

Chapter 38

Systematic and Analytical Substantiation of the Use of Multimedia Environment for the Prevention and Rehabilitation of Various Diseases in Information System Oranta-AO

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Abstract

The paper substantiates the use of multimedia factors to improve the effectiveness of rehabilitation of patients at different stages of the disease from the standpoint of system analysis. For the first time, a methodology for forming a vector of priorities is proposed when involving specialists from different fields with a graded weight of judgments according to their professional specialization.

Keywords: arterial pressure measurement, psychomodelling, health, psycho-correction, virtual reality, rehabilitation, heart, vessels, autonomic nervous system, telehealth, functional capabilities, Information system Oranta-AO, multimedia environment, rehabilitation, system analysis

1. Introduction

The world's leading countries are moving from an industrial economy to a knowledge economy, the so-called information society. Thanks to the progress of information and communication technologies (ICT) (Martseniuk et al., 2007, 2018, 2020, 2021, 2022; Mintser et al., 2020 & Vakulenko et al., 2015, 2017 - 2022), everyone can create and accumulate information and knowledge, and freely use and share it.

Modern medicine has accumulated extensive experience in the treatment of various diseases. However, insufficient attention is paid to the prevention and rehabilitation of various diseases. This leads to a significant increase in the cost of patients' visits during the initial

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treatment (prevention is the best way to prevent diseases) and repeated visits of past patients (since the diseases were not completely cured) (Saaty et al., 1993; Selskyy et al., 2018; Romaniv et al., 2022). Over the past decades, medicine has been divided into many narrow fields with fundamental achievements in each of them. These achievements are often not available to other fields. Another achievement of the twentieth and early twenty-first centuries was the introduction of computer and multimedia technologies in various spheres of life. An important task in the modern world, and particularly in the rapidly developing field of medicine, is the joint solution of important issues by specialists from different fields to preserve and improve human health. The field of systems analysis has gained experience in solving this class of problems.

In the sources available to us, we found many research results on the use of music (Opanasiuk, 2011; Edunov, 2001; Zhavinina, 2003; Ovchinnikova, 2004; Sedunova, 2004; Smirnov, 2004 & Kirillova, 2004), images, color (Kirillova, 2004), statements, videos, Zakharyin-Ged zones (Macheret et al., 2005) for the prevention and rehabilitation of various types of diseases. However, we have not seen a comprehensive use of multimedia environments with the possibility of interactive control for prevention and rehabilitation.

To ensure objectivity in setting the task, choosing priorities, and implementing a multimedia environment for the prevention and rehabilitation of various pathologies, 6 experts from various fields were invited: a representative of the healthcare department, a general practitioner, a rehabilitation doctor, a traditional Chinese medicine doctor, and a psychologist. Since these specialists have their own specialization, they will accompany the implementation of this environment at all stages.

The information capabilities of the blood pressure measurement procedure are endless. From 2010 to 2023, the authors of the study went from an idea to the development and implementation of an information system for conducting scientific research aimed at studying, substantiating and implementing into practice methods for analyzing arterial pulsations recorded during blood pressure measurement in 2000 patients (more than 4000 AO).

In 2021, clinical trials were conducted, and the Oranta-AO information system was certified as a medical device for implementation in various fields of medicine, rehabilitation, sports, education, in a telediagnostic information system and tele-rehabilitation with feedback.

The results of the research are reflected in publications (Selskyy et al., 2018; Romaniv et al., 2022; Martseniuk et al., 2007, 2018, 2020, 2021, 2022; Mintser et al., 2020 & Vakulenko et al., 2015, 2017 - 2022) and in sections of the monograph *Arterial oscillography: New capabilities of the blood pressure monitor with the Oranta-AO information system* (Vakulenko D. et al., Chapter 1-43, 2023). This Chapter presents a fragment of the results of our latest research.

2. Objective

To develop a methodology for forming a vector of priorities when involving specialists from different fields with grading the weight of judgments according to professional specialization and to assess the feasibility of using the multimedia environment in carrying out preventive measures at different stages of rehabilitation.

To solve this problem, we will use the approaches described in (Saaty et al., 1993 & Kifer et al., 2019) and propose approaches for solving problems in this class.

3. Results

3.1. Building a Hierarchy

Let's ask each specialist to describe a list of factors that they think are important to include in a multimedia environment.

General practitioner: Primary and secondary disease prevention, timely diagnosis and treatment, healthy lifestyle, rational drug therapy.

Rehabilitation specialist: physical exercises, natural and preformed physical factors, hardening, mechanotherapy, occupational therapy, motor activity, concentration of imagination on imaginary movements, controlled breathing, volitional regulation of inhalation and exhalation duration and pauses, aromatherapy, herbal medicine, healthy lifestyle, rational nutrition, psychohygiene, Zakharin-Ged zones (ZZG).

Psychologist: art therapy, bioenergetic analysis, hypnosis, game therapy, kinesiology, client-centered therapy, cognitive psychotherapy, personality-oriented (reconstructive) psychotherapy, neuro-linguistic programming (NLP), positive psychotherapy, process-oriented psychotherapy, rational-emotional-behavioral therapy, fairy tale therapy, body-oriented psychotherapy, emotional imagery therapy, etc.), using the maximum number of channels of influence to achieve health.

Representative of the health care department: ensuring conditions for disease prevention, rehabilitation of patients, activities of specialists in various fields of medicine and reducing health care costs, reducing the costs of treatment and rehabilitation for the state and employers.

Traditional Chinese Medicine (TCM) doctor: the concept of Wu-Xing, the concept of Yin-Yang, the doctrine of the main organs and the main elements of the body's internal environment, the doctrine of energy and meridians.

Patient: More comfortable conditions for the patient (MCCP), optimal patient time expenditure (OPT), reduced costs for the patient for treatment and rehabilitation (RR), maximum integration into the patient's life (MIP).

The factors (forces) proposed by the experts that influence the overall goal from the point of view of all the above-mentioned specialists are: primary prevention of diseases, multimedia environment, images, Zakharin-Ged zones, U-Sin concept, and patient's stay in the hospital.

Thus, we come to the decomposition of the topic of our study on 5 levels of the hierarchy of Figure 1:

Level 1: Overall objective: Increase the effectiveness of rehabilitation (IER).

Level 2: (Forces): preventive disease prevention (PDP), multimedia environment (ME), images (I), Zakharin-Ged zones (ZZG), U-Sin concept (USC), progression of pathological processes (PP).

Level 3: (Actors): rehabilitation therapist (R), psychologist (Ps), TCM doctor (TCMD), representative of the health department (RHD), patient (P).

Level 4: (Objectives): More comfortable conditions for the patient (MCCP), optimal patient time expenditure (OTE), use of the maximum number of channels of influence to

achieve health (OCIP), reduction of costs for the patient for treatment and rehabilitation (RCT), reduction of state costs for treatment and rehabilitation (RSC), reduction of employers' costs for hospital expenses (REC), maximum integration into the patient's life (MIP).

Level 5: (Scenarios): Rehabilitation interventions with the use of multimedia factors (R-With-M), rehabilitation interventions without the use of multimedia factors (R-Without-M).

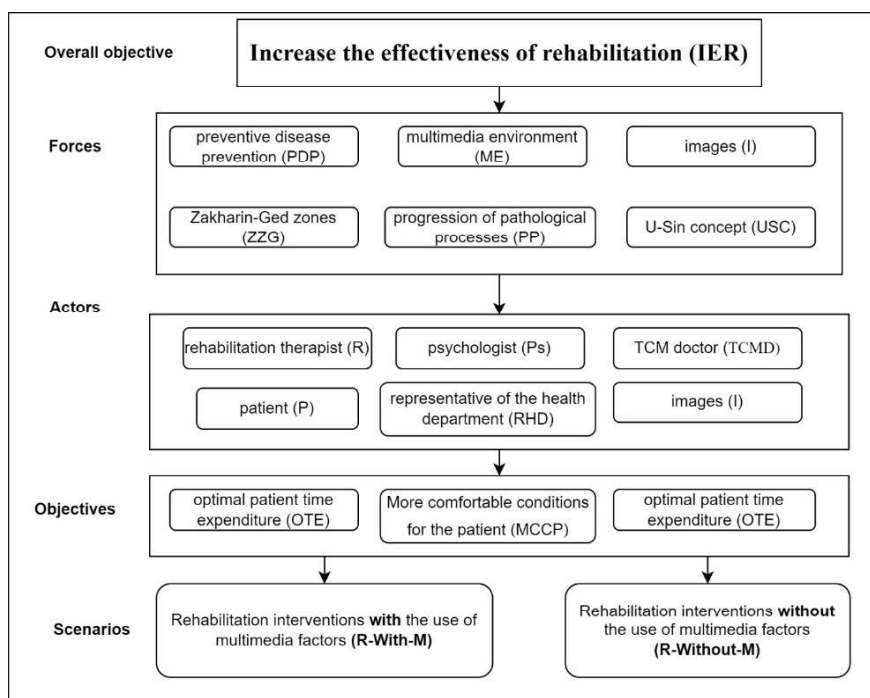


Figure 1. Hierarchical model of the task of justifying the use of multimedia environment in the process of different stages of patient rehabilitation.

3.2. Weighting of Experts' Opinions According to Their Professionalism

Each Expert has an area of expertise. Accordingly, it will have a different weight when answering each group of questions. Answers to questions from the expert's field will have a weight of 1, answers to questions from a related field - 0.7, answers to questions from a remote field - 0.3, and answers to questions from an unknown field for experts will have a weight of 0.1.

The degree of proficiency in the studied indicators at the second level will have the following distribution

	P	Ps.	TCMD	POS	Pa.
PPP	1	1	1	1	0,7
MS	1	1	0,7	0,7	0,7
Zo	0,7	1	0,7	0,7	0,7
ZZG	0,5	0,75	0,2	0,7	0,5
CU	0,7	0,75	1	0,5	0,5
PL	1	1	1	0,7	0,5

Applying to the above hierarchical model the method of hierarchy analysis based on pairwise comparison matrices obtained in (Flower et al., 2016), we obtain a Matrix of priorities for the use of multimedia factors to achieve the overall goal of increasing the effectiveness of patient rehabilitation, which will look like this for different participants in the rehabilitation process.

For a more balanced assessment, we suggest that the Actors answer questions such as “How important is the use of multimedia factors at the stage of preventive rehabilitation compared to the progression of pathological processes in increasing the effectiveness of rehabilitation?”

Rehabilitation therapist (R)						
	PPP	MS	Zo	ZZG	CU	PL
PPP	1	3	1.7	3.75	4.25	5
MS	0.33	1	2.1	1.5	2.55	3
Zo	2	0.23	1	0.19	0.18	1.7
ZZG	0.15	0.16	1.8	1	0.19	2.25
CU	0.17	2	2.8	1.8	1	2.55
PL	0.2	0.33	0.42	0.24	0.28	1

Patient (P).						
	PPP	MS	Zo	ZZG	CU	PL
PPP	1	4.9	1.4	3	3	3
MS	3.5	1	2.1	1.8	1.8	1.8
Zo	1.4	0.23	1	0.20	0.15	1.2
ZZG	0.12	0.20	1.8	1	0.17	1.5
CU	0.12	1.2	2.4	1.5	1	1.5
PL	0.12	0.20	0.3	0.17	0.17	1

Psychologist (Ps)						
	PPP	MS	Zo	ZZG	CU	PL
PPP	1	7	2	4.60	4.60	5
MS	5	1	3	2.76	2.76	3
Zo	2	0.33	1	0.30	0.23	2
ZZG	0.17	0.30	2.76	1	0.25	2.76
CU	0.18	1.84	3.68	2.25	1	2.76
PL	0.20	0.33	0.50	0.30	0.30	1

Traditional Chinese medicine doctor (TCM)						
	PPP	MS	Zo	ZZG	CU	PL
PPP	1	5.95	1.7	4.25	5	5
MS	4.25	1	2.1	2.1	2.55	2.55
Zo	1.7	0.23	1	0.23	0.21	1.7
ZZG	0.17	0.23	2.1	1	0.28	2.55
CU	0.2	1.7	3.4	2.55	1	3
PL	0.2	0.28	0.43	0.28	0.33	1

Representative of the health care department (HCD)						
	PPP	MS	Zo	ZZG	CU	PL
PPP	1	5.95	1.7	4.25	3.75	4.25
MS	4.25	1	2.1	2.55	1.8	2.1
Zo	1.7	0.21	1	0.23	0.15	1.4
ZZG	0.17	0.23	2.1	1	0.19	2.1
CU	0.15	1.2	2.4	1.8	1	1.8
PL	0.17	0.23	0.35	0.23	0.20	1

In this case, the vector of priorities will be as follows.

	P	Ps.	TCMD	POS	Pa.
PPP	0.3538	0.3498	0.3622	0.3751	0.3473
MS	0.1983	0.2533	0.2301	0.2477	0.2557
Zo	0.1004	0.0848	0.0803	0.0842	0.089
ZZG	0.1053	0.1047	0.1001	0.1041	0.1019
CU	0.1953	0.1693	0.1874	0.1499	0.1645
PL	0.047	0.0381	0.0398	0.0391	0.0415

Further answers to the questions will be given by the psychologist (PS) because the weight of his expertise in the issues under study is the greatest compared to other research participants.

Answering questions such as “How much more important is the influence of a psychologist compared to a representative of the health care department on preventive health care?”

For preventive health care (PHC)					
	P	Ps.	TCMD	POS	Pa.
P	1	3	2	5	0,3
Ps.	0,3	1	3	5	0,3
TCMD	0,5	0,3	1	3	0,3
POS	0,2	0,2	0,3	1	0,2
Pa.	3	3	3	5	1

In the use of multimedia environment in the process of rehabilitation (MS)					
	P	Ps.	TCMD	POS	Pa.
P	1	3	1	5	0,25
Ps.	0,3	1	3	5	0,3
TCMD	1	0,2	1	5	0,3
POS	0,2	0,2	0,2	1	0,2
Pa.	4	3	3	5	1

In the use of images (Zo)					
	P	Ps.	TCMD	POS	Pa.
P	1	0,3	1	5	0,5
Ps.	3	1	3	5	3
TCMD	1	0,3	1	5	0,3
POS	0,2	0,2	0,2	1	0,2
Pa.	2	0,3	3	5	1

In the use of the Zakhar'in-Ged zones (ZZG)					
	P	Ps.	TCMD	POS	Pa.
P	1	0,3	1	5	4
Ps.	3	1	0,3	3	3
TCMD	1	3	1	5	3
POS	0,2	0,3	0,2	1	3
Pa.	0,25	0,3	0,3	0,3	1

In the use of the U-Sing concept (CU)					
	P	Ps.	TCMD	POS	Pa.
P	1	0,3	0,3	3	4
Ps.	3	1	0,3	3	3
TCMD	3	3	1	5	5
POS	0,3	0,3	0,2	1	3
Pa.	0,25	0,3	0,2	0,3	1

In the progression of pathological processes (PP)					
	P	Ps	TCMD	POS	Pa.
P	1	1	0,5	2	1
Ps.	1	1	1	1	1
TCMD	2	1	1	0,5	1
POS	0,5	1	2	1	0,5
Pa.	1	1	1	2	1

In this case, the priority matrix, which consists of normalized vectors, has the form.

P	0.26	0.23	0.18	0.27	0.20	0.20
Ps.	0.22	0.21	0.34	0.25	0.24	0.19
TCMD	0.12	0.17	0.17	0.31	0.40	0.20
POS	0.04	0.04	0.04	0.11	0.11	0.19
Pa.	0.35	0.35	0.26	0.05	0.05	0.22

Answering the question “How important is the optimal time spent on ensuring a high level of health for a patient”

For a rehabilitation therapist (R)							
	MCCP	OPTE	OCIP	WIP	ZVD	ZVR	BETWEEN
MCCP	1	2	0,5	4	3	0,5	1
OPTE	0,5	1	5	4	4	4	2
OCIP	2	0,2	1	4	3	3	1
WIP	0,25	0,25	0,25	1	6	5	3
ZVD	0,33	0,25	0,3	0,15	1	1	0,2
ZVR	2	0,25	0,3	0,2	1	1	0,3
BETWEEN	1	0,5	1	0,3	5	3	1

For a psychologist (P)							
	MCCP	OPTE	OCIP	WIP	ZVD	ZVR	BETWEEN
MCCP	1	2	0,5	4	3	0,5	1
OPTE	0,5	1	5	4	4	4	2
OCIP	2	0,2	1	4	3	3	1
WIP	0,25	0,25	0,25	1	6	5	3
ZVD	0,33	0,25	0,3	0,15	1	1	0,2
ZVR	2	0,25	0,3	0,2	1	1	0,3
BETWEEN	1	0,5	1	0,3	5	3	1

For a doctor of traditional Chinese medicine (TCM)							
	MCCP	OPTE	OCIP	WIP	ZVD	ZVR	BETWEEN
MCCP	1	0,5	0,5	4	3	0,5	1
OPTE	2	1	5	4	4	4	2
OCIP	2	0,2	1	4	3	3	1
WIP	0,25	0,25	0,25	1	6	5	3
ZVD	0,33	0,25	0,3	0,15	1	1	0,2
ZVR	2	0,25	0,3	0,2	1	1	0,3
BETWEEN	1	0,5	1	0,3	5	3	1

For a representative of the security department health (POC)							
	MCCP	OPTE	OCIP	WIP	ZVD	ZVR	BETWEEN
MCCP	1	0,5	0,3	4	3	0,5	1
OPTE	2	1	5	4	4	4	2
OCIP	3	0,2	1	4	3	3	1
WIP	0,25	0,25	0,25	1	6	5	3
ZVD	0,33	0,25	0,3	0,15	1	1	0,2
ZVR	2	0,25	0,3	0,2	1	1	0,3
BETWEEN	1	0,5	1	0,3	5	3	1

For the Patient (P)							
	MCCP	OPTE	OCIP	WIP	ZVD	ZVR	BETWEEN
MCCP	1	0,5	0,3	0,25	3	0,5	1
OPTE	2	1	5	0,5	4	4	2
OCIP	3	0,2	1	4	3	3	1
WIP	4	2	0,25	1	6	5	3
ZVD	0,33	0,25	0,3	0,15	1	1	0,2
ZVR	2	0,25	0,3	0,2	1	1	0,3
BETWEEN	1	0,5	1	0,3	5	3	1

In this case, the priority matrix looks like this

MCCP	0.15	0.13	0.12	0.08	0.05
OPTE	0.25	0.27	0.26	0.23	0.21
OCIP	0.17	0.17	0.18	0.19	0.17
WIP	0.19	0.19	0.19	0.26	0.23
ZVD	0.04	0.04	0.04	0.04	0.13
ZVR	0.06	0.06	0.06	0.06	0.06
BETWEEN	0.14	0.14	0.14	0.14	0.16

Answering questions such as “How important is a multimedia environment for effective rehabilitation”

For more comfortable conditions for patient (MCCP)		
	R-WITH-M	R-WITHOUT-M
R-WITH-M	1	5
R-WITHOUT-M	0,2	1

To optimize the patient's time spent on preventive care		
	R-WITH-M	R-WITHOUT-M
R-WITH-M	1	3
R-WITHOUT-M	0,33	1

To use the maximum number of health promotion channels (HPCs)		
	R-WITH-M	R-WITHOUT-M
R-WITH-M	1	2
R-WITHOUT-M	0,5	1

To reduce the cost of treatment and rehabilitation for the patient		
	R-WITH-M	R-WITHOUT-M
R-WITH-M	1	5
R-WITHOUT-M	0,2	1

To reduce the state's expenditures on hospital costs		
	R-WITH-M	R-WITHOUT-M
R-WITH-M	1	3
R-WITHOUT-M	0,33	1

To reduce employers' sick leave expenses (SLE)		
	R-WITH-M	R-WITHOUT-M
R-WITH-M	1	3
R-WITHOUT-M	0,33	1

In this case, the priority matrix at the fourth level has the following form (in normal form):

	MCCP	OPTE	OCIP	WIP	ZVD	ZVR	BETWEEN
R-WITH-M	0,83	0,75	0,67	0,83	0,75	0,75	0,75
R-WITHOUT-M	0,17	0,25	0,33	0,17	0,25	0,25	0,25

It should be noted that the consistency index of all matrices is less than 0.1, which allows us to apply the procedure of the hierarchy analysis method.

According to the method of hierarchy analysis, the priority vector of the task of choosing the feasibility of using multimedia compositions in the process of preventive rehabilitation is calculated as the product of previously obtained matrices and priority vectors:

R-WITH-M	0,76
R-WITHOUT-M	0,24

Therefore, the utilization of multimedia compositions in the rehabilitation process will hold greater significance.

3.3. Results and Discussion

Using the results of building a matrix of priorities for improving the effectiveness of patient rehabilitation, we come to the following principles. Primary prevention of diseases will increase the level of human health. The integrated use of various multimedia factors will be able to use the maximum number of receptors to increase the effectiveness of various stages of rehabilitation. It will provide more comfortable conditions for the patient, optimal patient time, reduce the costs of treatment and rehabilitation for the patient, employers and the state, and help to integrate innovative health technologies into the patient's life to the maximum extent possible. The multimedia environment provides the ability to select the number of multimedia transmission channels, the voice of the announcer (male or female), the health improvement methods used by the user during rehabilitation and without their use, the groups of diseases targeted by the multimedia environment, and other features.

Conclusion

In today's fast-paced world, the demands on human health are substantial. Rehabilitation, occurring at different stages, plays a crucial role in maintaining it. However, the potential of

multimedia resources and media remains underutilized when it comes to citizen health and rehabilitation. By establishing a hierarchy of rehabilitation priorities, the significance of incorporating multimedia elements to enhance rehabilitation effectiveness has become evident.

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