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Evaluation of Effectiveness of Treatment of Patients with Maxillofacial Region Injuries: Results of Clinical Monitoring

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Abstract.

The application of methodology of clinical information assessment of efficiency of treating patients with maxillofacial region injuries was demonstrated to allow considering multifactorial effects (both positive and negative) of the chosen rehabilitation tactics in the system of comprehensive treatment. The increase in specific contribution of immune and metabolic component to the entropy of clinical information system and, consequently, in a sequence of adaptive mechanisms at the stages of clinical monitoring was proven. Absolute entropy of clinical information system was proven to decrease as a result of comprehensive treatment of patients with maxillofacial region injuries determining 12.4% of the effectiveness of the pathogenetic correction of changes being pathognomonic for maxillofacial region injuries.



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Problem statement and analysis of the recent research

Treatment of maxillofacial region (MFR) injuries is one of the urgent tasks of maxillofacial surgery and high incidence of complications determines the need for further improvement of comprehensive treatment including the timely and adequate use of rehabilitation measures [3,12]. Preoperative, intraoperative, and postoperative periods when the state of the periodontal tissues and psychophysical recovery of a patient are crucial concerning restoration and full functional recovery on the background of morphological substrate recovery are unconventionally important in the system of comprehensive treatment of patients with MFR injuries [13]. Modern trends in clinical monitoring (CM) of patients with MFR injuries undergo profound changes due to the introduction of modern surgical technologies, methods for assessing adaptive reserves, strategies for periodontal tissues protection and rehabilitation programs into practice [8, 9]. Nonetheless, methods for evaluating effectiveness of treatment as a prerequisite for selecting individualized tactics require further improvement. The information entropy analysis (IEA) is one of the methods for evaluating dynamic, multifactorial processes, the patient's physical condition in particular; the IEA is of special relevance in case of multicomponent evaluation of CM effectiveness [10, 11, 14]. Furthermore, clinical information models for evaluating the effectiveness of treating patients with MFR injuries being known today do not include componential consideration of its elements.

The objective of the research was to test the methods of the information entropy analysis for evaluating the effectiveness of comprehensive treatment of patients with maxillofacial region injuries.

Materials and methods

General clinical information analysis was made on the basis of initial data [7, 10, 11] obtained at the stages of CM by the indicators of specific components: the patient's psychophysiological state (PPS), general clinical dental status (CDS), biophysical and immune and metabolic properties of the oral fluid (OF). To obtain clinical information indicators for each of the components the final data of the preoperative period were used; information properties of specific clinical manifestations at subsequent stages of CM were evaluated compared to the preoperative period. Such innovative approach was implemented within the limits of clinical informatics principles; it fully meets all the modern requirements for substantiating clinical trials, in the field of clinical dentistry in particular.

Dental status of 179 patients with MFR injuries was studied at the stages of their CM: at the first stage – during the preoperative period, at the second stage – at the end of the first intraoperative period; at the third stage - at the end of the second intraoperative period and at the fourth stage – during the postoperative period.

The papillary marginal alveolar (PMA) index, the simplified oral hygiene index (OHI-S) as well as hemodynamic indicator of vacuum-pressure area-based resistance of gingival capillaries (VPABR) were used to assess dental health. The study was carried out according to a standardized program of the collection, accumulation and analysis of the results. When assessing the PMA index a five-point scoring system was used (0 points – no inflammatory reaction; 1 point – mild manifestations including slight edema, no bleeding while palpating, minor gums discoloration; 2 points – moderate inflammation, red gums, gingival swelling, bleeding at the slightest touch; 3 points – severe inflammation, significant hyperaemia and edema, ulceration; 4 points - the presence of a generalized inflammatory state. Oral hygiene was assessed using the OHI-S according to Green-Vermilion Index "Oral Hygiene Index Simplified, Green-Vermillion, 1964". Such indicators as saliva flow rate, oral fluid pH, its viscosity and urease activity in the OF [4, 6, 7, 9, 14] were measured in the patients' OF at the stages of evaluating treatment efficacy, before and in different periods after treatment followed by the calculation of oral fluid buffering capacity (OFBC) and relative urease activity index. In the OF the content/activity levels of catalase (CAT) [2], superoxide dismutase (SOD) [5], reduced glutathione (RG)

[11], and secretory immunoglobulin A as well as the severity of OF dysbiosis were determined [1, 3, 5, 9]. The research was conducted according to the standardized program of the collection, accumulation and analysis of the results. Common and widely used clinical and statistical methods including quantitative anamnestic analysis, variation statistics, and probability distribution of clinical signs with study validity assessment were applied. Clinical and statistical data were processed by methods of variation statistics (arithmetical means; their errors; differences in arithmetical means were considered statistically significant according to one-tailed Student's t-test at $p < 0.05$). The method of information analysis by individual indices was used calculating h – index informative value by the formula $h = -p_i \cdot \log_2 p_i$, where p_i – the ratio of the index during treatment to its value in the preoperative period. Since during the stages of CM all the above-mentioned indicators were used the absolute entropy and its components were calculated as the sum of informative indicators.

Results and discussion

Regularities (entropy) of the quaternary system of pathognomonic clinical indices of patients with MFR injuries during the intraoperative and postoperative stages of CM were characterized by dynamic changes, both by overall index and within the individual components and clinical indicators being included into the system.

The contribution of psychophysiological component to the entropy of clinical information system of patients with MFR injuries was characterized by a significant specific gravity – at the level of (37.5±27.8) % reducing at the final stage of CM being interrelated with individual psychophysiological indicators. Thus, stable physiological reactions in the form of psychophysiological disadaptation (the first rank position), decrease in the frequency and severity of vascular-reflex dyscirculatory reactions of the formation of neuro-dental reactions in patients (the second rank position) as well as increased cerebrovascular reactivity (the third rank position) had the most significant impact on the regularity. It should be noted that the average value of specific contribution of psychophysiological component into the system entropy increased by 35.0 % (from CM-II – 5.4%, CM-IV – 4.0%), and in absolute values – by 54.0 % (from 0.676 bit to 0.676 bit). Thus, physiological component in the information system of clinical indices of patients with MFR injuries is significant being the most dynamic component of the assessment of treatment efficiency (Table 1, Fig. 1).

The contribution of immune and metabolic component to the entropy of clinical information system depending on CM stage was characterized by a significant specific gravity at the level of (29.5±32.3) % reducing at CM stages being determined by the dynamics of changes in corresponding indicators. Thus, the severity of OF dysbiosis (the first rank position), sIgA levels in the OF (the second rank position), and OF lysozyme activity (the third rank position) had the most significant impact on the regularity. It should be noted that the average value of specific contribution of immune and metabolic component to the system entropy increased by 9.5% (from CM-II – 4.2%, CM-IV – 4.6%), and in absolute values – by 4.5% (from 0.533 bit to 0.510 bit). Thus, immune and metabolic component in the information system of clinical indicators of patients with MFR injuries is the least dynamically variable component of the assessment of treatment efficiency.

The contribution of clinical and morphological component to the entropy of clinical information system of patients with maxillofacial region injuries was characterized by specific gravity - at the level of (15.0±20.1) % increasing at CM stages being determined by the dynamics of changes in corresponding indicators. Thus, the level of necessity of periodontal treatment (the contribution increased almost twofold; the first rank position), the gingival bleeding index (the

second rank position), and the PMA index (the third rank position) had the most significant impact on the regularity.

Table 1

Component structure of clinical informativeness of patient's general state at the stages of treatment of maxillofacial region injuries

Components	Clinical informative value of the index (h, bit)			Specific contribution of the index (P, %)			
	CM-II	CM-III	CM-IV	CM-II	CM-III	CM-IV	
1	2	3	4	5	6	7	
Psychophysiological	0.676	0.565	0.439	37.5	33.6	27.8	
Disadaptive type of MBE	0.553	0.519	0.482	4.4	4.4	4.4	
Changes in CVR	0.654	0.558	0.476	5.2	4.7	4.3	
VRD	0.667	0.578	0.484	5.3	4.9	4.4	
Decrease in CVR and VRD	0.621	0.513	0.469	4.9	4.4	4.2	
Stable PPR	0.848	0.541	0.071	6.7	4.6	0.6	
Transitory PPR	0.785	0.748	0.616	6.2	6.4	5.6	
Absence of PPR	0.605	0.495	0.474	4.8	4.2	4.3	
Immune and metabolic	0.533	0.506	0.510	29.5	30.1	32.3	
Relative urease activity	0.793	0.598	0.475	6.3	5.1	4.3	
OF superoxide dismutase	0.092	0.116	0.138	0.7	1.0	1.2	
OF reduced glutathione	0.061	0.174	0.265	0.5	1.5	2.4	
OF catalase	0.038	0.339	0.423	0.3	2.9	3.8	
OF sIgA	0.958	0.814	0.722	7.6	6.9	6.5	
OF lysozyme activity	0.843	0.629	0.693	6.7	5.4	6.3	
OF dysbiosis severity	0.943	0.872	0.856	7.5	7.4	7.7	
Clinical and morphological	0.380	0.415	0.445	15.0	17.7	20.1	
PMA	0.324	0.399	0.476	2.6	3.4	4.3	
OHI-S	0.288	0.324	0.341	2.3	2.8	3.1	
DMF index	0.167	0.167	0.218	1.3	1.4	2.0	
VPABR	0.933	0.915	0.873	7.4	7.8	7.9	
CPITN	0.186	0.271	0.317	1.5	2.3	2.9	
Clinical and biochemical	0.567	0.545	0.548	18.0	18.5	19.8	
OF pH	0.985	0.835	0.787	7.8	7.1	7.1	
OF viscosity	0.88	0.802	0.718	7.0	6.8	6.5	
OF buffer capacity	0.072	0.175	0.189	0.6	1.5	1.7	
Saliva flow rate	0.332	0.367	0.496	2.6	3.1	4.5	
System entropy	absolute, bit	12.628	11.749	11.059	100.0	100.0	100.0
	relative, %	100	93.0	87.6			
Correction effectiveness, %	-	7.0	12.4				

Notes:

PPR – psychophysiological reaction;

CVR – cerebrovascular reactivity;

VRD – vascular-reflex discirculation;

MBE – mitochondrial bioenergetic exchange of buccal epithelium;

CM-II – early period of clinical monitoring;

CM-III – late period of clinical monitoring;

CM-IV – remote period of clinical monitoring.

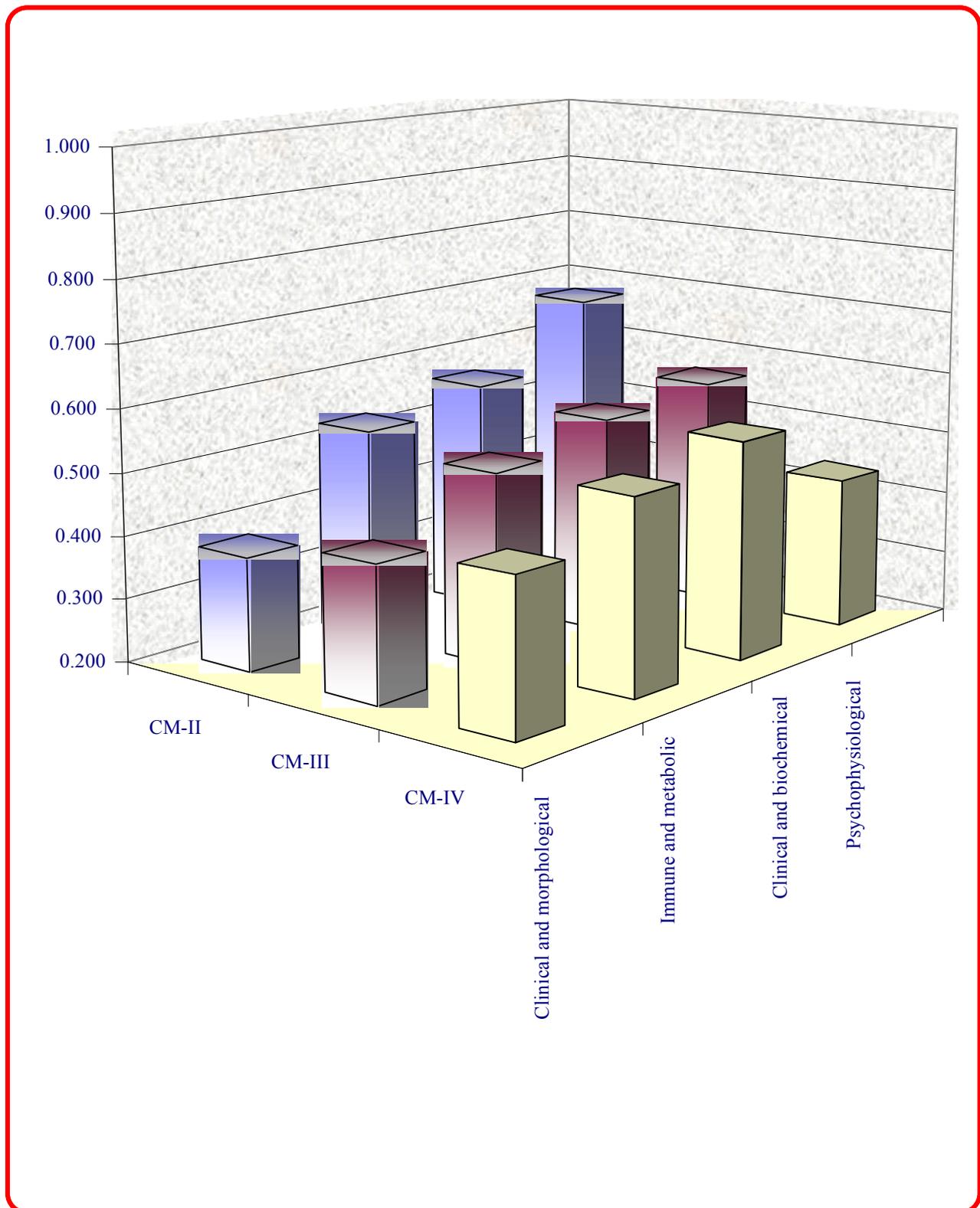


Fig. 1. Comparative clinical informativeness (bit) of components of assessing treatment efficiency at the stages of clinical monitoring of patients with maxillofacial region injuries.

It should be noted that the average value of specific contribution of clinical and morphological component to the system entropy increased by 33.3% (from CM-II – 3.0%, CM-IV – 4.0%), and in absolute values it decreased by 17.0% (from 0.380 bit to 0.445 bit). Thus, clinical and morphological component in the information system of clinical indicators of patients with MFR injuries is dynamically variable

component of the assessment of treatment efficiency and its significance in the remote postoperative period increases (Fig. 2.)

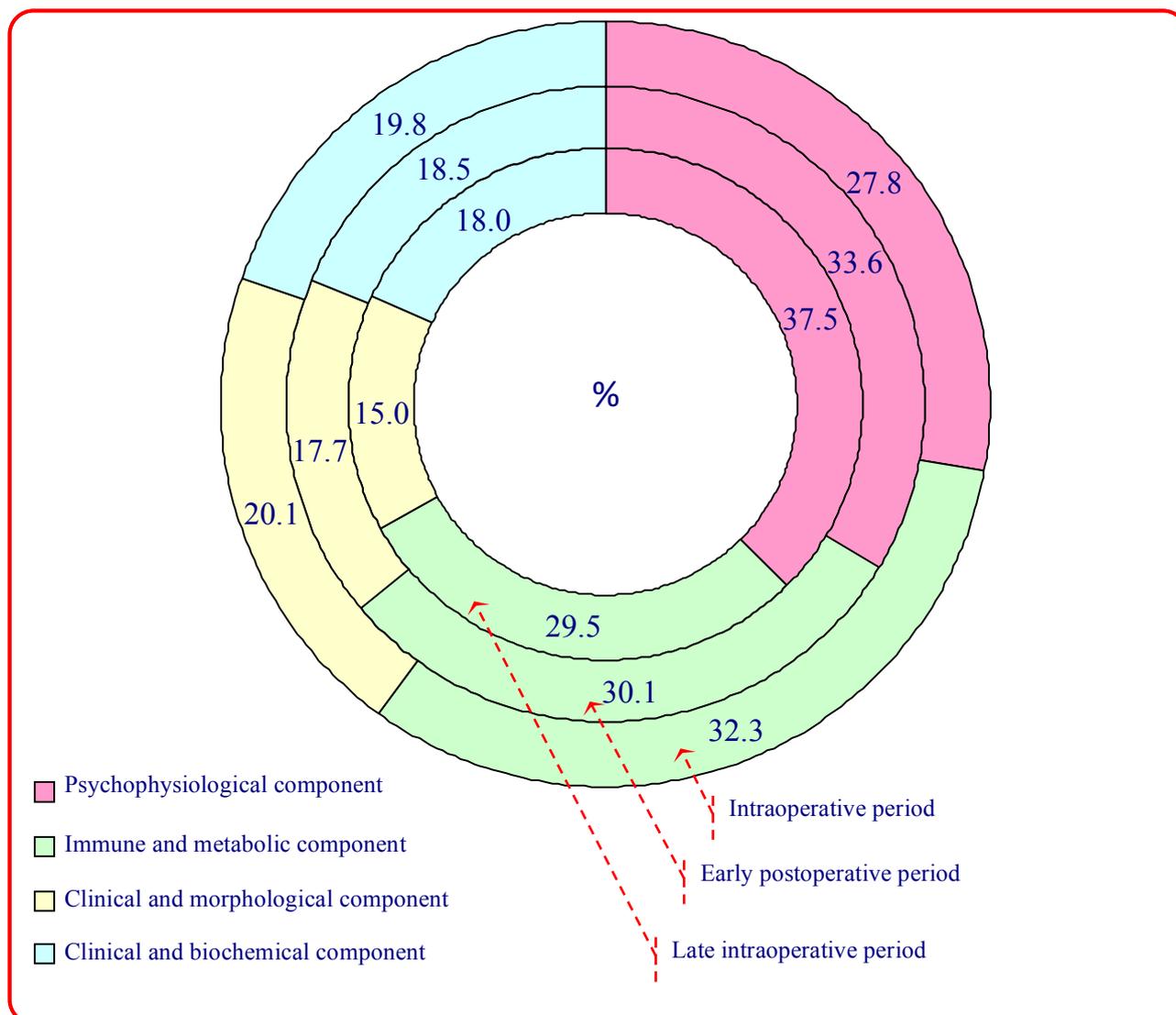


Fig 2. Component structure (%) of decreasing entropy of pathometric system of patients with maxillofacial region injuries during the intraoperative and postoperative stages

The contribution of clinical and biochemical component to the entropy of clinical information system depending on CM stage was characterized by specific gravity at the level of (18.0±19.8) % increasing at CM stages being determined by the dynamics of changes in corresponding indicators. Thus, OF viscosity index (the first rank position), OF pH (the second rank position), and OF buffer capacity (as an integral indicator of the component state; the third rank position) had the most significant impact on the regularity. It should be noted that the average value of specific contribution of clinical and morphological component to the system entropy increased by 11.1 % (from CM-II – 4.5%, CM-IV – 5.0%), and in absolute values it decreased by 3.4% (from 0.567 bit to 0.548 bit).

Conclusions

1. The application of methodology of clinical information assessment of efficiency of treating patients with MFR injuries allows us to consider multifactorial effects (both positive and negative) of the chosen rehabilitation tactics in the system of comprehensive treatment.

2. The increase in specific contribution of immune and metabolic component to the entropy of clinical information system and, consequently, in a sequence of adaptive mechanisms at the stages of clinical monitoring was proven.

3. Absolute entropy of clinical information system was proven to decrease from 12.628 bit to 11.059 bit as a result of comprehensive treatment of patients with maxillofacial region injuries reducing the disorganization of adaptive mechanisms to 87.6% and determining 12.4% of the effectiveness of the pathogenetic correction of changes being pathognomonic for maxillofacial region injuries.

Prospects for further research are related to the study of the effectiveness of individual rehabilitation in the remote period of treatment.

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