FORMALIZATION OF ANALGESICS ACCOUNTING IN PATIENTS WITH SPINAL PATHOLOGY DURING POSTOPERATIVE PERIOD

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Objective. To test validity of formalized Analgesic Assessment Scale (AAS) by examining the correlation of its parameters (gradations) with other parameters characterizing pain intensity during the treatment, and to assess the adequacy of conducted analgesia in patients with spinal tuberculosis by taking into account AAS gradations.

Material and Methods. The study was performed in a prospective cohort of 15 consecutive patients who underwent similar elective spine surgery for tuberculous spondylitis. Postoperatively, all patients received systemic analgesia with parenteral narcotic and non-narcotic analgesics, depending on pain intensity subjectively assessed by patients using VAS. The protocol for postoperative analgesia included records of pain intensity assessed by VAS, systolic and diastolic blood pressure (BPsist and BPdiast), heart rate, and the AAS gradations of analgesic consumption.

Results. An analysis of the correlation between AAS and other variables characterizing pain intensity in the postoperative period showed a strong positive association of AAS with VAS ($r = 0{,}567$; $P < 0{,}05$) and ADsist ($r = 0.340$; $P < 0.05$) variables, which confirms usability of each of these parameters in the assessment of pain intensity.

Conclusion. The AAS tested in a pilot study on the cohort of 15 consecutive patients operated for spinal disorders proved its effectiveness in pain intensity assessment, pain therapy, and convenience of analgesics accounting.

Key Words: postoperative pain, multimodal analgesia, postoperative analgesia, inventory of consumed analgetics

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Standardization of the accounting for analgesics in the multimodal approach to treatment of postoperative pain necessitates unified methods to assess the amount of consumed drugs.

Postoperative pain is an individual subjective criterion, which comprises sensory, emotional, and behavioral aspects caused by tissue damage [1, 2].

According to modern principles of the multimodal approach, postoperative pain is managed using narcotic and (or) non-narcotic analgesics with various analgesic activity and pathogenetic mechanism of action. In practical terms, this means that an analgesic can be substituted by another one, having different mechanism of nociceptive impulse interruption and higher or lower analgesic activity [1, 2]. Given that the amount of consumed analgesics in the postoperative period is indicative of analgesia quality, calculation of the amount of consumed drugs and especially their comparison is a challenging when assessing the adequacy of analgesia [4, 11], since patients differ from each other in anthropometric, age, and somatic characteristics, pain threshold, and many other parameters.

Evaluation of the amount of consumed analgesics in milligrams is convenient in the case of the patient-controlled analgesia (PCA), as exemplified by morphine [7, 9] and NSAIDs [6, 7]. However, PCA is not always available in the Russia, which is primarily due to the organizational complexity of accounting for narcotics. Moreover, the efficacy of this method is questioned in patients with drug abuse, mental confusion, and in newborns [3, 6, 8].

We were faced with this problem when assessing the quality of analgesia in patients with tuberculous spondylitis. In these patients, pain after reconstructive spinal surgery is managed using the multimodal analgesia, which includes the regional analgesia and/or systemic parenteral administration of analgesics as its main component [4, 5]. When comparing the analgesic activity of morphine preparations administered in the postoperative period, we failed to find a unified conversion scale for narcotic and non-narcotic agents; moreover, the literature provides different equianalgesic doses of these drugs [1, 8]. This necessitated the development of a simple, reproducible,

and objective method of accounting for the use of parenteral analgesics.

The study was aimed at testing the validity of formalized Analgesic Assessment Scale (AAS) by examining the correlation of its parameters (grades) with other parameters characterizing pain intensity during the treatment and assessing the adequacy of analgesia in patients with spinal tuberculosis taking into account AAS grades.

Material and Methods

AAS was developed based on the principle of the gradient reflection of analgesia strength [10], whereby six qualitative grades (Table 1) have been identified.

Selection of 4-hour evaluation interval was determined by two factors: first, minimum duration of analgesic action and second, the recommendations on the control and correction of postoperative pain management, which is carried out during the first 15 minutes of patient's postanesthetic recovery, then within the first 2 hours, and subsequently every 4 hours during the early postoperative period [2].

This scale was designed to be used in the postoperative period in patients with spinal disorders and other diseases.

The study was carried out in a prospective cohort of 15 consecutive patients with tuberculous spondylitis, who underwent equitype elective spinal surgery during the period from 02.03.2015 to 02.04.2015 (one month).

Criteria for inclusion of patients in the study:

– patient's written consent for the surgery and involvement to the clinical trial; no less than one day prior to the surgery, the pain assessment methodology in the postoperative period was explained to all patients;

– patient's age 18 years or older;

– the absence of mental illness;

– physical condition scoring no more than 3 points as assessed on the scale of the American Society of Anesthesiologists (ASA);

– all patients were operated on by the same surgeon (D.V. Kuklin) using the same surgical approaches and spinal reconstruction techniques;

– uniform anesthetic management involved the induction of anesthesia by intravenous administration of sodium thiopental (4.6 mg/kg) and fentanyl (0.1 mg), tracheal intubation with underlying miorelaxation with Dithylinum (1.5 mg/kg) followed by fractional injection of pipecuronium bromide (40–50 μg/kg); sevoflurane vapor inhalation (1.0–1.5 vol % in the oxygen-air mixture stream with Fi02 0.35) was used to maintain anesthesia, mechanical ventilation was carried out using Dathex-Ohmeda device in the VCV mode. Fractional administration of fentanyl (0.1–0.2 mg) and droperidol (2.5–5.0 mg) as a single injection every 20–30 minutes was used for neuroleptanalgesia.

Exclusion criteria included the language barrier and the level of anesthetic risk higher than 3 points as assessed on the ASA.

The study included 5 females and 10 males, mean age 47.0 ± 2.8 years (min 25, max 52), the average weight 73.0 ± 3.3 kg. Postoperatively, all patients received systemic analgesia by parenteral administration of narcotic and non-narcotic analgesics with allowance for the subjectively assessed pain intensity on the VAS scale [2]. According to this scale, the pain score of 0—3 points does not necessitate administration of additional analgesics; the score of 4—6 necessitate administration of additional non-narcotic analgesics, 7 points or more necessitate additional administration of narcotics.

In our study, we used narcotics *S. Promedoli* 2 % (20 mg), *S. Tramadoli* 5 % (100 mg i.m.) and non-narcotic drugs *S. Ketoprofeni* 5 % (100 mg), *S. Metamisoli* Na 50 % (1000 mg i.m.), *S. Lornoxicami* (8 mg i.v.) at a standard dose.

The following parameters were recorded in the postoperative pain management protocol:

– pain intensity as assessed on the 10-point VAS scale;

– systolic and diastolic blood pressure values (BPsist and BPdiast);

– heart rate (HR);

– grades of the used analgesics accounted bases on AAS.

A total of 90 observations in 15 patients were carried out; taking into account repetition factor, this corresponds to six observations per patient within 24 hours, starting from the second hour after surgery.

Processing of the results was carried out using the Statistica 10.0 software package, including the assessment of descriptive statistics parameters: position and scattering of the graphical representation of the results with normality test (Shapiro – Wilk Test).

Table 1
Formalized analgesic assessment scale

Grades	Characteristics
1	Analgesics were not injected during 4 hours
2	Standard single dose of one non-narcotic drug was injected during 4 hours
3	Standard single dose of a narcotic analgesic with mild analgesic effect was injected during 4 hours
4	Standard single dose of a narcotic analgesic with strong analgesic effect was injected during 4 hours
5	Combined administration of standard doses of narcotic or non-narcotic analgesics during 4 hours
6	Repeated administration of standard doses of narcotic or non-narcotic analgesics during 4 hours, when the analgesic was already injected.

Spearman's correlation analysis was used to assess the relationship between the variables. AAS score was the main variable, for which the correlation strength was assessed.

K-mean clustering was used to cluster characteristics. Significance level of $P < 0.05$ was established.

In order to provide objective evaluation of pain management, the protocols were analyzed by an expert, who was not directly involved in the post-operative monitoring of patients.

Results

Identification of correlations between the analyzed parameters. Analysis of the correlation between AAS and other variables characterizing the intensity of pain revealed strong positive correlation of AAS with VAS score ($d = 0.567$; $P < 0.05$) and BPsist ($d = 0.340$; $P < 0.05$), which confirms the possibility of using each of these values (AAS, VAS, and BPsist) in the assessment of pain intensity. Increase in dosage of analgesics in accordance with high AAS grades reflects increase in pain subjectively assessed by the patient on the VAS, which clinically presents with increased BPsist. The revealed correlations between these variables can be represented in the form of three-dimensional surface plot, where the analyzed parameter is shown as Z coordinate. Its values depend on changes in the correlation variables shown on the X and Y axes. This nonlinear relationship is graphically represented in Fig. 1.

Relationship between AAS, HR, and BPdiast demonstrated no significant correlation ($r = 0.144$ and 0.036).

Cluster analysis of the effectiveness of postoperative pain management. The study of the effectiveness of pain management in a small group of patients with tuberculous spondylitis is based on their clustering into two groups characterised by more and less severe pain based on VAS and AAS scores. Software clustering principle is based on the maximum difference between the mean values of variables, when predetermined number of clusters is 2, in accordance with the study objectives (Cluster 1 – there is no pain, cluster 2 – there is pain; Fig 2). Integrated Euc. Dist. values (Euclidean distance) of 133557.75 and 115.5 prove the significance level of differences in VAS and AAS for both clusters ($P < 0.05$).

The results of statistical analysis enable assessing the adequacy of postoperative pain management with allowance for AAS parameters.

Analysis of the adequacy postoperative pain management. The extent of surgical intervention generally involves major (traumatic) surgical approaches with dissection or separation of large muscle masses. The preliminary working hypothesis showed normal distribution of various AAS grades with frequent use of medium grades and rarer use of extreme grades in the postoperative period. However, practical analysis showed that in most cases, extreme grades 1 and 6 were used during the postoperative pain management (Table 2).

Frequent use of grade 1 has an objective explanation: pain management period of many analgesics is more than 4 hours, i.e. by the time of interim control, the effect of previous analgesic injection persisted. However, the second most frequently used grade 6 (repeated administration of the combination of analgesics during 4 h), in our opinion, has rather negative explanation. It is known that in actual practice, patients are repeatedly injected with several analgesics acting at different levels of nociceptive response in order to provide comfortable patient's condition using parenteral analgesia [1, 2], which provides sufficiently deep and long-lasting effect. In our study, an extremely rare use of grade 5 compared to grade 6 is indicative of the inadequacy of postoperative pain management.

In our opinion, varying frequency of the use of narcotic analgesics having different strength (grade 3 and 4) reflects the organizational limitations.

Thus, the use of AAS enabled not only the control of the accuracy of the administered pain therapy, but also the semi-quantitative analysis of analgesics without the need for calculating the absolute doses of administered drugs or any formulas to recalculate them.

Conclusion

The results of the study correspond to the evidence level III. The study was carried out in a group consisting of limited number of patients. The results provided the basis for the use of AAS in a randomized level II study on a broader group of patients with infectious spinal disorders, which were oriented on both surgical and anesthetic audience [4, 5]. These studies do not reflect the essentials of the AAS, and we found it appropriate to discuss them in the present publication. In our opinion, the aforementioned data suggest the following conclusions:

1) AAS grade can be used as one of the criteria to monitor pain intensity, since its values strongly correlate with other parameters traditionally used to assess this subjective criteria, i.e. VAS score and BPsist value;

2) AAS is easy and convenient for the qualitative analysis of postoperative pain management by means of parenteral administration of analgesics, since it does not require quantitative conversion of drug doses with respect to some certain standard;

3) AAS can be used in the comparative analysis of the effectiveness of pain management using various drug classes.

AAS cannot influence the choice of specific analgesics. These issues are determined by each institution in accordance with its capabilities and traditions. This scale is only a technical tool, which can be used for research and clinical purposes. Its application in a larger group of patients, who underwent various spinal surgeries, could probably be useful not only in our institution, but also in the anesthesiology departments of other medical clinics providing surgical care to patients with spinal disorders and injuries.

Table 2
The recorded frequency of the used of AAS grades

Grade	Cases, n (%)
1	29 (32.0)
2	15 (16.7)
3	14 (15.5)
4	8 (8.9)
5	7 (7.8)
6	17 (18.9)

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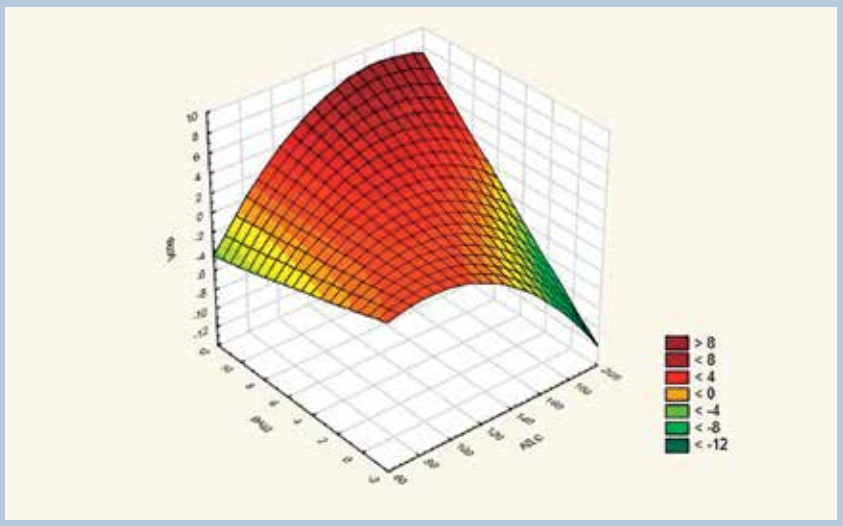

Fig. 1
Nonlinear relationship between the analyzed variables: increase in the grade of the formalized analgesic assessment scale (analyzed values, Z axis) as a function of changes in the X (BPsist) and Y (VAS) values; $P < 0.05$; the highest quantitative values of the color legend correspond to maximum correlation

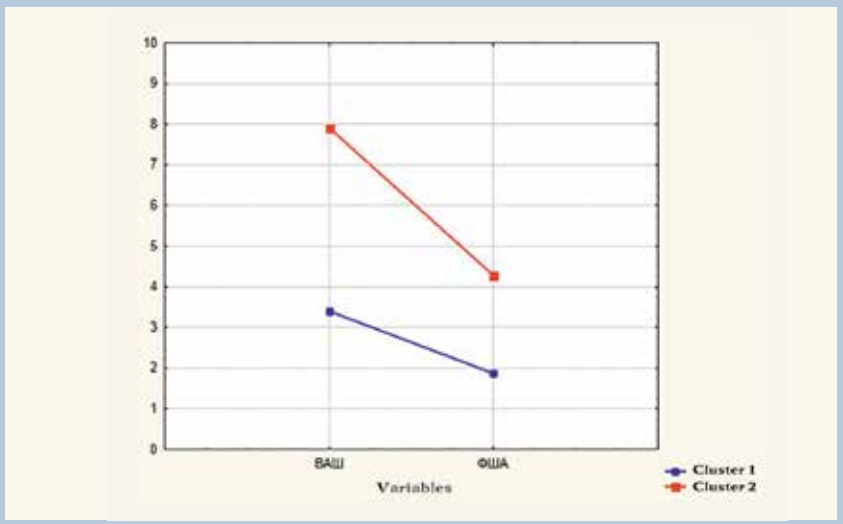

Fig. 2
Clusters of the presence and absence of pain ($P < 0.05$): terminal values on the lines correspond to average VAS and AAS scores in the clusters

References

1. **Kubynin AN, Pchelintsev MV, Evartau EE.** Opioid analgesics: ways to improve the treatment of pain syndromes. Russian Medical Journal. 2007;(5):417–424. In Russian.
2. Postoperative Pain Management – Good Clinical Practice: General recommendations and principles for successful pain management / Transl. and ed by AM Ovechkin. Moscow, 2006. In Russian.
3. Morgan & Mikhail's Clinical Anesthesiology, in 3 books / Transl. and ed. by AA Bunyatin, AM Tseitlin. Moscow, St. Petersburg, 2001. Book 1. In Russian.
4. **Pulkina ON, Ulrikh GE, Kuklin DV, Bragilevsky VM.** Continuous intralesional analgesia after spine reconstruction surgery in patients with tuberculous spondylitis. Hir Pozvonoc. 2014;(2):74–78. In Russian. DOI: http://dx.doi.org/10.14531/ss2014.2.74-78.
5. **Pulkina ON, Ulrih GE, Kuklin DV, Bragilevsky VM.** Interpleural analgesia after surgical interventions on the vertebral column in tuberculous spondylitis patients. Messenger of Anesthesiology and Resuscitation. 2015;12(2):59–64. In Russian.
6. **Romanova TL, Ovechkin AM, Nikolaev IV.** Using various options of patient-controlled analgesia (PCA) for postoperative analgesia in abdominal surgery. Intensive Care Herald. 2005;(5):123–125. In Russian.
7. **Romanova TL.** Postoperative analgesia. The role and place of patient-controlled analgesia. Novosti Nauki I Tehniki. Seria: Meditsina. Novosti Anestesiologii I Reanimatologii. 2007;(1):11–23. In Russian.
8. **Zhirkova YuV, Kucherov YuI, Stepanenko SM.** Pain in neonates: prevalence, diagnostics, prevention and treatment. Pediatric pharmacology. 2012;9(4):37–40. In Russian.
9. **Grass JA.** Patient-controlled analgesia. Anesth Analg. 2005;101:44–61.
10. **Knaus WA, Sun X, Wagner DP.** Evaluation of prognosis from MSOF. Data from APACHE III study. Crit Care Med. 1993;21:S224.
11. **Ip HY, Abrishami A, Peng PW, Wong J, Chung F.** Prediction of postoperative pain and analgesic consumption. Anesthesiology. 2009;111:657–677. DOI: 10.1097/ALN.0b013e3181aae87a.

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