On insomnia analysis using methods of artificial intelligence

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ABSTRACT

Insomnia generally is defined as a subjective report of difficulty falling sleep, difficulty staying asleep, early awakening, or nonrestorative sleep. It is one of the most common health complaints among the general population. in this paper we try to find relationships between different insomnia cases and predisposing, precipitating, and perpetuating factors following by pharmacological treatment.

Keywords: insomnia, clustering, insomnia profiles

1. INTRODUCTION

In pathogenesis of insomnia predisposing, precipitating, and perpetuating factors play an important role. Predisposing factors include arousal-prone personality, elevated baseline physiologic arousal, rigid circadian system, and other individual characteristics that make one vulnerable to or set the stage for the development of insomnia. Precipitating factors are the events or conditions that trigger the insomnia. Common examples include life stressors and change of sleep-wake schedule. The perpetuating factors, such as conditioning of bedtime cues with arousal, maladaptive sleep-wake habits and worries over sleeplessness, then should become the focus of the treatment.

In this paper we search for some interesting relationships between insomnia kinds[1] and the mentioned factors.

2. OBLIGATORY PRINCIPLES IN MODERN INSOMNIA TREATMENT

In line with obligatory principles, I strongly believe that insomnia treatment should begin at the earliest possible stage of the disorder, ideally soon after the first symptoms appear, are recognised and a diagnosis is set. An immediately began treatment allows to eliminate factors causing sleep problems before they develop into persisting sleep disorders.

The focus of the chapter's introduction: contemporary requirements for optimal insomnia treatment setting the sleep medicine as a multi-disciplinary science and practice operating in open relation with neurology, psychiatry and general medicine "On-time Treatment" and "Late treatment"/ case histories.

2.1 Non-pharmacological insomnia treatment

Non-pharmacological treatment can provide effective solutions for sleep disorders. Non-pharmacological methods are very often easy to implement since they require from patients good recognition of their life quality. Very often patients complaining about not getting enough restful sleep can help themselves making basic changes in their sleep hygiene. While it is not enough for many people suffering insomnia only to change their habits, sleep hygiene rules should be adopted by everyone, regardless the level of insomnia problem. Implementation of sleep hygiene may be or needs to be followed by other alternatives to medications such as stimulous control, sleep restriction, relaxation techniques, stress reduction classes and biofeedback. Almost all of them, with exception to biofeedback, can be done by patients alone at their homes and everything they require is reading or listening and adopting new rules. Some techniques will give better effects when learned with therapists or trainers. Cognitive

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behavioral therapy for insomnia is more demanding in practice since it requires multiple sessions with a therapist, though its efficiency, based on scientific research, exceeds results of any other technique used by patients alone as well as it is more effective than medications.

Focus of this part of the chapter: Sleep hygiene rules, stimulous control, sleep restriction, relaxation techniques, biofeedback - description CBT: gaining patient commitment, setting realistic goals, thoughts-modifying, monitoring patient's own practice of CBT techniques CBT workshop at Sleep Disorders Clinic (Dept. of Psychiatry Medical University of Warsaw) - case history.

2.2 Medications for insomnia treatment

Pharmacological treatments, followed by a consultation with a doctor and controlled by him, are generally safe and effective for short-term use. As the choice of medications aimed at treating sleep disorders is endless, a responsible decision has to be made in the face of possible health risks such as dependence and possible side effects. In addition to prescription medications, over-the-counter drugs are quite commonly used to manage one-night sleep, with no evidence provided on their efficiency in long-term use. The most commonly used sleep pills also include benzodiazepine receptor agonists and new generation non-benzodiazepine hypnotics such as – zolpidem, zopiklon i zaleplon. Growing popularity of antidepressants in medical insomnia treatment medical grounds and concerns in pharmaceutical insomnia treatment research on effects of pharmaceutical insomnia treatment.

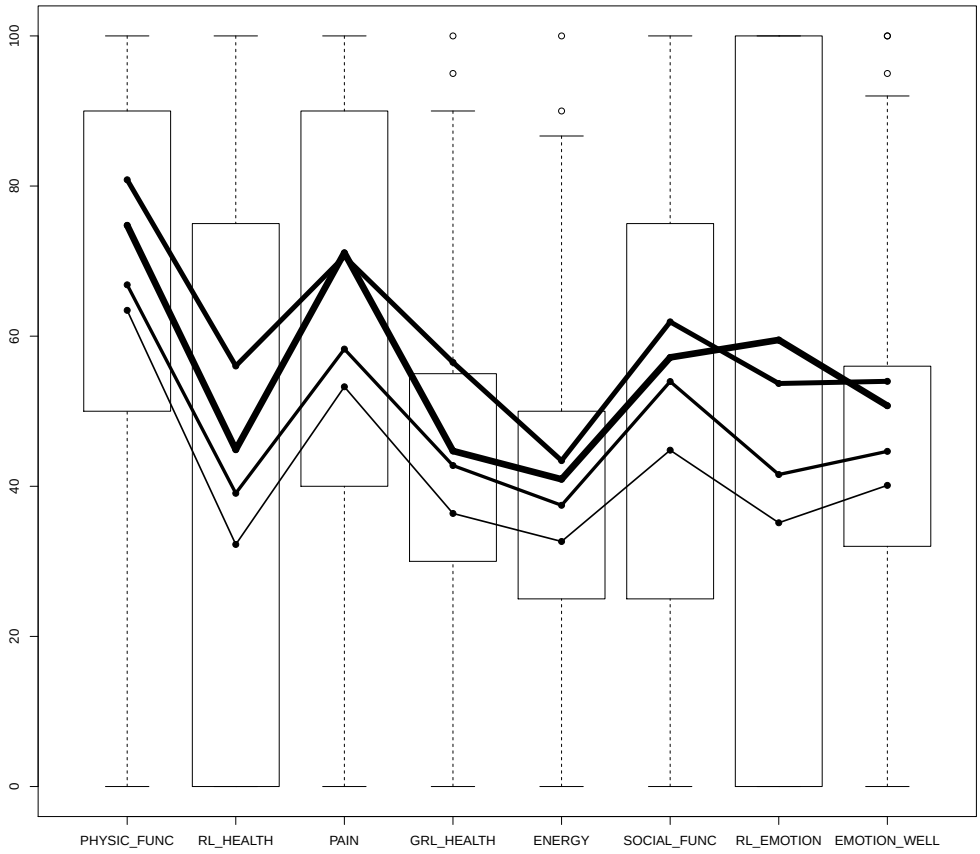

Figure 1. The four main groups of the level II, I insomnia and new insomnia two kinds

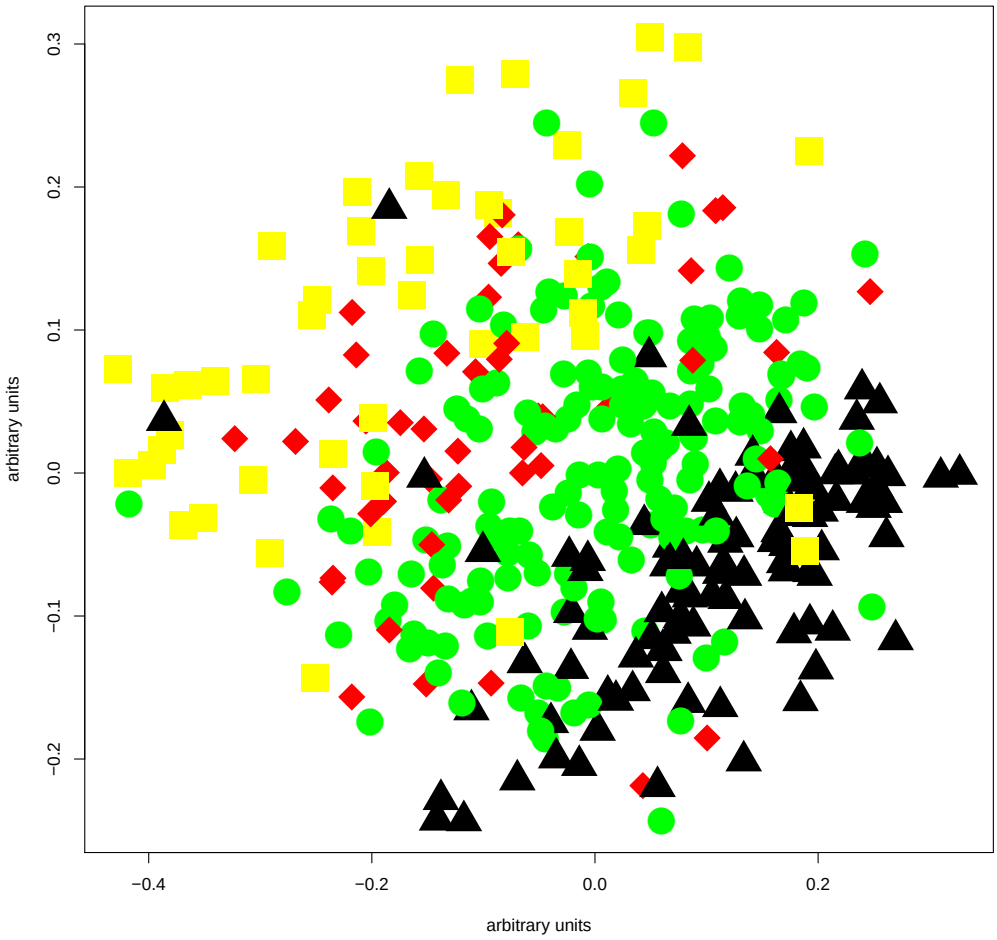

Figure 2. Multidimensional scaling plot of patients: black triangles - patients from the cluster no 1 with severe insomnia are dominating on the right, big cirles - the cluster no 2, squares - 3, rhombs - 4

3. DATA RETRIEVAL METHODOLOGY

Data Mining is the analysis of often large observational data sets to discover unsuspected relationships and to summarize the data in novel ways that are both understandable and useful to the data owner.[2] It is an all-purpose toolbox, which contains such methods that allow of revealing new patterns and dependencies in researched data among them classical ones: data clustering and multidimensional scaling (MDS).

Data clustering is the unsupervised clustering of patterns e.g. observations, data items, feature vectors into groups, so the data in each subset share common trait like proximity according to some defined distance measure.[3] In general, a grouping is method to show similar objects near in features space.

In fuzzy clustering (fuzzy analysis clustering), each point has a degree of belonging to clusters, as in fuzzy logic, rather than belonging completely to just one cluster. Thus, points on the edge of a cluster, may be in the cluster to a lesser degree than points in the center of cluster. For each point its coefficients of being in the clusters are computed. The minimum is a local minimum and the results depend on the initial choice of weights.

Another method of classification visualization only with the help of raw data and special distance measures between examined children – points in the multivariable space is multidimensional scaling (MDS). Such the multidimensional space can be visualized in two "artificial" dimensions after scaling based e.g. on the general

Table 1. The value table of four clusters

	0	1	2	3
falling asleep in the cluster no 1	0	0	0	107
night awakening in the cluster no 1	0	0	0	107
morning awakening in the cluster no 1	0	0	0	107
falling asleep in the cluster no 2	0	0	87	84
night awakening in the cluster no 2	4	21	100	46
morning awakening in the cluster no 2	18	26	98	29
falling asleep in the cluster no 3	38	5	6	0
night awakening in the cluster no 3	10	23	15	1
morning awakening in the cluster no 3	32	17	0	0
falling asleep in the cluster no 4	20	30	0	0
night awakening in the cluster no 4	0	6	24	20
morning awakening in the cluster no 4	1	11	26	12

Table 2. ANOVA Table of four clusters

		1	2	3	4	sd/dmean	p_anova	sd
3	GRL_HEALTH	36.38	42.77	56.51	44.70	2.33	0.0000006	21.17
1	EMOTION_WELL	40.12	44.65	53.98	50.73	3.17	0.0000533	19.23
5	PHYSIC_FUNC	63.44	66.84	80.84	74.77	3.31	0.0001589	25.27
8	SOCIAL_FUNC	44.81	53.96	61.91	57.17	3.33	0.0008490	27.17
7	RL_HEALTH	32.25	39.07	56.03	44.88	3.49	0.0046405	39.77
2	ENERGY	32.65	37.47	43.42	40.93	3.66	0.0012699	17.61
6	RL_EMOTION	35.14	41.57	53.70	59.50	3.85	0.0014184	41.20
4	PAIN	53.26	58.28	70.62	71.11	16.76	0.0001302	29.11

dissimilarity coefficient of Gower[4] and Kruskal nonmetric MDS,[5] where each point dissimilarities with other ones are transferred into two dimensional spacial distances between them. An another dissimilarities measure is Manhattan measure equal to the sum of absolute differences for each variable. A more common measure is Euclidean distance, computed by finding the square of the distance between each variable, summing the squares, and finding the square root of that sum. A property of the Euclidean space is that distances are symmetric (the distance from object A to B is the same as the distance from B to A). MDS participates in the new emphasis on methods of data analysis which are exploratory. Its value is not helping to measure something accurately, nor in determining how accurate a measurement is. Instead, it helps provide insight into relationships among the objects of the domain.[5]

The solution space can be also visualized in two dimensions after scaling based e.g. on principle component analysis (PCA), which transform real dimensions to artificial ones, where first ones have the most correlations within and the rest of dimensions may be omitted with small resulting errors.

4. DATA RETRIEVAL RESULTS

Data sets were obtained from 377 patients of Outpatient Sleep Disorders Clinic at WUM at the beggining of their therapy. It is obligatory for every patient to fill all necessary surveys at the treatment beginning, but only 377 patients full data was typed into computer database to test new ideas.

Data with three Athens Insomnia Scale (AIS)[1,6,7] answers with four values: 0 - no problem,1,2,3: falling asleep difficulties, awakenings throughout the night, waking up too early in the morning was used for clustering. For clustering the best procedure[1] from R environment[8] was Fuzzy Analysis Clustering with squared dissimilarity input matrix (function fanny). The 5 groups were obtained with separated life quality profiles (SF-36)[1,9,10] and we added a new insomnia kind with only awakenings problems (groups no 4 and 5) to the level I and II insomnia.[11] Our level II insomnia patients have severe, very high problems with all three AIS problems (the group no 1). Our level I insomnia people have more than medium and medium problems with falling asleep and awakenings (joint groups no 2 and 3).

Table 3. The general survey parameter values for four groups

the parameter name	0	1	the parameter name	0	1
constant_fear in severe ins.	55	52	eatatnight in severe ins.	88	19
constant_fear in medium ins.	103	68	eatatnight in medium ins.	136	35
constant_fear in evenin ins.	40	9	eatatnight in evenin ins.	45	4
constant_fear in wakeup ins.	34	16	eatatnight in wakeup ins.	42	8
fatigue_interest in severe ins.	60	47	rest_lack in severe ins.	16	91
fatigue_interest in medium ins.	119	52	rest_lack in medium ins.	28	143
fatigue_interest in evenin ins.	40	9	rest_lack in evenin ins.	18	31
fatigue_interest in wakeup ins.	39	11	rest_lack in wakeup ins.	13	37
energy_lack in severe ins.	33	74	focus_lack in severe ins.	36	71
energy_lack in medium ins.	65	106	focus_lack in medium ins.	89	82
energy_lack in evenin ins.	22	27	focus_lack in evenin ins.	19	30
energy_lack in wakeup ins.	30	20	focus_lack in wakeup ins.	22	28
fatiguability in severe ins.	26	81	inextricmorning in severe ins.	95	12
fatiguability in medium ins.	72	99	inextricmorning in medium ins.	136	35
fatiguability in evenin ins.	22	27	inextricmorning in evenin ins.	33	16
fatiguability in wakeup ins.	27	23	inextricmorning in wakeup ins.	43	7
despondency in severe ins.	50	57	inextricatnight in severe ins.	97	10
despondency in medium ins.	99	72	inextricatnight in medium ins.	148	23
despondency in evenin ins.	35	14	inextricatnight in evenin ins.	39	10
despondency in wakeup ins.	30	20	inextricatnight in wakeup ins.	38	12
irritability in severe ins.	29	78	snore in severe ins.	80	27
irritability in medium ins.	66	105	snore in medium ins.	111	60
irritability in evenin ins.	23	26	snore in evenin ins.	24	25
irritability in wakeup ins.	21	29	snore in wakeup ins.	26	24
alcohol in severe ins.	96	11	daysleep in severe ins.	94	13
alcohol in medium ins.	163	8	daysleep in medium ins.	127	43
alcohol in evenin ins.	49	0	daysleep in evenin ins.	29	20
alcohol in wakeup ins.	48	2	daysleep in wakeup ins.	31	19

Table 4. The next parameter values of four clusters

	0	1	2	3
daysleepiness in severe ins.	88	11	8	0
daysleepiness in medium ins.	146	17	6	2
daysleepiness in evenin ins.	30	8	5	6
daysleepiness in wakeup ins.	32	12	5	1
dizzy in severe ins.	41	41	22	3
dizzy in medium ins.	61	74	32	4
dizzy in evenin ins.	22	18	8	1
dizzy in wakeup ins.	25	19	5	1

Table 5. The patient number under the given treatment in each cluster

	1	2	3	4
pharmacological treatment	55	107	15	25
non-pharmacological treatment	52	64	34	25

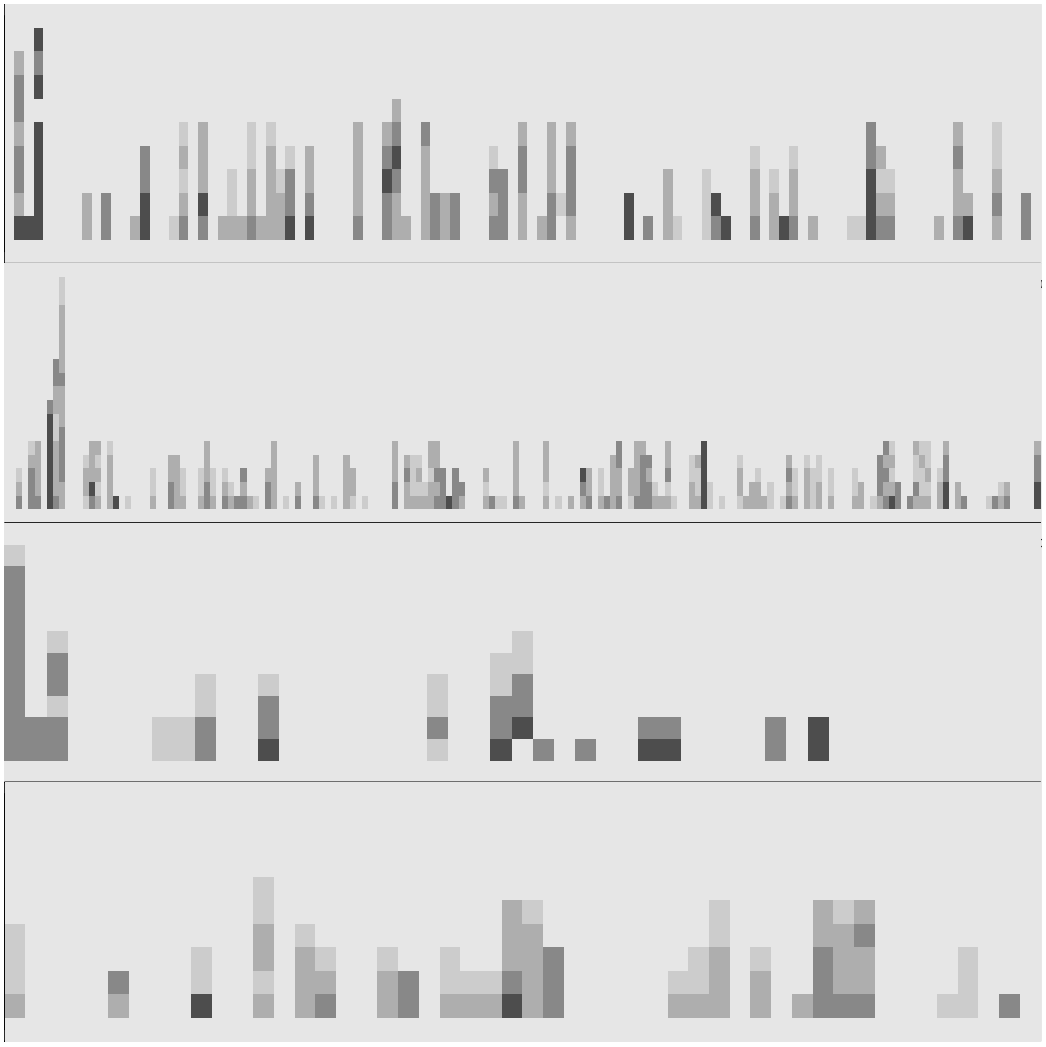

Figure 3. Plot of the pharmacological treatment progress in our four groups: from top no 1, 2, 3, 4

However, in this paper the 4 clusters were used and visualised with Kruskal isoMDS and Gower dissimilarities in function daisy in Fig. 2. All four clusters were found in two approaches in our previous work,[1] but this is their new union: the first two clusters are the level II and I insomnia, the last two groups came from the found 5 groups[1] and forms together the new insomnia kind (one of them - now number 3 - with light nigth awakenings problems is similar to the level I and II insomnia - the same line shape put higher in SF-36 profiles, the another one with medium awakenings problems has an unusual outline as is seen in Fig. 1).

We search for some extraordinary and remarkable relashionships between patients profile and further pharmacological treatment, which helps in chronic insomnia diagnosis, so we decided to choose such the interesting cluster combination.

The value sums of three AIS answers are put in Table 1. In every cluster means of parameters were computed and for all clusters their statistical significance (panova - p value) was determined with a use of anova tests for each parameter. Finally, standard deviation (sd) for every attribute was calculated as is provided in Table 2. The column called sd/dmean contains means of standard deviations divided by substracted neighbouring cluster means. The table is ordered by the mentioned column values and quality of life parameters in the first rows are better divided into separated groups. In Table 2 only PAIN SF-36 parameter has the higner sd/dmean value and is not correctly separated in clusters (groups no 3 and 4 has almost the same mean PAIN values).

Thus, for the mentioned properly clustered four groups (with severe, medium, light in the evening, awakenings insomnias) a general survey parameters were carefully examined. Several parameters were equally scattered among these clusters e.g. people able to faint from sleepless, with somnabulism, after accidents - up to 25% equally in all clusters; patients with a coffee drinking habit, with hindering problems after sleep, with nightmares, with leg movements during their sleep, with legs or hands tingling - up to 50% equally in all clusters. However, the other several parameters seen in Tables. 3 and 4 have more influence on the first and second clusters e.g. people with fatigue of interest, a lack of energy and rest, with fatiguability, despondency, irritability, heavy dizzy after wakeup, with alcohol drinking before sleep, , who eat at night have more often the severe insomnia problems.

There are few parameters which positive values dominate in last two clusters e.g. patients who sleep or feel sleepiness during a day, who snore, and have an inextricable sleepiness in the night are in the majority in our new separated last two groups. Poor concentration or focus dominates in severe and light evening insomnia groups. People from medium and light evening insomnia clusters have an inextricable sleepiness in the morning.

Pharmacological treatment is the most often used in the medium insomnia group, in the second place are the severe and wakeup groups, as is seen in Table 5, which was created based on patients opinions about their health (their lack or presence during the second visit). Progress of the treatment based on patient opinions is visualized in Fig. 3. One "square" is just a one visit and one patient opinion about health in a range from 0 to 5. The more grey, the worse health patients have. The longest treatments with opinions or the largest visit numbers above 6 are in the medium insomnia group despite far more lower opinion means.

5. SUMMARY

We obtained different sets of general survey parameters for our new patient clusters. We tried to research each group special properties during pharmacological treatment. In future more new data will be typed in our database and we will continue our search for unusual relationships between new survey factors and our new clustered patient groups.

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