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ASSESSMENT OF FLUID BALANCE IN DIFFERENT REGIMENS OF INFUSION THERAPY OF HIGH SURGICAL RISK PATIENTS WITH ACUTE ABDOMINAL PATHOLOGY

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Ключевые слова: *целенаправленный режим, рестриктивный режим, инфузионная терапия, водный баланс, острая абдоминальная патология, высокий хирургический риск*

Abstract. Assessment of fluid balance in different regimens of infusion therapy of high surgical risk patients with acute abdominal pathology. Kravets O.V. *Fluid disorders always accompany acute pathology of abdominal organs. To conduct comparative analysis of efficiency of the goal-directed and restrictive regimens of infusion therapy of replenishment of volume depletion in high surgical risk patients with acute abdominal pathology 80 patients, operated by urgent laparotomy were studied. Patients were divided into two groups. In the first group (n=40) a goal-direct infusion therapy was conducted in the second (n=40) – restrictive. Rheographic method was used to investigate the performance of water sectors of the organism, daily and cumulative water balances, the percentage of excess fluids were determined and estimated. In patients of the first group an increase in plasma volume by 11% (p<0.05), exceeding by 14% (p<0.05) of the volume of interstitium and by 7% (p<0.05) of the volume of extracellular fluid in the 1st and 2nd day were noted. From 3 to 7 day a reduction in extracellular fluid to 91.5% (p<0.05) of the norm was noted. Recovery of all the studied parameters was detected on the 10th postoperative day, when the percent of excess fluid reached 9.6%. In patients of the second group there was restoration of plasma volume to normal, reduced by 10% (p<0.05) and 12% (p<0.05) from the norm of the interstitium volume, to the 1st and 2nd day after surgery respectively. From the 3 day there was a significant restoration to normal of all the studied parameters, which coincided with the "zero" values of the daily water balance and sufe limits of the percent of excess fluid, which reached 6.1% by the 10th day of treatment. Thus, the goal-direct infusion therapy allows to perform the correction of volume depletion in high surgical risk patients with acute abdominal pathology by increasing intravascular volume excess and increased volume of interstitium in 1 and 2 day, development of a mild volume depletion from 3 to 5 day, maintainance the percentage of excess fluids within secure borders. Restrictive mode of infusion therapy normalizes fluid balance of water sectors due to restoration of plasma volume in 6 hours of treatment and maintains it within the limits of the norms during all the postoperative period, preventing the development of interstitial oedema, ensures the "zero" daily water balance and limits the postoperative growth of the percentage of excess fluid.*

Реферат. Оцінка рідинного балансу при різних режимах інфузійної терапії у хворих високого хірургічного ризику з гострою абдомінальною патологією. Кравець О.В. *Рідинні порушення завжди супроводжують гостру патологію органів черевної порожнини. З метою проведення порівняльного аналізу ефективності цілеспрямованого та рестриктивного режимів інфузійної терапії при поповненні об'ємного виснаження у хворих високого хірургічного ризику з гострою абдомінальною патологією вивчалися показники 80 пацієнтів, прооперованих ургентно в обсязі лапаратомія. Хворі розподілені на дві групи. У першій групі (n=40) проводилася цілеспрямована інфузійна терапія, у другій (n=40) – рестриктивна. Реографічним методом досліджувались показники водних секторів організму, розрахунково визначалися добовий і кумулятивний водні баланси, відсоток надлишкової рідини. У пацієнтів першої групи було встановлено збільшення об'єму плазми на 11% (p<0.05), перевищення норми на 14% (p<0.05) об'єму інтерстицію та на 7% (p<0.05) об'єму позаклітинної рідини в 1 та 2-у добу. З 3-ї по 7-у добу відзначалося скорочення об'єму позаклітинної рідини до 91,5% (p<0.05) норми. Відновлення всіх досліджуваних показників визначалось на 10-ту добу, коли відсоток надлишкової рідини досягав 9,6%. У пацієнтів другої групи встановлено відновлення об'єму плазми до норми при зниженому на 10% (p<0,05) – 12% (p<0,05) від норми об'єму інтерстицію відповідно 1 і 2-ї доби. З 3-ї доби післяопераційного періоду відзначалося достовірне відновлення до норми всіх досліджуваних показників, що збігалося з «нульовими» значеннями добового водного балансу в безпечних межах відсотка надлишкової рідини, що досягав 6,1% у 10-у добу. Таким чином, цілеспрямований режим інфузійної терапії дозволяє провести корекцію об'ємного виснаження в пацієнтів високого хірургічного ризику з гострою абдомінальною патологією шляхом підвищення внутрішньосудинного об'єму до надлишкового та збільшення об'єму інтерстицію в 1 й 2-у добу, розвитку об'ємного виснаження легкого ступеня тяжкості з 3-ї по 5-у добу, підтримання відсотка надлишкової рідини в безпечних межах. Рестриктивний режим інфузійної терапії нормалізує рідинний баланс водних секторів за рахунок відновлення об'єму плазми через 6 годин лікування і підтримки його в межах норми весь післяопераційний період, запобігання розвитку інтерстиціального набряку, забезпечення «нульового» добового водного балансу та обмеження післяопераційного зростання відсотка надлишкової рідини.*

Fluid disorders always accompany acute pathology of the abdominal organs and are associated with impaired water intake, pathological losses and redistribution of fluid in the sectors of the body against the background of the underlying disease [8, 10]. The main way to correct fluid deficiency is infusion therapy (IT) [9]. The introduction of new IT regimes in various fields of surgery can reduce the length of hospital stay, the incidence of complications and the number of repeated hospitalizations [6]. The necessity of limiting large volumes of infusion and maintaining a "zero water balance" has been proved, which is associated with the threat of the development of generalized tissue edema [9, 11]. A number of studies have recommended a targeted IT regimen for patients with high surgical risk, which allows to correct fluid deficiency, reducing the risk of excessive fluid administration, based on objective hemodynamic parameters. This is associated with a

reduced risk of adverse postoperative outcomes [2, 4, 11, 12]. In clinical practice, the most accessible and objective criteria for the development of generalized edema are the calculated indicators of daily and cumulative water balances, the percentage of excessive fluid [10].

The aim is to conduct a comparative analysis of the effectiveness of targeted and restrictive regimes of infusion therapy in replenishing volumetric depletion in patients at high surgical risk with acute abdominal pathology.

MATERIALS AND METHODS OF RESEARCH

A prospective observational study was conducted with the approval of the ethics committee of the SE "DMA". We examined 80 patients with emergency pathology of the abdominal organs, operated urgently in the volume of laparatomy. The average age of the patients was 71 [Me – 61:75] years, of them 41 (51%) men and 39 (49%) women. Surgical pathology was distributed as: acute intestinal obstruction (n=40), perforated ulcer of the stomach and duodenum (n=9), strangulated hernia (n=31).

Inclusion criteria: urgent laparatomy; age over 45 and less than 75 years; the degree of volumetric depletion of more than 10% and less than 30% [1]; the degree of surgical risk is high (the predicted percentage of postoperative complications and mortality of 50% and higher by the P-POSSUM scale) [3]; degree of anesthetic risk according to ASA-III; informed consent of the patient to participate in the study.

Exclusion criteria: planned surgical interventions; age less than 45 and more than 75 years; volumetric depletion of less than 10% and more than 30%; the degree of surgical risk is mild, moderate (the predicted percentage of postoperative complications and mortality is less than 50% by the P-POSSUM scale); gastrointestinal bleeding; the volume of intraoperative blood loss is higher than I level according to Bryusov; degree of anesthetic risk according to ASA I-II-IY; patient's refusal to participate in the study.

According to the "blind envelope" method, patients were divided into 2 groups. The first (n=40) included patients who received goal-directed IT (GDIT). For patients of the second group (n = 40), IT was performed in a restrictive regimen. The groups were representative by age, gender distribution, the nature of the surgical and concomitant somatic pathology.

Preoperative preparation in all patients was carried out in an intensive care unit according to the Protocol of the of Health Ministry of Ukraine No. 297 (04/02/2010) [1]. According to the GDIT protocol, patients received an infusion of 500 ml of a balanced crystalloid solution intravenously for 15 minutes. An increase in stroke volume of the heart (SV) by 10% or more from the initial value was evaluated as a positive response and was the basis for further infusion under the control of SV after every 500 ml. After optimization of SV, patients received IT according to the restrictive regime – 2.5 ml/kg/hour of a balanced crystalloid solution. In the case of a negative response to the infusion load against the background of the restrictive regimen of IT, dopamine was prescribed in an inotropic dosage of 2-10 $\mu g/kg^{-1} min^{-1}$ until the minimum cardiac index was reached (CI) as an alternative to preventing low SV values [2]. Subsequently, patients were managed according to the restrictive regimen of infusion therapy.

The restrictive regime of IT was carried out by balanced crystalloid solutions in a volume of 50±10 ml/kg/day. The total estimated volume of infusion was introduced according to the stages: rescue, optimization and stabilization [5]. The de-escalation stage was started from the 2nd day of the postoperative period by combining the intravenous and enteral routes of fluid administration. On the 2nd day of the postoperative period, water was administered orally at a rate of 20 ml / hour, from the 3d day – up to 40 ml / hour, with a maximum volume of up to 70 ml / hour for patients of both groups. The volume of intravenous infusion was reduced correspondingly to the same oral one. Contraindication to the introduction of fluid orally was the presence of a residual volume of the stomach of more than 300 ml for 6 hours.

Using non-invasive bioelectric rheography with the "Diamant" apparatus, we determined the parameters of the body's water sectors, such as extracellular fluid volume (ECFV), intracellular fluid volume (ICFV), total fluid volume (TFV), plasma volume (PV), intravascular fluid volume (IVFV) [7]. According to the physiology of fluid distribution, the volume of interstitial space (IS) was calculated as the difference between the volumes of extracellular and vascular fluids [7]. The daily water balance was determined by the difference between the amount of injected and withdrawn fluid per day, the cumulative water balance – by the difference between the amount of injected and withdrawn fluid for the study period. The percentage of excessive fluid was determined by the formula [7]:

$$\frac{\text{total volume of fluid injected} - \text{total volume of fluid losses}}{\text{body mass}} \times 100\%$$

The studied parameters, measured on healthy volunteers (n=40), were taken as normal values.

Control points: before surgery; 6th hour of the perioperative period; 1, 2, 3, 5, 7 and 10th day after surgery.

Statistical processing of the research results was carried out using Microsoft Excel (Office Home Business 2KB4Y-6H9DB-BM47K-749PV-PG3KT) and the software product STATISTICA 6.1 (StatSoftInc., Serial number AGAR909E415822FA). The results are presented M±m, the level $p<0.05$ was statistically significant.

RESULTS AND DISCUSSION

When analyzing the initial state of patients with acute abdominal pathology of high surgical risk, we established the formation of volumetric depletion of moderate severity (Table 1). So, ECFV was 80% ($p<0.05$) from the norm and did not statistically differ between groups. Moreover, a decrease in PV by 15% ($p<0.05$) from the norm formed a depletion of the intravascular sector by 16% ($p<0.05$) without a significant difference between the groups. The interstitial volume was 79% of the norm ($p<0.05$). The depletion of moderate severity was accompanied by a decrease in TFV by 10% from the norm ($p<0.05$) in both groups of patients without signs of dehydration.

In six hours after perioperative IT in both groups of patients, the replenishment of plasma volume deficiency was established. Therewith, the distribution of fluid relative to the water sectors of the body was significantly different and determined by the IT regime. So, an early goal-directed IT regimen made it possible to replenish IVFV to the norm by increasing PV by 11% ($p<0.05$) from the norm. The use of the restrictive regimen of IT restored IVFV to 92% of the physiological volume against the normal values of PV. The severity of volumetric depletion was significantly reduced by performing early goal-directed IT. The intracellular fluid volume had no significant differences from the norm in both groups of patients.

Table 1

Indicators of the body's water sectors in different IT regimens in patients at high surgical risk with acute abdominal pathology (M±m)

Indicator	Norm (n=40)	Initial (n=50)	6 hours (n=50)	1st day (n=50)	2nd day (n=50)	3d day (n=50)	5th day (n=50)	7th day (n=50)	10th day (n=49)
Goal-directed regimen									
ECFV (l)	14.1	11.4*±0.3	13.3†±0.3	15.1†*±0.3	14.8*±0.2	12.9†±0.1	12.8*±0.2	13.3†±0.3	13.4*±0.3
ICFV (l)	24.9	23.6±0.7	24.6*†±0.7	23.7±1.3	24.0*±1.3	23.5†±0.9	24.4*±0.7	23.9†±0.4	23.5*±0.3
TFV (l)	39	35.1*±1.0	37.9*†±1.4	38.8*†±1.1	38.8*±0.6	36.4±1.3	37.2*±0.9	37.2†±1.3	36.9±1.0
PV (l)	2.7	2.3*±0.2	3.0†±0.2	2.6±0.1	3.0±0.1	2.4±0.1	2.8±0.1	2.4±0.1	2.5*±0.1
IVFV (l)	4.9	4.1* ±0.3	4.9†±0.3	4.6±0.2	5.2±0.1	4.3±0.1	5.1±0.4	4.5±0.2	4.4*±0.1
IS (l)	9.2	7.3*±0.5	8.4±0.3	10.5*†±0.3	9.6*±0.2	8.6†±0.2	7.7*±0.3	8.8±0.2	9.0±0.3
Restrictive regimen									
ECFV (l)	14.1	11.4*±0.4	11.8†±0.2	12.8†*±0.2	12.6*±0.2	13.6†±0.1	13.1*±0.2	13.7†±0.3	13.7*±0.2
ICFV (l)	24.9	23.7±0.8	23.7±0.7	23.7±1.3	23.5*±1.3	24.5†±0.9	23.3*±0.7	24.3†±0.4	24.3±0.3
TFV (l)	39	35.1*±1.3	35.5*†±1.4	36.5*†±1.1	36.1*±0.6	38.1†±1.3	36.4*±0.9	38.0†±1.3	38.0±1.0
PV (l)	2.7	2.3*±0.1	2.6†±0.2	2.7±0.1	2.6±0.1	2.8±0.1	2.7±0.1	2.7±0.1	2.6*±0.1
IVFV (l)	4.9	4.1*±0.2	4.5†±0.3	4.6±0.2	4.5±0.1	4.7±0.1	4.6±0.3	4.9±0.1	4.8*±0.1
IS (l)	9.2	7.3*±0.4	7.3±0.3	8.2*†±0.3	8.1*±0.2	8.9†±0.2	8.5*±0.3	8.8±0.2	8.7±0.3

Note: * $p<0.05$ compared with norm, † $p<0.05$ compared with previous observation stage.

Over the further postoperative period, qualitative differences in fluid redistribution between groups persisted. So, restoration of TFV to the norm on the 1st and 2nd day was accompanied by interstitial edema in early goal-directed IT. The maximum IS values corresponded to 114% of the norm ($p<0.05$) on the 1st day after the operation and were accompanied by an excess of ECFV by 7% ($p<0.05$). Therewith intravascular volume made up 94% of the norm ($p<0.05$). On the 2nd day of the postoperative period, ECFV did not significantly differ from the previous day and exceeded the norm by 6% ($p<0.05$). This coincided with an increase in the IVFV by the same values and PV, which was 111% ($p<0.05$) of the norm. The interstitial volume was reduced by 10% compared with the previous day. The described dynamics was accompanied by positive values of the daily water balance on the first two days. The greatest increase in fluid was noted on the 1st day after the operation, when the daily water balance was 2.45 L (Table 2). Intracellular dehydration was not observed in this period. From the 3d to 7th day of the postoperative period, the formation of mild volumetric depletion was established. This was confirmed by a decrease in ECFV to 91.5-94.3% ($p<0.05$) of the norm corresponding to the days and was determined by a decrease both in IS 6.6% ($p<0.05$) – 16.4% ($p<0.05$) and IVFV 12.3% ($p<0.05$) – 8.2% ($p<0.05$). On the 10th day after the operation, the described indicators did not differ significantly from the norm. The percentage of excessive fluid on the 10th day reached 9.6% – the limit of the allowable and safe interval of fluid growth.

Management of IT in a restrictive regimen made it possible to preserve PV within physiological values throughout the observation period. This was accompanied by mild volumetric depletion up to 3 days against a background of reduced IS by 10% ($p<0.05$) – 12% ($p<0.05$), corresponding 1st and 2nd day after the operation (Table 1). From the 3d day of the postoperative period we noted a reliable restoration of all studied parameters to the norm. This coincided with the "zero" values of the daily water balance and a slight increase in the cumulative water balance from the 1st to the 10th day of observation (Table 2). Moreover, the percentage of excessive fluid was within safe limits for the entire observation period and made up 6.1% by the 10th day of treatment.

Table 2

Water balance in different IT regimens in patients at high surgical risk with acute abdominal pathology (M±m)

Indicator/day of observation	1st day (n=50)	2nd day(n=50)	3d day (n=50)	5th day сутки (n=50)	7th day (n=50)	10th day (n=49)
Goal-directed regimen						
Daily water balance (l)	2.45±0.3	1.2†±0.4	0.9±0.2	1.1±0.5	0.5†±0.4	0.5±0.3
Cumulative water balance, (l)	2.45±0.3	3.65†±0.3	4.55†±0.3	5.65†±0.3	6.15†±0.3	6.75†±0.3
Percentage of excessive fluid (%)	3.5±0.3	5.2†±0.3	6.5†±0.3	8.0†±0.3	8.7†±0.3	9.6†±0.3
Restrictive regimen						
Daily water balance (l)	2.0±0.3	0.5†±0.2	0±0.1	1.0†±0.1	0.4†±0.05	0.3±0.1
Cumulative water balance, (l)	2.0±0.3	2.5±0.3	2.5±0.3	3.5†±0.3	3.9±0.3	4.3±0.3
Percentage of excessive fluid (%)	2.9±0.1	3.6†±0.2	3.6±0.1	5.1†±0.1	5.6±0.1	6.1±0.1

Note: † $p<0.05$ compared with previous observation stage.

CONCLUSIONS

1. An early goal-directed IT regime allows to correct volumetric depletion in patients at high surgical risk with acute abdominal pathology, which is accompanied by:
- excessive intravascular volume and an increase in the volume of interstitium on the 1st and 2nd day;
- development of volumetric depletion of mild severity from the 3d to 5th day;
- increase in the percentage of excessive fluid within safe limits.

2. The restrictive regimen of IT in patients at high surgical risk with acute abdominal pathology allows to correct volume depletion and normalize fluid balance of the water sectors by:
- restoration of plasma volume in 6 hours after treatment and maintaining it within normal limits throughout the postoperative period;
- prevention of development of interstitial edema throughout the observation period;
- maintenance of "zero" daily water balance and limiting the postoperative increase in the percentage of excessive fluid.

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СПИСОК ЛИТЕРАТУРИ

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