INTRODUCTION

Today mortality from acute ischemic stroke (AIS) is one of the leading causes of mortality worldwide [1, 2]. Neurological examination of patients with acute stroke is a compulsory component of not only diagnosis of stroke, but also objectification of the severity of AIS, the dynamics of treatment efficacy, the severity of neurological changes. Today’s most popular neurological scales are NIHSS (National Institutes of Health Stroke Scale), FOUR (Full Outline of UnResponsiveness), Glasgow Scale [3, 4].

Infusion therapy is an important component in the treatment of patients with acute ischemic stroke (AIS), and at the same time one of the most difficult problems in the complex of conservative treatment of these patients. As modern literary sources show, the clear principles of infusion therapy in patients with AIS have not yet been established by evidence-based medicine [5, 6]. Today, the question of choosing an optimally effective infusion strategy in patients with AIS remains open: the optimum composition, dose, control of the infusion volume, the definition of the endpoints of the effectiveness of therapy is the subject of discussion. At present, there are no clear recommendations for the infusion therapy algorithm in the treatment of AIS [3, 5, 6].

THE AIM

Compare the dynamics of changes neurological deficiency in the application of solutions: 0.9% NaCl, HES 130, HAES-LX-5% and mannitol 15% in patients with AIS.
MATERIALS AND METHODS
The study included 100 patients with AIS (non-differentiated by pathogenetic subtype). Randomization was performed using random numbers. The average age of patients was 71.84 ± 1.67 years, of which 47 were men and 53 women. The study included patients whose body weight did not exceed 120 kg. The study groups did not differ in age composition, severity of disease and other outcomes that could affect the final results of the study.

Diagnosis of AIS was established on the basis of computer tomography data. The main criterion for the selection of patients was the presence of AIS in patients and disturbances of consciousness on a scale of Glasgow 12 points and below, but not less than 4 points at admission (average was 12 points). Investigated solutions:

An isosmorl 0.9% NaCl solution in 1 ml as a crystalloid base contains sodium chloride 0.009 g, theoretical osmolality – 308 mosmol/l.

The colloid-isosmorl solution hydroxyethylcrystal 6% 130/04 (HES 130) contains 1000 ml of coloidal base (O-2-hydroxyethyl) starch (molar substitution degree – 0.4; average molecular weight - 130000 Da) 60.0 g, sodium chloride 9.0 g, auxiliary substances: sodium hydroxide (for pH correction), hydrochloric acid (for pH adjustment), water for injection - up to 1000 ml, electrolytes: Na+ -154 mmol/l; Cl− -154 mmol/l, theoretical osmolality – 308 mosmol/l.

The colloid-hyperosmorl solution hydroxyethylcrystal 6% 130/04 (HES 130) contains 1000 ml of colloidal base (O-2-hydroxyethyl) starch (molar substitution degree – 0.4; average molecular weight - 130000 Da) 60.0 g, sodium chloride 9.0 g, auxiliary substances: sodium hydroxide (for pH correction), hydrochloric acid (for pH adjustment), water for injection - up to 1000 ml, electrolytes: Na+ -154 mmol/l; Cl− -154 mmol/l, theoretical osmolality – 308 mosmol/l.

The colloid-hyperosmorl solution hydroxyethylcrystal 6% 130/04 (HES 130) contains 1000 ml of colloidal base (O-2-hydroxyethyl) starch (molar substitution degree – 0.4; average molecular weight - 130000 Da) 60.0 g, sodium chloride 9.0 g, auxiliary substances: sodium hydroxide (for pH correction), hydrochloric acid (for pH adjustment), water for injection - up to 1000 ml, electrolytes: Na+ -154 mmol/l; Cl− -154 mmol/l, theoretical osmolality – 308 mosmol/l.

The intra-group analysis of NIHSS scores in patients of the HES 130, and mannitol showed no significant difference in the variation of this indicator within 7 days of treatment (p>0.05). What can not be said by analyzing the group of HES 130, which shows a significant difference in the evaluation of seven-day therapy from the 1st to the 4th day (p=0.05) and from the 1st to 7th day (p=0.01). The similar positive dynamics of the GCS, as in the HES 130 group, was observed in the group with HAES-LX-5%, but more indicative: the assessment of the seven-day therapy in this group from 1st to 4th day showed a statistical significance of changes (p=0.01) and from the 1st to 7th day (p=0.004).

Analysis of the scale FOUR in groups with 0.9% NaCl, HES 130, and mannitol showed no significant different in the variation of this indicator within 7 days of treatment (p>0.05). Only patients with HAES-LX-5% received a positive, significant neurological dynamics according of the scale FOUR from the 1st to the 4th day of treatment (p=0.009) and from the 1st to the 7th day (p=0.0006).

The intra-group analysis of NIHSS scores in patients of all 4 groups did not show a significant difference of this indicator within 7 days of treatment (p>0.05).

Dynamic analysis of the BIS-index showed that there was a significant positive dynamics in the treatment from the 1st to the 7th day for the groups: 0.9% NaCl (p=0.04), HES 130 (p=0.01) and HAES-LX-5% (p=0.005). In the group
with mannitol was not observed a significant intra-group difference in the changes of this indicator during 7 days of observation (p>0.05).

Analyzing the initial level of intergroup neurological deficits (table II) for all studied groups, we can say that there is no statistically significant difference among the groups (p>0.05) according to the GCS, FOUR, NIHSS and BIS-index. It shows the relative initial intergroup identity of patients according to neurological deficits.

On the 4th day of study should be noted statistically significant deterioration of the neurological status of patients who receive mannitol compared to HAES-LX-5%: GCS (p=0.02), FOUR (p=0.01), NIHSS (p=0.001), BIS-index (p=0.008), and HES 130: GCS (p=0.03), FOUR (p=0.03), BIS-index (p=0.05). Comparison of other groups did not show a significant difference in neurological deficit during 4-days observation period.

Dynamic intergroup analysis of the neurological deficit at the 7th day of observation confirmed a similar picture, as in the 4th day. Thus, the statistical deterioration of the neurological status of patients in the intergroup analysis was reliably noted only in the group with mannitol compared to HAES-LX-5% by the indicators: FOUR (p=0.02), NIHSS (p=0.02), HES 130: FOUR (p=0.04), 0.9% NaCl: FOUR (p=0.02). Other intergroup indices did not have a significant difference (p>0.05).

**DISCUSSION**

The modern treatment tactics of patients with AIS requires a multimodal approach, both in diagnostics and in treatment. The main endpoints of infusion therapy in such patients are the normalization of fluid balance and blood pressure levels to restore optimal perfusion in the area of ischemic brain damage.

Undoubtedly, the main points of infusion therapy in neurointensive therapy are reducing mortality and disability in patients with AIS. The level of neurological deficits in patients with severe ischemic stroke can today be one of the main markers of effectiveness of treatment. Today, determination of the level of neurological deficits precisely with help of scales: FOUR and NIHSS has proven validity and faithfulness. The use of the abovementioned scales from the onset of treatment and the analysis in the dynamics provides the opportunity to predict the possible outcome of the treatment of neurological patients [4].

Assessing the efficiency of the scales used today, we can say that the FOUR scale has some advantages over the Glasgow coma scale, namely: it details the neurological status more precisely, gives an assessment of the respiratory pattern. The evaluation of the FOUR scale was one of the main points in the analysis of the effectiveness of the therapy, as this scale provides additional information on the prognosis in patients with low score of the GCS.
The FOUR scale is a modification of the Glasgow scale for neurological patients, it allows an objective assessment of consciousness in patients with aphasia and/or with mechanical ventilation device through an intubation tube. The probability of an inpatient mortality is higher in patients with the lowest score of the FOUR scale than in patients with the lowest score on the Glasgow coma scale [11]. Analysis of FOUR scores groups of patients: 0.9% NaCl, HES 130 and mannitol showed no significant difference in changes in the given index within 7 days of treatment (p>0.05). Only patients with HAES-LX-5% received a positive, reliable neurological dynamics of the FOUR scale from the 1st to the 4th day of treatment (p=0.009) and from the 1st to the 7th day (p=0.0006).

Today, one of the most commonly used and popular is National Institute of Health stroke severity scale that can reflect a general stroke severity profile (level of evidence A) [3]. The data obtained from our intra-group analysis of NIHSS scores in patients of all 4 groups did not show a significant difference in the changes of this indicator within 7 days of treatment (p> 0.05). However, the intergroup analysis of NIHSS scores showed a significantly better result on the 4th and 7th day of observation in patients with HAES-LX-5% compared to the mannitol group (p<0.05), which most likely is due to the better ability of the colloid-hyperosmolar solution HAES-LX-5% to restore and stabilize brain perfusion in the zone of ischemic lesion.

The dynamics of neurological status in patients with AIS has shown that in the group with colloidal-hyperosmolar solution the most likely dynamics of restoration of the neurological status during the acute period of ischemic stroke was observed in comparison with other investigated solutions, which is in full agreement with the data we have received regarding the effect of this solution on the mortality of patients with AIS [12].

Based on the data obtained in our study of intensive care in patients with acute ischemic stroke, one of the possible and recommended strategies for infusion support in acute cerebral ischaemia in patients with AIS may be the use of isosomolyar 0.9% NaCl solution and polyfunctional solutions (possibly colloidal-hyperosmolar), which combining a number of polypharmacological effects that are so necessary to combat acute cerebral ischemia.

**CONCLUSIONS**

1. The application of 0.9% NaCl and mannitol did not have a significant effect on the dynamics of neurological deficits according to the GCS, FOUR and NIHSS scales
for 7 days of observation (p>0.05). The use of HES 130 contributed to a statistically significant improvement in the parameters of the GCS (p<0.05), which is confirmed by significant changes in BIS-index (p<0.05) during a seven-day infusion therapy. The most significant positive changes were observed in the HAES-LX-5% group, which was marked by an improvement in the neurological state during 7 days treatment according to the GCS, FOUR and BIS-index (p<0.05).

2. The intergroup analysis of the neurological deficiency confirmed the worst reliable result in the mannitol group: on the 4th day compared to HAES-LX-5% with the following indices: GCS (p=0.02), FOUR (p=0.01), NIHSS (p=0.001), BIS-index (p=0.008) and HES-130: GCS (p=0.03), FOUR (p=0.03), BIS-index (p=0.05); on the 7th day in comparison with HAES-LX-5%: FOUR (p=0.02), NIHSS (p=0.02), HES 130: FOUR (p=0.04) and 0.9% NaCl: FOUR (p=0.02).

REFERENCES

Authors' contributions:
According to the order of the Authorship

Conflict of interest:
The Authors declare no conflict of interest