V:* Analysis of risk factors as outcome predictors after open aortic repair in patients with a ruptured abdominal aortic aneurysm. Seminars in Cardiovascular Medicine 2011; 17: 5.
11. *Kantonen I, Lepanto M, Brommels M:* Mortality in ruptured abdominal aortic aneurysm. Eur J Vasc Endovasc Surg 1999; 17: 208–212.
12. *Glock Y, Smile E, Dalous P:* Abdominal aortic aneurysmectomy in octogenarian patients. J Cardiovasc Surg 1990; 31: 71–76.

13. *O`Donell F, Darling R, Linton R:* Is 80 years too old for aneurysmectomy? Arch Surg 1976, 111; 1250–1257.
14. *Norman P, Powell J:* Abdominal aortic aneurysm: the prognosis in women is worse than in men. Circulation 2007; 115: 2865–2869.
15. *Stenbaek J, Granath F, Swedenborg J:* Outcome after abdominal aortic aneurysm repair. Difference between men and women. Eur J Vasc Endovasc Surg 2004; 28: 47–51.
16. *Alonso-Perez M, Segura R, Sanchez J:* Factors increasing the mortality rate for patients with ruptured abdominal aortic aneurysm. Ann Vasc Surg 2001; 15: 601–607.
17. *Kluczewski G, Gierek D, Kaczmarska A, Cyzowski T:* Continuous veno-venous haemofiltration in adult intensive therapy. Anaesthesiol Intensive Ther 2011; 43: 69–73.
18. *Maziak DE, Lindsay TF, Marshall JC, Walker PM:* The impact of multiple organ dysfunction on mortality following ruptured abdominal aortic aneurysm repair. Ann Vasc Surg 1998; 12: 93–100.
19. *Ho K, Burgess K, Braude S:* Ruptured abdominal aortic aneurysm — outcome in a community teaching hospital intensive care unit. Anaesth Intensive Care 1999; 27: 497–502.
20. *Meester R, van der Graff Y, Vos A:* Ruptured aortic aneurysm: early postoperative prediction of mortality using an organ system failure score. Br J Surg 1994; 81: 512–516.

Corresponding author:
Danuta Gierek MD, PhD
Department of Anaesthesiology and Intensive Therapy
University Hospital No 7
Medical University of Silesia in Katowice
ul. Ziołowa 45/47, 40–635 Katowice, Poland
tel.:+ 48 32 359 81 00
e-mail: oait@gcm.pl

Received: 13.01.2012
Accepted: 28.12.2012