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Screening Models for Cardiac Risk Evaluation in Emergency Abdominal Surgery. I. Evaluation of the Intraoperative Period Risk based on Data from the Preoperative Period

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Abstract: *A classification of intraoperative cardio-vascular complications (CVC) was performed, based on data from 466 patients subjected to emergency surgery, due to severe abdominal surgical diseases or traumas, in accordance with the severe criteria of ACC/AHA for CVC in noncardiac surgery. There were 370 intraoperative CVC registered, distributed as follows: groups with low risk (148), moderate risk (200), and high risk (22). Patient groups were formed, according to the CVC risk level, during the intraoperative period, for which the determinant factor for the group distribution of patients was the complication with the highest risk. Individual data was collected for each patient, based on 65 indices: age, physical status, diseases, surgical interventions, anaesthesiological information, intra and postoperative cardio-vascular complications, disease outcome, causes of death, cardio-vascular disease anamnesis, anamnesis of all other nonsurgical diseases present, laboratory results, results from all imaging and instrumental examinations, etc. On the basis of these indices, a new distribution of the risk factors was implemented, into groups with different levels of risk of CVC during intraoperative period. This result is a solid argument, substantiating the proposal to introduce these adjustments for determining the severity of CVC in the specific conditions of emergency abdominal surgery.*

Keywords: *Cardiac risk, Methods of perioperative risk assessment, Emergency abdominal surgery.*

Introduction

Emergency abdominal surgery is an area in which the possibilities for a number of cardiologic tests and methods for perioperative cardiac risk evaluation are limited [7, 8, 9, 15]. Our former studies [10, 11, 12, 14] show the low reliability of the known indices for cardiac risk evaluation: of Goldman [2, 3, 4], of Larsen [6] and of Detsky [1] in patients subject to emergency abdominal operations with and without perioperative cardiovascular accidents.

The evaluation of cardiac risk as part of the total operative risk defines the probability for onset of cardiac complications during the operation and in the postoperative period, enables prediction of complication severity (based on the standards adopted by ACC/AHA [5]) and the period of their onset. Thus such evaluation is a prerequisite for recommendations about the therapeutic and surgical tactics.

The aim of this study is to outline constellations of risk factors for the emergence of perioperative cardiac complications in patients subject to emergency abdominal surgery and

thus to generate screening models for prediction of intraoperative cardiovascular complications with specific risk level.

Method and materials

Data have been used about 508 patients subjected to emergency operation in Emergency Surgery Section of N. Pirogov University Hospital for Emergency Care. All patients suffer from acute surgical abdominal diseases and are distributed in nosologic groups of different severity – Table 1. Since a small number of patients falls into groups from F to I, which limits the application of statistical methods, the study is concentrated on groups from A to E (hereinafter referred to as Studied Nosologic Groups – SNG), encompassing 466 (91.7%) of the patient contingent.

Table 1. Nosologic groups of urgent abdominal surgical diseases

Group	Code	Number
Acute appendicitis	A	102
Complicated hernia	B	92
Stomach-duodenal	C	84
Liver-billiary-pancreatic	D	108
Intestinal	E	80
Abdominal traumas	F	10
Combined traumas involving the abdomen	G	13
Gynecological	H	6
Others (not subject to classification)	I	13

The recorded intraoperative cardiovascular complications (CVC) for the SNG are 370 and are classified according to the ACC/AHA criteria – Table 2.

Among the 508 patients there are 97 for whom preoperative data are available for cardiac pathology, *but intra- or postoperative CVC did not occur*. This patient group represents the control group (CG) in comparison to which the differences in the SNG patient data were studied.

Patient contingent data were collected from the personal anamneses, physical examination, patient history, special hospital documentation and are structured in 4 subgroups:

1. Personal data; surgical diseases (SD); operative interventions; data related to the anesthesia; intraoperaive surgical and cardiovascular complications; about the medication of the intraoperaive CVC; outcome of the diseases and death cause;
2. CVD anamnesis; from anamneses for other non-surgical accompanying diseases; physical status;
3. Laboratory investigations;
4. Image and instrumental investigations.

Each indicator in the data groups has got own internal structure of category parameters, which are coded with respective quantitative value for the purpose of storage and statistical processing – Table 3. The management of the collected data is carried out with CardioRisk subject-oriented database [13] developed by the authors on the basis of Microsoft Access®.

Table 2. Intraoperative cardiovascular complications

Risk type	Complication type	Number of complications	Number of patients
Low	Transient hypotension	70	69
	Transient transitory hypertension	63	
	Supraventricular extrasystoles	13	
	Ventricular extrasystoles	2	
	Total:	***148***	
Moderate	Non-provoked prolonged hypertension (> 1 hour)	22	198
	Prolonged hypertension (> 1 hour)	24	
	Supraventricular arrhythmia (atrial fibrillation, supraventricular tachycardia)	11	
		55	
	Raised heart rate (> 120 beats per minute)	7	
	Sinus bradycardia	44	
	Manifested ischemia (on ECG)	37	
	Frequent ventricular extrasystoles		
	Total:	***200***	
High	Hypertension in the case of sudden heart failure	6	22
	Ventricular extrasystoles class 4	5	
	Ventricular tachycardia	5	
	Acute myocardial infarction	4	
	Acute cardiogenic pulmonary edema	1	
	Cardiac arest	1	
	Total:	***22***	

Variation analysis is applied and Student's t-criteria for assessment of the possibility for differentiation between average values or frequencies (relative shares).

Results

Table 4 shows the values of the calculated t-criteria for differentiation between the indicators by couples of groups according to degree of severity of the intraoperative CVC: high risk CVC in relation to the CG and in relation to moderate risk CVC group; moderate risk CVC in relation to the CG and in relation to low risk CVC; low risk CVC in relation to the CG. There is not a single case of intraoperative cardiogenic death. The calculated t-values exceeding the limit values at $p < 0.05$ (for respective degrees of freedom) are marked with *.

The data presented in Table 4 enable differentiation of specific constellations of indicators (risk profiles) which are sensitive to the appearance of intraoperative CVC with different degree of the cardiac risk.

I. Constellation of indicators sensitive to the appearance of low risk intraoperative CVC

1. **Age** (62 and 49); 2. **AH** (52.2% and 20.7%); 3. **RD** (26.1% and 5.2%); 4. **HF** (50.7% and 22.7%); 5. **SAP** (raised for 59.4% and 40.2%, and reduced for 11.6% and 9.3%); 6. **DAP** (raised for 49.3% and 32%, and reduced for 23.2% and 26.8%).

Table 3. Coding of indicators (the extension Op stands for intraoperative values)

Indicator	Description	Coding
Age	Age	1 – >[18-40]; 2 – >[41-55]; 3 – >[56-65]; 4 – >[66-75]; 5 – >[76-90]; 6 – >> 90
COpT	Condition of operative treatment	0 – urgent (emergency or early postponed); other – 1
EOpInt	Extent of the operative intervention	1 – small; 2 – medium; 3 – large
DAnest	Duration of the anesthesia	1 – up to 60 min, 2 – from 61 to 120 min, 3 – from 121 to 180 min, 4 – over 180 min
TIP	Total intubation period	0 – no, 1 – up to 1 h, 2 – from 1 to 2 h, 3 – from 2 to 3 h, 4 – from 3 to 6 h, 5 – from 6 to 12 h, 6 – over 12 h, 7 – over 24 h
SuOpE	Surgical complications established or ensued during the operation	0 – no; 1 – local pyoperitoneum or local choleperitoneum; 3 – intraoperative haemorrhage, traumatic or hypovolemic shock, septic or endotoxic shock; 2 – all other cases
CVC-LR-Op	Non-surgical interoperative complications, low risk	0 – if no; otherwise 1
CVC-MR-Op	Non-surgical interoperative complications, medium risk	0 – if no; otherwise 1
CVC-HR-Op	Non-surgical interoperative complications, high risk	0 – if no; otherwise 1
SPOpC	Surgical postoperative complications	0 – no; 2 – dehiscention of the operative wound necessitating laparotomy; 3 – postoperative haemorrhage or postoperative peritonitis necessitating laparotomy, ileus or other spontaneous postoperative complication necessitating relaparotomy; 1 – all other cases
CVC-LR	Non-surgical postoperative complications (low)	0 – if no; otherwise 1
CVC-MR	Non-surgical postoperative complications (medium)	0 – if no; otherwise 1
CVC-HR	Non-surgical postoperative complications (high)	0 – if no; otherwise 1
nonCD	Cause of death, non-cardiogenic	0 – if no death occurred; 1 – if death occurred; 2 – if there is more than one reason for the death
CD	Cause of death, cardiogenic	0 – if no death occurred; 1 – if death occurred; 2 – if there is more than one reason for the death
AH	Arterial hypertension, degree	0 – no; 1 – labile; 2 – mild; 3 – moderate; 4 – severe; 5 – ISAH

Table 3. Continuation

IHD	Ischemic heart disease	0 – no; 1 – stable fk 1-2; 2 – stable fk2-3; 3 – stable fk3-4; 4 – non-stable during the last 3 months; 5 – non-stable during the last 6 months
MI	Myocardial infarction	0 – no; 1 – yes
RD	Rhythm disorders	0 – no; 1 – supraventricular; 2 – ventricular; 3 – atrial fibrillation; 4 – STC
HF	Heart failure	0 – no; 1 – fk1; 2 – fk2; 3 – fk3; 4 – fk4; 5 – for the others
CNPD	Chronic nonspecific pulmonary diseases	0 – no; 1 – without cor pulmonale; 2 – with cor pulmonale
DM (Diabetes)	Diabetes	0 – no; 1 – type 1, 2 – type 2
L-Res	Lung respiration	0 – norm; 1 – dyspnea; 2 – orthopnea; 3 – tachypnea; 4 – IBV
L-ResOp		
L-Aus	Lung auscultatory	0 – no find; 1 – moist rales; 2 – dry rales; 3 – (1+2); 4 – lung edema
L-AusOp		
SAP	Blood pressure, in mm H_2O-syst.	0 – if the value is > 100 and < 140; 1 – if the value is ≤ 100; 2 – if the value is ≥ 140
SAP-Op		
DAP	Blood pressure, in mm H_2O-diast.	0 – if the value is > 70 and < 90; 1 – if the value is ≤ 70; 2 – if the value is ≥ 90
DAP-Op		
CVP	Central venous pressure: in mm H_2O	0 – if the value is less than 90; 1 – in all others cases
CVP-Op		
HR	Rate: beats per minute	0 – if the value is less than 100; 1 – in all others cases
HR-Op		
CR	Heart, rhythm	0 – no; 1 – sinus rhythm; 2 – abs. arrhythmia; 3 – pace-maker
CR-Op		
HAusc	Heart, auscultatory	0 – no; 1 – systolic murmur; 2 – diastolic murmur; 3 – TZ-cantering; 4 – (1+3)
HAusc-Op		
Hb	Hemoglobin	1 – if Hb < 100; 0 – in other cases
Hb-Op		
Glu	Glucose	1 – if Glu < 3 or Glu > 6; 0 – in all other cases
Glu-Op		
Urea	Urea	1 – if Urea > 8.2; 0 – in all other cases
Urea-Op		
Crea	Creatinine	1 – if Crea > 134; 0 – in all other cases
Crea-Op		
Potassium	Potassium	1 – if P < 3 or P > 6; 0 – in all other cases
Potassium-Op		

Table 3. Continuation

SGOT	Enzymes – sgot	1 – if SGOT > 12; 0 – in all other cases
SGOT-Op		
SGPTT	Enzymes - sgpt	1 – if SGPT > 12; 0 – in all other cases
SGPT-Op		
Rö L	Rö Lung	1 – left ventricle hypertrophy; 2 – congestion, effusion; 3 – OBO; 0 – in all other cases
Rö L-Op		
LVH	ECG overburden	1 – left ventricle hypertrophy; 0 – in all other cases
LVH-Op		
Isch-ECG	Myocardial ischemia – preoperative	1 – if in the Isch-ECG or in the Isch-ECG-Op there is a value, different from 0; in all other cases – 0
Isch-ECG-Op	Myocardial ischemia – intraoperative	1 – if in the Isch-ECG-Op there is a value, different from 0; in all other cases – 0

Table 4. T-criteria for differentiation between the indicators

Indicator	**LR-RG**	**MR-RG**	**HR-RG**	**MR-LR**	**HR-MR**
Age	*5.9811	*4.9347	1.4123	1.7756	*3.2400
AH	*3.8142	*2.5123	*2.4817	*2.0653	1.4490
IHD	0.9172	*3.0918	*1.9791	1.3684	1.1453
MI	1.2362	1.5654	*2.4479	1.3351	*2.0429
RD	*3.3619	*2.5259	*2.0561	*1.9861	1.3034
HF	*4.2184	*5.4973	*4.7256	0.4626	*2.9815
CNPD	1.4316	*4.8549	*2.6268	0.9042	0.9124
DM	0.4480	0.3663	0.6412	0.8526	0.4901
L-Res	1.5618	*4.6786	*3.0663	*2.3763	1.4131
L-Aus	1.6500	*3.7460	*3.0432	1.1646	*2.0192
SAP	*4.0255	*3.1690	0.9257	*1.9853	0.1811
DAP	*11.6654	*16.9698	1.8498	1.3099	0.7776
CVP	N.A.	N.A.	N.A.	N.A.	1.8940
HR	0.4810	*4.9068	*2.1303	*3.7383	0.3586
CR	1.5068	1.4462	1.2319	1.1265	1.5020
HAusc	0.3664	1.7670	*2.2361	*2.0306	*1.9723
Hb	0.7192	*2.8112	*2.4479	*3.6225	*2.0165
Glu	N.A.	1.8103	*3.6018	*8.4877	*2.0007
Urea	0.0073	0.4137	0.9915	0.3597	1.8835
Crea	N.A.	N.A.	1.8062	0.4916	1.8306
Potassium	0.8189	0.3589	0.7541	0.6252	0.6548
SGOT	0.8098	1.2104	1.3703	0.0797	0.9865
SGPT	0.8345	0.5498	1.2261	0.4773	1.0543
Rö L	1.2774	*2.9410	*2.4092	0.1622	1.4804
LVH	1.0411	0.6978	1.1359	*1.6710	0.8494
Isch-ECG	1.0000	*11.3159	*4.1833	*10.0625	0.5312

II. Constellation of indicators sensitive to the appearance of moderate risk intraoperative CVC

II.1. Comparison between the indicators for the patients from the group with moderate risk complications and the control group of patients: 1. **age** (60 and 49); 2. **AH** (37.4% and 22.7%); 3. **IHD** (3.5% and 4.1%); 4. **RD** (17.1% and 5.2%); 5. **HF** (46.5% and 22.7%); 6. **CNPD** (24.3% and 7.2%); 7. **lung respiration** (17.2% and 2.1%); 8. **lung auscultatory find** (18.7% and 4.1%); 9. **SAP** (raised for 48% and 40.2%, and reduced for 12.6% and 9.3%); 10. **DAP** (raised for 39.9% and 32%, and reduced for 26.3% and 26.8%); 11. **raised HR** (63% and 34%); 12. **reduced hemoglobin values** (11% and 3%); 13. **pathology Rö-lung** (13.6% and 5.2%); 13. **manifested ischemia on ECG** (39% and 0%).

II.2. Comparison between the indicators for the patients from the groups with moderate risk intraoperative CVC and with low risk CVC: 1. **AH** (37.4% and 52.2%); 2. **RD** (17.1% and 26.1%); 3. **pathology lung respiration** (17.2% and 7.3%); 4. **SAP** (raised for 48% and 59.4%, and reduced for 12.6% and 11.6%); 5. **raised HR** (63% and 38%); 6. **heart auscultatory find** (10.6% and 5.8%); 7. **reduced hemoglobin values** (11% and 1%); 8. **increased serum glucose** (63% and 5%); 9. **LVH on ECG** (19% and 29%); 10. **manifested ischemia on ECG** (39% and 1%).

III. Constellation of indicators sensitive to the appearance of high risk intraoperative CVC

III.1. Comparison between the indicators for the patients from the group with high risk complications and the control group: 1. **AH** (50% and 22.7%); 2. **IHD** (13.6% and 4.1% with considerable internal differences); 3. **myocardial infarction** (27.3% and 3.1%); 4. **RD** (27.2% and 5.2%); 5. **HF** (72.7% and 22.7%); 6. **CNPD** (36.4% and 7.2%); 7. **pathology lung respiration** (36.4% and 2.1%); 8. **lung auscultatory** (45.5% and 4.1%); 9. **raised HR** (59% and 34%); 10. **heart auscultatory find** (27.3% only of the first group with high relative frequency of T3 gallop); 11. **reduced hemoglobin values** (27% and 3%); 12. **increased serum glucose** (82% and 46%); 13. **pathology Rö - lung** (31.8% and 6.2%); 14. **manifested ischemia on ECG** (45.5% and 0%).

III.2. Comparison between the indicators for the patients from the group with high risk intraoperative CVC and the group with moderate risk intraoperative CVC: 1. **age** (66 and 60); 2. **MI** (27.3% and 7%); 3. **HF** (72.7% and 46.5%); 4. **lung auscultatory** (45.5% and 17.2%); 5. **heart auscultatory** (27.3% and 10.6%); 6. **reduced hemoglobin values** (27% and 11%); 7. **increased serum glucose** (82% and 64%).

The comparative quantitative data, summarized in chapters ***PI***, ***PII*** and ***PIII***, combined with the severity of the SD (Table 5) enable identification of specific profiles (screening models) of the basic patient groups by CVC type.

Patient group (69 cases) with low risk intraoperative CVC

The average age in this group is 62. Typical characteristics are AH, rhythm disorders, HF (50.7%), SAP and DAP. SD are most often of group B (24%), the rest are almost equally distributed among A, C, D and E.

Patient group (198 cases) with moderate risk intraoperative CVC

Average age – 60. Specific prognostic indicators are: IHD, CNPD, lung-respiration, lung-auscultatory, raised heart rate, heart-auscultatory, reduced hemoglobin values, raised serum glucose, Rö-lung, manifested ischemia on preoperative ECG. The most frequent SD for this

group are those from the relatively more-severe category D, and relatively rare – from the mildest one (A).

Table 5. Distribution of surgical diseases by groups of intraoperative cardiovascular complications

Group	CG	CG%	Low risk	LR%	Moderate risk	MR%	High risk	HR%
A	**22**	**22.7**	10	**14.5**	**15**	**7.6**		
B	**18**	**18.5**	17	**24.6**	**38**	**19.2**	5	**22.7**
C	**28**	**28.9**	10	**14.5**	**38**	**19.2**	2	9.1
D	14	**14.5**	11	**15.9**	**48**	**24.2**	9	**40.9**
E	11	11.3	10	**14.5**	**33**	**16.7**	6	**27.3**
F	1	1.0	1	1.4	5	2.5		
G	2	2.1	3	4.3	8	4.0		
H	1	1.0	4	5.8	4	2.0		
I			3	4.3	9	4.5		
Total for groups:		**A,B,C,D**		**A,B,C,D,E**		**B,C,D,E**		**B,C,D,E**
%		**84.6**		**84.0**		**79.3**		**100.0**

Patient group (22 cases) with high risk intraoperative CVC
Significant indicators for this group, although with non-typical differences from the previous one are average age – 66, AH, RD, reduced hemoglobin, raised serum glucose (82%). More sensitive indicators are: CNPD, raised HR, ischemia on preoperative ECG, IHD, HF, lung-respiration, lung-auscultatory, heart-auscultatory, Rö-lung. Particularly important indicator in this case is MI. The severity of the surgical diseases visibly increases to groups D and E.

Summary of results and conclusions

The systematized profiles binding the patient groups by risk degree with constellations of indicators the preoperative values of which are group-specific, allow for formulating guidelines for advance prognosis for occurrence of intraoperative CVC with specific risk level and surgical disease diagnosis:

- **Age, AH, RD or HF anamneses** could be defined as prognostic factor for all groups of intraoperative CVC;
- **IHD, HR**, **pathologic auscultatory heart find, manifest ECG ischemia**, indicators for lung pathology **(CNPD, pathologic modifications of breathing mechanic and the lung auscultation, Rö-lung pathology), increased serum glucose and reduced hemoglobin values** have prognostic significance for moderate risk and high risk intraoperative CVC;
- **The previous MI** is a serious predictor of high risk CVC.

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References

1. Detsky A. L., H. B. Abrams, J. R. Mc Laughlin et al. (1986). Predicting Cardiac Complications in Patients Undergoing Noncardiac Surgery, J Gen Intern Med, 1, 211-219.
2. Goldman L. (1987). Multifactorial Index of Cardiac Risk in Noncardiac Surgery, Ten-year Status Report (Review Article), J Cardiothoracs Anesthesiol, 1, 237-244.
3. Goldman L. (1995). Cardiac Risk in Noncardiac Surgery: An Update, Anesth Anal, 80, 810-820.
4. Goldman L., D. Caldera, S. Hussbaum et al. (1977). Multifactorial Index of Cardiac Risk in Noncardiac Surgical Procedures, N Engl J Med, 297, 845-850.
5. Guidelines for Perioperative Cardiovascular Evaluation for Noncardiac Surgery (1996). Report of ACC/AHA Task Force, Circulation, 6, 1286-1317.
6. Larsen S. F., K. H. Olesen, E. Jacobsen et at. (1987). Prediction of Cardiac Risk in Noncardiac Surgery, Eur Heart J., 8, 179-185.
7. Mangano D. T. (1995). Perioperative Assessment of the Patient with Cardiac Disease, Curr Opin Cardiol, 10(5), 530-542.
8. Mangano D. T., W. S. Browner, M. Hollenberg et al. (1992). Long-term Cardiac Prognosis following Noncardiac Surgery, J Am Med Assoc, 268, 233-239.
9. Massie B. M., D. T. Mangano (1993). Risk Stratification for Noncardiac Surgery. How (and Why)?, Circulation, 87, 1752-1755.
10. Milanova M., M. Matveev (1998). Cardiac Risk Evaluation in Noncardiac Surgical Procedures, J Emerg Med, 6(2), 27-32.
11. Milanova M., M. Matveev (1999). Heart Risk Assessment Indicators in Emergency Noncardiac Surgery. I. Practicability in Patients Presenting Perioperative Cardiovascular Accidents, J Emerg Med, 7(2), 45-52.
12. Milanova M., M. Matveev (2001). Heart Risk Assessment Indicators in Emergency Noncardiac Surgery. II. Practicability in Patients Free of Perioperative Cardiovascular Accidents, J Emerg Med, 9, 60-63.
13. Milanova M., M. Matveev (2006). Program Tools for Computer-aided Perioperative Cardiac Risk Evaluation in Emergency Noncardiac Surgery, 10th Congress of Bulgarian Society of Cardiology, Sofia, Oct. 27-29, Bulgarian Cardiology, 4, 39-40 (in Bulgarian).
14. Milanova M., M. Matveev, Sh. Tadjer et al. (2002). Heart Risk in Urgent Abdominal Surgery – What's New? Proceedings of the 12th World Congress of International Association of Surgeons & Gastroenterologists, Istanbul, Oct. 30 - Nov. 2, OP166, 1-3.
15. Wender N. (1990). A 50-year-old Useful Report on Coronary Risk for Noncardiac Surgery, Am J Cardiol, 66, 1375-1376.

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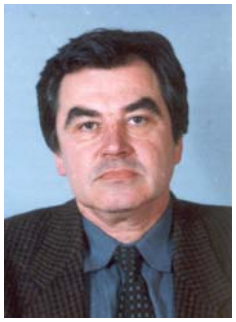

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