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ORIGINAL ARTICLE

# Factors Effect to Results of Abdominal Aortic Aneurysm Repair Surgery in Khonkaen Hospital

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## ABSTRACT

**Background**: Morbidity and mortality for intervention treatment abdominal aortic aneurysm (AAA) is still high. Many factors from disease, patients and surgery are modalities which can tell and improve survival of these patients. In Khonkaen hospital, we studied the prognostic factors influencing patient survival after the intervention

**Objective**: To study factors from disease, patients and surgery which related to outcomes of treatment in Khonkaen hospital.

**Materials and Methods**: This is a retrospective comparative analytical study collecting data from medical records in Khonkean hospital. Data include patients who were admitted in Khonkean hospital and were diagnosed with AAA from 1stAugust 2014 to 31thDecember 2019. Categorical factors analysis was conducted using Chi-square test and Continuous data factors analysis were conducted using student's t-test. The results are reported as odds ratio and incidence rate ratio.

**Results**: This study includes 144 AAA patients who were treated as intervention treatment; 67(46.5%) being in Open Surgery (OS), another 77(53.5%) in Endovascular Aneurysm Repair (EVAR). The overall 30-day mortality of our study was 10.4% (Open repair 73.33%, EVAR 26.67%; p-value 0.036) and odds ratio was 0.28 (95%CI: 0.08 to 0.92). Aging patients showed higher 30-day mortality rate, odds ratio 1.09 (95% CI 1.01-1.17), p-value 0.031. In addition, ruptured status of disease showed increasing mortality when compared with non-ruptured groups, odds ratio 14.13, p-value <0.001. For preoperative factors e.g., Hematocrit and renal function status in our study showed association with 30-day mortality which had odds ratio 0.83 (95% CI 0.75-0.93), p-value 0.001 and 0.95 (95% CI 0.93-0.98), p-value 0.001, respectively. For intraoperative factors - blood transfusion, the higher given blood component also showed association with 30-day mortality which had odds ratio 1.35 (95% CI 1.29-2.59), p-value 0.001, including estimated blood loss intraoperative field showed odds ratio 1.05 (95% CI 1.02-1.08) p-value 0.001.

**Conclusions**: Open repair aneurysm were shown associated with higher mortality rate compared to EVAR. In addition, age of patients significantly in statistical survival of intervention. Including other factors e.g. clinical status ruptured abdominal aortic aneurysm, estimated blood loss and blood transfusion intraoperation, preoperative hematocrit and renal function status, shows increasing 30-day mortality rate.

**Running title**: Factors effect to result of abdominal aortic aneurysm

**Keywords**: abdominal aortic aneurysm, endovascular aneurysm repair, mortality, ICU stay

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## Introduction

Abdominal Aortic Aneurysm is a localized, abnormal dilatation of the aorta greater than 3 cm or 50% of the aortic diameter under diaphragm.[1] Most of these aneurysms are below the level of the renal arteries.[2] A true Abdominal Aortic Aneurysm involves all 3 layers of the vessel wall. If untreated, continuing extension and thinning of the vessel may result in rupture. Diagnosis of this condition as early as possible is important because it can be treated as planning and reduces risk factors that effected outcome of treatment. Medical management is recommended for asymptomatic patients with diameter < 5 cm and focuses on modified risk factors, including smoking cessation and blood pressure control. Primary indications for intervention are development of symptoms, rupture, rapid growth (> 10 mm/year), or presence of a fusiform aneurysm with maximum diameter of 5.5 cm or greater. Currently, there are two majors' operation in Abdominal Aortic Aneurysm Repair, Open repair surgery (OS) and Endovascular Aneurysm Repair (EVAR).

Interventions in treatment of abdominal aortic aneurysm are commonly open repairs and Endovascular aneurysm repair (EVAR). There are many studies that compare open repair to EVAR, e.g. EVAR-1 trial,[3] DREAM trail.[4] There are several factors influencing the outcome of surgery Abdominal Aorta Aneurysm.[5] Perioperative mortality after EVAR was 3.8% in the patients, who are older than 80 years, and 1.6% in younger, in addition, for open repair surgery was 20.1% and 7.1%, respectively.[6] In statin therapy study, patients who received perioperative treatment experienced higher adjusted 1-year survival from the date of surgery (94% vs 90%) compared with those who were not.[7] In addition, for endovascular repair, size of abdominal aorta aneurysm was related to outcomes, the adjusted increase in morbidity is 9.7% per centimeter increase in size of abdominal aorta aneurysm.[8] The 30-day mortality in patients with hemodynamic stability was 23.6% and in hemodynamic instability was 42.6 %, which was not a non-significant statistic.[9] Among hemodynamic-unstable, OS subgroups had a higher rate of pneumonia (33.3% vs 6.3%) and longer ICU stay (43.2 vs 15.2 hours) compared to EVAR subgroups.[9] For COPD patients, the OS subgroup was strongly and positively associated with the 30-day/in hospital mortality (OR 1.43) and no significant association between COPD and the 30-day mortality after EVAR.[10] In women, roles for EVAR seem to have higher mortality 2.9% vs 1.5% compared to men group.[11] Studies comparing the outcome of EVAR and OS in patients with risk factors should be performed to support decision-making.

Due to high mortality rate of rupture abdominal aortic aneurysm after treatment, mortality rate 30-day was 30% for open repairs.[12] and 17% for endovascular repair.[13] Then, we tried to study the factors that affect the improvement of the results in these patients.

In Khonkaen Hospital, Excellence Center is referred to hospitals from Khonkaen province and nearby provinces – Roi Et, Kalasin, Mahasarakham. Abdominal Aortic Aneurysm Repairs don't have been reviewed compared to outcomes and these factors. Researchers believed that this study will help and develop better outcomes in the future.

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## Materials and Methods

*Patient population*

Consecutive patients with AAA and treated in Khonkaen hospital from August 2014 to December 2019 were retrospectively reviewed from the p[illegible]t database. Exclusion criteria were patients w[illegible]lidn't have history intervention procedure to abdominal aortic aneurysm and incomplete patient database. Sample size in this study, we used Taro Yamane Formula for calculating the number which enrolled a total 179 cases, remaining 144 cases due to excluding incomplete databases.

*Outcome*

Factors which associated patients were collected from the database. The factors that effected to 30-day mortality is the most important primary outcome of our study. Secondary outcomes were postoperative complications which were related to open repair and EVAR surgery

*Study design*

*Retrospective Analytical Study*

Continuous variables were expressed by student's t-test. Categorical variables were expressed by Fisher's exact test and Pearson Chi-square test. Negative binomial regression and Logistic regression were used for performing survival analysis. For all statistical evaluation, a P value of <0.05 was considered significant. All statistical analyses were performed with STATA version 13.

## Results

Between August 2014 and December 2019, a total of 144 patients with AAA underwent operation in Khonkaen Hospital. The demographic data was shown in (table 1.), classified to open repair and EVAR. Among them, 67 patients (45.8%) were treated as open repair and 77 patients (54.2%) were treated as EVAR. The overall 30-day mortality of our study was 10.4% (Open repair 73.33%, EVAR 26.67%; p-value 0.036) and odds ratio was 0.28 (0.08 to 0.92; 95%CI). The 30-day mortality subgroup in non-rupture and rupture group were 4.23% and 38.4% p-value <0.001 and odds ratio was 14.13 (4.28 to 46.63; 95%CI) respectively. Age of patient was shown significantly statistically between improved group and dead group; ratio was 1.09 (1.01 to 1.17). Including clinical presentation – patients with ruptured status were improved 16 patients (12.4%) and were dead 10 patients (66.67%) which showed odds ratio 14.13 (4.28 to 46.63; 95%CI) compared with non-ruptured groups. The other demographic patients, gender, Glasgow score, symptoms, blood pressure, underlying disease, weren't shown significant in the 30-day mortality rate. (Table 3.)

For intraoperative factors, higher estimated blood loss was affected by 30-day mortality which showed odds ratio 1.05 (1.02 to 1.08; 95%CI). Other factors such as blood transfusion who received fewer showed an odds ratio 1.35 (1.29 to 2.59; 95%CI). In contrast, other factors such as hematocrit and renal function showed odds ratio 0.83 (0.75 to 0.93; 95%CI) and 0.95 (0.93 to 0.98; 95%CI) respectively, which meaning higher value reduced 30-day mortality. (Table 3)

**Table 1.** Demographic data between open repair and EVAR

| Characteristics | Open repair (n = 67) | EVAR (n = 77) |
|---|---|---|
| Age (years) - Mean | 71.77 | 74.55 |
| Gender | | |
| - Male | 49 (73.13) | 62 (80.51) |
| - Female | 18 (26.86) | 15 (19.48) |
| Clinical presentation | | |
| - Non-ruptured | 57 (85.07) | 61 (79.22) |
| - Ruptured | 10 (14.92) | 16 (20.77) |
| Symptoms | | |
| - Asymptomatic | 9 (13.43) | 13 (16.88) |
| - Symptomatic | 58 (86.56) | 64 (83.11) |
| Underlying | | |
| - Smoking | 3 (4.47) | 12 (15.58) |
| - Hypertension | 34 (50.74) | 51 (66.23) |
| - Diabetic Mellitus | 11 (16.41) | 14/ (18) |
| - Chronic renal disease | 5 (7.46) | 12 (15.58) |
| - Coronary arterial disease | 2 (2.98) | 14 (18.18) |
| - Valvular heart disease | 1 (1.49) | 3 (3.89) |
| - Arrhythmia | 1 (1.49) | 4 (5.19) |
| - Dyslipidemia | 1 (1.49) | 10 (12.98) |
| - COPD | 3 (4.47) | 2 (2.59) |
| Total operative time (min) | 191.16 | 143.05 |
| Estimated blood loss (ml) | 1980 | 256.10 |
| Blood transfusion (u) | 3.44 | 0.54 |
| Hematocrit | 31.10 | 32.64 |
| Renal function (GFR) | 64.52 | 61.34 |

COPD, chronic obstructive pulmonary disease; GFR, glomerular filtration rate (mL/min/1.73 m2)

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**Table 2.** Patient characteristic demographic data between improve group and dead group

| Characteristics | Improve (n = 129) | Dead (n=15) | p-value |
|---|---|---|---|
| Type of operations | | | 0.436 |
| - Open repair | 56 (43.31) | 11 (73.33) | |
| - EVAR | 73 (56.69) | 4 (26.67) | |
| All interventions | 129 (89.6) | 15 (10.4) | |
| Age (years) | 72.74 ± 8.29 | 77.73 ± 7.13 | 0.027 |
| Gender | | | >0.999 |
| - Male | 99 (76.74) | 12 (80.00) | |
| - Female | 30 (23.26) | 3 (20.00) | |
| Underlying disease | | | |
| - Smoking | 15 (11.63) | 0 (0.00) | 0.367 |
| - Hypertension | 74 (57.36) | 11 (73.33) | 0.234 |
| - Diabetic Mellitus | 23 (17.83) | 2 (13.33) | >0.999 |
| - Chronic renal disease | 16 (12.40) | 1 (6.67) | >0.999 |
| - Coronary arterial disease | 15 (11.63) | 1 (6.67) | >0.999 |
| - Valvular heart disease | 4 (3.10) | 0 (0.00) | >0.999 |
| - Arrhythmia | 4 (3.10) | 1 (6.67) | 0.428 |
| - Dyslipidemia | 11 (8.53) | 0 (0.00) | 0.605 |
| - COPD | 5 (3.88) | 0 (0.00) | >0.999 |
| Previous Medications | | | |
| - ASA | 33 (25.58) | 4 (26.67) | >0.999 |
| - Plavix | 6 (4.65) | 0 (0.00) | >0.999 |
| - Statin | 34 (26.36) | 4 (26.67) | >0.999 |
| - Diabetic mellitus drug | 19 (14.73) | 1 (6.67) | 0.694 |

EVAR, endovascular aneurysm repair; COPD, chronic obstructive pulmonary disease

**Table 3.** Primary outcome: improve and dead – logistic regression

| Factors | Improve (n = 129) | Dead (n=15) | Odds Ratio (95%CI) | p-value |
|---|---|---|---|---|
| Type of operations | | | | 0.036 |
| - Open repair | 56 (43.31) | 11 (73.33) | 1 | |
| - EVAR | 73 (56.69) | 4 (26.67) | 0.28 (0.08 to 0.92) | |
| Age | 72.74 ± 8.29 | 77.73 ± 7.13 | 1.09 (1.01 to 1.17) | 0.031 |
| Gender | | | | 0.777 |
| - Male | 99 (76.74) | 12 (80.00) | 1 | |
| - Female | 30 (23.26) | 3 (20.00) | 0.83 (0.22 to 3.12) | |
| Glasgow score | 75.64 ± 10.98 | 81.20 ± 12.28 | 1.04 (1.00 to 1.09) | 0.072 |
| Clinical presentation | | | | <0.001 |
| - Non-ruptured | 113 (87.60) | 5 (33.33) | 1 | |
| - Rupture | 16 (12.40) | 10 (66.67) | 14.13 (4.28 to 46.63) | |
| Symptoms | | | | 0.346 |
| - Asymptomatic | 21 (16.28) | 1 (6.67) | 1 | |
| - Symptomatic | 108 (83.72) | 14 (93.33) | 2.72 (0.34 to 21.83) | |
| SBP (mmHg) | 137 (92, 225) | 130 (70, 199) | 0.99 (0.97 to 1.02) | 0.561 |
| Total operative time (min) | 190.66 ± 46.00 | 193 ± 83.67 | 1.00 (0.99 to 1.01) | 0.860 |
| Estimated blood loss (ml) | 350 (20, 8,000) | 2,200 (100, 10,000) | 1.05 (1.02 to 1.08) | 0.001 |
| Blood transfusion (unit) | 1 (0, 14) | 4 (0, 9) | 1.35 (1.29 to 2.59) | 0.001 |
| Hematocrit | 32.50 ± 5.17 | 27.04 ± 7.08 | 0.83 (0.75 to 0.93) | 0.001 |
| Renal function (GFR) | 65.45 ± 25.78 | 40.19 ± 16.29 | 0.95 (0.93 to 0.98) | 0.001 |

EVAR, endovascular aneurysm repair; COPD, chronic obstructive pulmonary disease; GFR, glomerular filtration rate (mL/min/1.73 m2)

For postoperative complications, Open repair group and EVAR group showed 39 patients (39.80%) and 60 patients (60.20%) who had no complication compared to 28 patients (61.36%) and 17 patients (38.64%) who had complication, respectively; p-value 0.018, and odds ratio was 0.42 (0.20 to 0.86; 95%CI) (Table 4.). After specific complications which related to type of intervention, pneumonia was shown significantly; odds ratio 0.21 (0.06 to 0.67; 95%CI) in EVAR group. (Table 5.)

In addition, when compared between non-rupture and rupture group, respiratory complication seems be related to rupture group. Pneumonia and difficult weaning ventilator were show odds ratio 4.59 (1.61 to 13.11; 95%CI) and 9.42 (2.99 to 29.64; 95%CI), respectively. Other complications weren't showed significant statistic analytic from our study. (Table 6.

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**Table 4.** Secondary outcome: post-operative complication – logistic regression

| Factors | No complications | Complications | Odds Ratio (95%CI) | p-value |
|---|---|---|---|---|
| Type of operations | | | | 0.018 |
| - Open repair | 39 (39.80) | 28 (61.36) | 1 | |
| - EVAR | 60 (60.20) | 17 (38.64) | 0.42 (0.20 to 0.86) | |
| Age | 72.47 ± 8.56 | 74.91 ± 7.29 | 1.04 (0.99 to 1.09) | 0.104 |
| Sex | | | | 0.372 |
| - Male | 75 (75.00) | 36 (81.82) | 1 | |
| - Female | 25 (25.00) | 8 (18.18) | 0.67 (0.27 to 1.62) | |
| Glasgow score | 75 (51, 102) | 77 (56, 111) | 1.03 (1.00 to 1.06) | 0.074 |
| Clinical presentation | | | | 0.001 |
| - Non-ruptured | 89 (89.00) | 29 (65.91) | 1 | |
| - Rupture | 11 (11.00) | 15 (34.09) | 4.18 (1.73 to 10.13) | |
| Symptoms | | | | 0.717 |
| - Asymptomatic | 16 (16.00) | 6 (13.64) | 1 | |
| - Symptomatic | 84 (84.00) | 38 (86.36) | 1.21 (0.44 to 3.32) | |
| SBP (mmHg) | 137 (98, 225) | 131 (70, 199) | 1.00 (0.98 to 1.01) | 0.520 |
| Total operative time | 180 (100, 300) | 183.5 (120, 395) | 1.01 (1.00 to 1.02) | 0.185 |
| Estimated blood loss | 300 (50, 7,000) | 900 (20, 10,000) | 1.04 (1.01 to 1.07) | 0.004 |
| Blood transfusion (u) | 1 (0, 10) | 3 (0, 14) | 1.46 (1.21 to 1.76) | <0.001 |
| Hematocrit | 32.90 ± 5.41 | 29.73 ± 5.60 | 0.90 (0.84 to 0.96) | 0.003 |
| Renal function (GFR) | 68.17 ± 24.90 | 51.51 ± 25.11 | 0.97 (0.96 to 0.99) | 0.001 |

EVAR, endovascular aneurysm repair; SBP, systolic blood pressure; GFR, glomerular filtration rate (mL/min/1.73 m

**Table 5.** Secondary outcomes: Specific postoperative complications compare to open repair and EVAR

| Factors | Open repair (n=67) | EVAR (n=77) | Odds Ratio (95%CI) | p-value |
|---|---|---|---|---|
| Re-operation | 1 | 3 | 2.68 (0.27 to 26.35) | 0.399 |
| Intra-abdominal bleeding | 2 | 1 | 0.43 (0.04 to 4.82) | 0.492 |
| Groin bleeding | 0 | 2 | n/a | |
| Myocardial infarction | 2 | 2 | 0.87 (0.12 to 6.33) | 0.888 |
| Arrhythmia | 3 | 4 | 1.17 (0.25 to 5.42) | 0.842 |
| Heart failure | 3 | 1 | 0.28 (0.03 to 2.76) | 0.276 |
| Renal failure | 9 | 2 | 0.17 (0.04 to 0.83) | 0.028 |
| Stroke | 2 | 1 | 0.43 (0.04 to 4.82) | 0.492 |
| Bowel ischemia | 1 | 1 | 0.87 (0.05 to 14.16) | 0.921 |
| Pneumonia | 14 | 4 | 0.21 (0.06 to 0.67) | 0.008 |
| Acute limb ischemia | 3 | 0 | n/a | |
| Surgical site infection | 2 | 2 | 0.87 (0.12 to 6.33) | 0.888 |
| Difficult weaning | 10 | 5 | 0.40 (0.13 to 1.22) | 0.107 |

**Table 6**. Secondary outcomes: Specific complications compared to non-ruptured and rupture

| Factors | Non-ruptured (n=118) | Ruptured (n=26) | Odds Ratio (95%CI) | p-value |
|---|---|---|---|---|
| Re-operation | 2 | 2 | 4.68 (0.63 to 34.82) | 0.132 |
| Intra-abdominal bleeding | 1 | 2 | 9.44 (0.82 to 108.19) | 0.071 |
| Groin bleeding | 2 | 0 | n/a | |
| Myocardial infarction | 3 | 1 | 1.49 (0.15 to 14.88) | 0.736 |
| Arrhythmia | 7 | 0 | n/a | |
| Heart failure | 2 | 2 | 4.68 (0.63 to 34.82) | 0.132 |
| Renal failure | 7 | 4 | 2.78 (0.75 to 10.29) | 0.125 |
| Stroke | 2 | 1 | 2.25 (0.20 to 25.76) | 0.514 |
| Bowel ischemia | 0 | 2 | n/a | |
| Pneumonia | 10 | 8 | 4.59 (1.61 to 13.11) | 0.004 |
| Acute limb ischemia | 1 | 2 | 9.44 (0.82 to 108.19) | 0.071 |
| Surgical site infection | 2 | 2 | 4.68 (0.63 to 34.82) | 0.132 |
| Difficult weaning | 6 | 9 | 9.42 (2.99 to 29.64) | <0.001 |

## Discussion

Interventions for abdominal aortic aneurysm mainly are open repair and endovascular aneurysm repair (EVAR). Due to high mortality and morbidity rate in disease and postoperative, many studies were designed to clarify factors affected to outcomes. In the overall mortality case (n=15), 30-day mortality between EVAR and open repair had shown 4 patients (26.67%) and 11 patients (73.33%), in addition, odds ratio was 0.28 (0.08 to 0.92; 95%CI) and subgroup analysis between non-rupture and rupture group, 30-day mortality rate were 4.23% and 38.4% respectively, p-value <0.001 and odds ratio was 14.13 (4.28 to 46.63; 95%CI). For other factors, Age was shown significantly relative to 30-day mortality which odds ratio was 1.09 (1.01 to 1.17; 95%CI). Older patients were associated with higher mortality rate. But these factor, age, was significantly different in two patient groups, the improved group and dead group. The outcome which were analysis may be decreased accurate. Rupture status in pre-operation was associated with 30-day mortality which odds ratio was 14.13 (4.28 to 46.63; 95%CI). Due to rupture status, operation must be managed in emergency setting, the mortality rate may be higher than elective setting. Intraoperative factors such as, estimated blood loss and blood transfusion showed effects to higher mortality rate odds ratio were 1.05 (1.02 to 1.08; 95%CI) and 1.35 (1.29 to 2.59; 95%CI), respectively. But higher hematocrit and renal function were improvement outcomes, odds ratio were 0.83 (0.75 to 0.93; 95%CI) and 0.95 (0.93 to 0.98; 95%CI), respectively.

For postoperative complications, EVAR was shown trendy results as 30-day mortality which odd ratios was 0.42 (0.20 to 0.86; 95%CI). After subgroup analysis in specific postoperative complications, pneumonia was related to EVAR in statistical results. Odds ratio in EVAR group was 0.21 (0.06 to 0.67; 95%CI). Other specific postoperative complications weren't shown significant results when were compared between open repair and EVAR.

## Limitation

However, these factors were similar to other studies. The collected data and method was retrospective analysis and had many confounding factors such as small sample size. For accurate outcomes, these problems are needed for planning in higher population and forward study design and subgroup analysis in dead group need to identify factors related between open surgery and EVAR group.

## Conclusion

Open repair aneurysm, age, rupture status, estimated blood loss and blood transfusion were shown to be associated with higher mortality rate. In contrast, EVAR, higher hematocrit and renal function were shown associated with decreased 30-day mortality. However, due to limitation of the study, data and number of patients need more enrollment for further improvement and the accuracy of results.

## References


1. Ullery BW, Epidemiology and contemporary management of abdominal aortic aneuryms. Abdom Radio 2018;43:1032-43
2. Patterson C, Screening for abdominal aortic aneurysm. In: Canadian Task Force on the Periodic Health Examination. Canadian Guide to Clinical Preventive Health Care. Ottawa: Health Canada, 1994;672-78
3. Greenhalgh RM, Brown LC, Kwong GP et al. Comparison of endovascular aneurysm repair with open repair in patients with abdominal aorta aneurysm (EVAR trail 1), 30-day operative mortality results: randomized controlled trial. Lancet 2004 364(9437): 843-48
4. Prinsen M, Verhoeven EL, Buth J, et al.A randomized trial comparing conventional and endovascular repair of abdominal aorta aneurysms. N Engl Med 2004;351:1607-18
5. Bardenhagen J, Kausch H, and Wenk HH. Factors with impact on the outcome after surgical interventions for abdominal aorta aneurysms, Zentralbl Chir 2015;140(5):516-24.
6. Caitlin W, Tammam O, Umair Q, Abdominal aortic aneurysm repair in octogenarians is associated with higher mortality compared with nonoctogenarians, Southern Association for Vascular Surgery 2016.
7. Thomas F, Sarah D, Katie E et al. Statin therapy is associated with higher long-term but not perioperative survival after abdominal aortic aneurysm repair, Journal of Vascular Surgery Vol.68, Number 2, 2018: 392-9
8. Douglas M, Natalia O, Brandon C, Patrick W, Morbidity of endovascular abdominal aortic aneurysm repair is directly related to diameter, Journal of Vascular Surgery Vol.66 Number 4, 2017:1037-47
9. Tiehao W, Jichun Z, Ding Y, and Yukui M et al. Comparative effectiveness of open surgery versus endovascular repair for hemodynamically stable and unstable ruptured abdominal aortic aneurysm, Medicine. 2018;97:27
10. Jiang X, Zhongyin W., Chen C and Wei G. Chronic obstructive pulmonary disease effect on the prevalence and postoperative outcome of abdominal aortic aneurysm: meta-analysis. Scientific reports 6,25003;doi 10.1038 April 2016;1-12
11. Grootenboer N, Hendriks JM, Cuypers PWM. Endovascular Abdominal Aortic Aneurysm Repair in Women, Acta Chir Belg, 2011;111:2-6
12. F. Pecoraro, S. Gloekler, M. Roos, L. Chaykovska, et al. Mortality rates and risk factors for emergent open repair of abdominal aortic aneurysms in the endovascular era. Updates in Surgery 2018;70:129-36
13. SG. Rodel, R Meewaldt, RJ Beuk, AB. Huismann, et al. Endovascular treatment of ruptured abdominal aortic aneurysm: is there a long-term benefit at follow-up?. Journal Cardiovascular Surg. (Torino) 2012;53(1):83-9.