INVESTIGATION OF BIOCHEMICAL MARKERS OF CHRONIC ALCOHOLISM

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ABSTRACT: Alcohol is a prominent risk factor in traffic accidents. Investigations have shown that both in Germany and in Hungary a significant number of chronic alcoholics take part in traffic and form a special risk-group. Diagnosing chronic alcoholism at present is almost exclusively based on psychiatric and psychological tests. It is necessary to work out an objective laboratory investigation method, by means of which chronic alcoholics can be identified in time and, if necessary, sanctioned effectively. Besides the high concentration of blood alcohol, the so-called biochemical markers of chronic alcoholism are taken into account, one of which is the increased methanol level of the blood. The methanol level of the blood and the methanol content of consumed beverages are related to each other. There are significant regional differences in alcohol-consuming habits and in the quality of alcoholic beverages. In our work we collected blood samples from chronic alcoholics in the Szeged region, Hungary. The samples were analysed with headspace gas chromatography. The following biochemical markers of alcoholism were measured: ethanol, methanol, acetone, 2-propanol and 1-propanol. Our data were compared with similar data from Düsseldorf and Vienna. The result of the investigation contributes to the unambigous evaluation of methanol as a biochemical marker of chronic alcoholism. The results can be used in Hungary for the modification of the traffic safety regulations.

KEY WORDS: Alcoholism; Biological markers; Methanol.

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INTRODUCTION

The diagnosis of chronic alcoholism is based almost exclusively on psychiatric and psychological examinations [6]. Recent tests of the biochemical markers of alcoholism have provided a more reliable assessment. In addition to an increased blood alcohol concentration, elevated values of the biochemical markers are also indicative of chronic alcoholism [3]. Blood tests of alcoholics revealed that there is a correlation between

congeners in alcoholic beverages and biochemical markers, specifically methanol, 1-propanol and 2-propanol elimination [1]. Musshoff et al. also reported that methanol is independently of ethyl alcohol [5].

According to the authors' tests home made alcoholic beverages in the Szeged region tend to contain a higher amount of methanol than reported by the literature [4]. It was also observed that elevated serum methanol concentration occurs more frequently than the average in the target region [8]. Metabolism of different alcohols and their interrelations were examined in samples collected from patients of the Department of Addiction of the Szeged Municipal Hospital.

MATERIAL AND METHOD

Blood samples were collected from a total of 25 chronic alcoholics in the Szeged region in Hungary. Sampling took place between July 1997 and March 1999. Among the patients, 16 were males and 9 females with an average age of 46.4 years (± 10.5 years). Samples were taken from the cubital vein upon admission; then, with the patient's consent, every other hour during the first 12 hours, and then at the 18th and 24th hour following admission, and finally upon discharge.

The samples were stored deep frozen until analysis. Analysis was carried out by the Department of Forensic Medicine of Heinrich Heine University, Düsseldorf. The samples were salted out and after incubation at 70°C for a period of 20 minutes headspace analysis was carried out to determine the levels of ethanol, methanol, acetone, 2-propanol and 1-propanol respectively. Calibration and measurement conditions were those described by Musshoff [5].

FINDINGS

Table summarises the findings.

The ethanol concentration values seem to indicate that some of the patients consumed alcohol during hospitalisation, thus in their case it was impossible to calculate the elimination speed (β_{60}). In the case of 21 patients ethanol concentration exceeded 2 g/l, the level typical for chronic alcoholics.

In 60% of the cases the serum methanol concentration (SMC) at the time of admission exceeded 10 mg/l.

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Compound	Concentration after given time [h]								
		Person 1							
	00:00	02:00	04:00	06:00	08:30	10:30	12:30	14:30	33:00



Fig. 1. Ethanol, methanol, 2-propanol changing in the percentage of the admission values.

Methanol [mg/l]	14.67	12.22	13.14	13.61	12.85	13.75	15.11	14.24	5.32		
Aceton [mg/l]	8.05	9.05	8.82	7.88	7.77	9.54	10.98	11.63	3.8		
Ethanol [g/l]	2.79	2.40	2.97	2.4	1.99	1.46	0.96	0.50	1.75		
2-Propanol [mg/l]	3.90	4.21	2.8	3.59	3.21	2.27	2.58	1.99	0.85		
1-Propanol [mg/l]	0.50	0.42	0.35	0.34	0.3	0.18	0.16	0.00	0.6		
		Person 2									
	00:00	02:00	04:00	6:00?	8:00?	10:00?	12:00?	18:00?	30:00?		
Methanol [mg/l]	2.24	1.66	4.55	3.38	3.55	3.62	2.17	0.00	6.58		
Aceton [mg/l]	5.3	8.57	3.42	8.06	10.2	9.75	14.17	12.95	3.86		
Ethanol [g/l]	1.86	1.48	2.13	0.7	0.3	0.05	0.00	0.00	1.89		
2-Propanol [mg/l]	0.97	1.33	1.19	2.18	1.87	0.75	0.52	0.00	0.91		
1-Propanol [mg/l]	0.9	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.53		
	Person 3										
	00:00	02:00	04:00	06:00	08:00	10:00		16:00	28:00		
Methanol [mg/l]	2.77	6.2	6.5	8.31	11.31	6.6		1.79	8.32		
Aceton [mg/l]	14.09	4.3	4.4	5.83	7.16	5.28		2.39	5.74		
Ethanol [g/l]	0.97	1.73	1.21	0.69	0.17	0.00		0.00	1.34		
2-Propanol [mg/l]	2.36	1.6	1.5	1.1	1.26	0.72		0.76	0.7		
1-Propanol [mg/l]	0.38	0.15	0.1	0.00	0.00	0.00		0.00	0.65		
	Person 4										
	00:00	02:00	06:00		08:00	10:00					
Methanol [mg/l]	35.03	28.36	42.72		37	8.18					
Aceton [mg/l]	3.49	4.05	6.01		7.13	6.91					
Ethanol [g/l]	2.8	2.41	1.9		1.48	0.96					

2-Propanol [mg/l]	0.42	1.24	0.97		1.1	0.91			
1-Propanol [mg/l]	0.54	0.4	0.28	<u> </u>	0.00	0.56			
	L				Person 5				
	00:00	02:00	04:00	<u> </u>			12:00		
Methanol [mg/l]	30.59	26.8	26.41	ļ			8.57		
Aceton [mg/l]	2.66	4.21	4.04	ļ			12.1		
Ethanol [g/l]	2.72	2.02	2.06	ļ			0.64		
2-Propanol [mg/l]	1.67	2.49	2.41	ļ			1.42		
1-Propanol [mg/l]	1.53	1.03	0.97	l			0.3		
					Person 6	1	1		
	00:00	02:00	04:00	06:00		10:00	12:00	18:00	24:00
Methanol [mg/l]	29.51	29.04	32.19	28.65		27.37	30.26	20.52	8.78
Aceton [mg/l]	18.89	21.78	25.06	24.39		22.91	24.03	17.98	14.14
Ethanol [g/l]	3.63	3.17	2.81	2.48		2.09	2.01	1.49	0.15
2-Propanol [mg/l]	5.3	5.17	4.92	5.3		4.16	4.51	3.78	1.97
1-Propanol [mg/l]	1.06	1.45	1.67	1.31		0.95	1.03	0.98	0.00
	L				Person 7				
	00:00	02:00	04:00	06:00	08:00	10:00	12:00		
Methanol [mg/l]	1.93	1.55	2.88	3.37	3.91	5.7	2.82		
Aceton [mg/l]	4.22	5.89	8.72	11.83	13.81	13.05	40.31		
Ethanol [g/l]	2.21	1.77	1.25	0.86	0.43	0.17	0.00		
2-Propanol [mg/l]	1.25	1.32	1.77	1.83	2.51	1.71	1		
1-Propanol [mg/l]	1.2	0.7	0.34	0.12	0.00	0.00	0.00		
	L				Person 8				•
	00:00	02:00	04:00	06:00	08:00	10:00		16:00	22:00
Methanol [mg/l]	3.1	2.03	2.57	3.72	4.71	5.92		0.00	0.00
Aceton [mg/l]	3.85	3.44	4.01	5.71	6.25	7.66		88.77	10.58
Ethanol [g/l]	1.83	1.65	1.23	0.97	0.63	0.35		0.00	0.00
2-Propanol [mg/l]	0.89	0.8	1.85	1.91	2.15	2.64		1.08	1.15
1-Propanol [mg/l]	1.07	0.62	0.21	0.00	0.00	0.00		0.00	0.00
	L				Person 9				
	00:00	02:00	04:00	06:00		10:00		16:00	22:00
Methanol [mg/l]	24.5	23.28	21.5	21.04		23.76		21.18	3.42
Aceton [mg/l]	13.86	15.64	23.94	22.07		25.69		99.16	111.79
Ethanol [g/l]	3.5	3.22	1.95	1.97		1.86		0.03	0.00
2-Propanol [mg/l]	4.94	4.7	3.77	3.62		4.33		1.38	0.2
1-Propanol [mg/l]	0.68	0.59	0.44	0.42		0.5		0.00	0.00
					Person 10)			
	00:00	02:00						15:30	
Methanol [mg/l]	21.64	23.96						23.31	
Aceton [mg/l]	14.77	18.11						33.18	
Ethanol [g/l]	3.86	3.39						0.19	

2-Propanol [mg/l]	3.79	3.73				2.88	
1-Propanol [mg/l]	2.11	1.55				0.00	
				Person 11			
	00:00	02:00				14:15	
Methanol [mg/l]	11.64	10.12				9.55	
Aceton [mg/l]	6.06	7.07				56.39	
Ethanol [g/l]	3	2.57				0.02	
2-Propanol [mg/l]	1.03	1.41				0.9	
1-Propanol [mg/l]	1.61	1.48				0.00	
			1	Person 12			
	00:00	02:00					21:00
Methanol [mg/l]	68.98	67.32					20.91
Aceton [mg/l]	8.42	13.53					106.79
Ethanol [g/l]	3.27	2.87					0.02
2-Propanol [mg/l]	3.35	3.18					0.71
1-Propanol [mg/l]	3.86	2.94					0.00
				Person 13			
	00:00	02:00					20:30
Methanol [mg/l]	32.47	31.16					15.85
Aceton [mg/l]	5.41	7.08					69.92
Ethanol [g/l]	3.65	3.2					0.02
2-Propanol [mg/l]	2.17	2.7					0.74
1-Propanol [mg/l]	1.06	1.09					0.00
			•	Person 14			
	00:00	02:00		08:00			
Methanol [mg/l]	10.33	10.26		11.95			
Aceton [mg/l]	4.38	4.48		5.14			
Ethanol [g/l]	2.23	2.19		1.09			
2-Propanol [mg/l]	1.1	1.13		1.86			
1-Propanol [mg/l]	0.87	0.84		0.36			
			1	Person 15			
	00:00	02:00				14:15	
Methanol [mg/l]	21.94	18.5				21.86	
Aceton [mg/l]	3.01	3.09				5.95	
Ethanol [g/l]	4 19	3 74				1.21	
2-Propanol [mg/l]	1 76	1.92				2	
1-Propanol [mg/l]	2.03	2.18				0.36	
- rrepairor [mg/1]	2.05		 1	Person 16		0.00	
	00.00	02:00				13.30	
Methanol [mg/l]	11 84	12.00				13.9	
A ceton [mg/l]	5.17	5.51				0 30	
Ethanol [g/l]	2 40	2.15				0.28	
2 Proposal [ma/1]	1.47	1.0				1.24	
2-Propanol [mg/l]	1.35	1.8				1.54	

1 Due une a 1 Fair a /11	0.0	0.69				0.14	
I-Propanoi [mg/1]	0.9	0.08	Domon 1'	-		0.14	
	00.00	02.00	Person 1	10.15			
	10.01	02:00		10:15			
Methanol [mg/1]	10.81	9.84		12.1			
Aceton [mg/1]	2.32	3.34		12.84			
Ethanol [g/l]	2.81	2.44		0.7			
2-Propanol [mg/l]	1./1	2.08		2.76			
I-Propanol [mg/I]	3.36	3.26		0.38			
	00.00	02.00	Person 1	00:45			
Mathanal [max/1]	2.50	02:00		09:45			
Methanol [mg/1]	3.59	2.75		4.8/			
Aceton [mg/1]	2.92	3.15		4.46			
Ethanol [g/l]	3.32	2.92		1.47			
2-Propanol [mg/l]	0.92	1.02		1.49			
1-Propanol [mg/l]	1.65	0.98		0.22			
			Person 19	9		1	1
	00:00	02:00					
Methanol [mg/l]	8.47	8.54					
Aceton [mg/l]	2.78	4.26					
Ethanol [g/l]	2.98	2.65					
2-Propanol [mg/l]	0.5	0.46					
1-Propanol [mg/l]	0.69	0.57					
			Person 20	0	1		1
	00:00	02:00				13:40	
Methanol [mg/l]	9.66	9.61				12.33	
Aceton [mg/l]	1.51	1.65				4.06	
Ethanol [g/l]	2.62	2.21				0.21	
2-Propanol [mg/l]	0.36	0.9				1.17	
1-Propanol [mg/l]	1.18	0.97				0.00	
			Person 2	1			
	00:00	02:00				14:50	
Methanol [mg/l]	6.57	5.7				1.73	
Aceton [mg/l]	3.24	3.2				31.07	
Ethanol [g/l]	3.02	2.23				3.43	
2-Propanol [mg/l]	0.9	1.25				1.17	
1-Propanol [mg/l]	1.45	0.98				0.00	
		-	Person 22	2			
	00:00	02:00			11:15		
Methanol [mg/l]	17.23	18.5			19.04		
Aceton [mg/l]	2.93	3.31			4.18		
Ethanol [g/l]	2.4	2.01			0.63		
2-Propanol [mg/l]	0.78	0.74			1.29		
1-Propanol [mg/l]	0.59	0.5			0.21		

		Person 23								
	00:00	02:00					11:00			
Methanol [mg/l]	7.02	6.96					8.73			
Aceton [mg/l]	5.17	7.36					10.66			
Ethanol [g/l]	3.12	2.79					1.28			
2-Propanol [mg/l]	1.71	1.59					2.22			
1-Propanol [mg/l]	2.36	2.23					0.31			
		Person 24								
	00:00	02:00	C)5:15						
Methanol [mg/l]	3.36	4.39		5.67						
Aceton [mg/l]	1.14	1.47		1.69						
Ethanol [g/l]	1.47	1.12		0.79						
2-Propanol [mg/l]	0.66	0.66		1.39						
1-Propanol [mg/l]	1.37	1.29		1.01						
]	Person 25					
	00:00	02:00					12:00			
Methanol [mg/l]	36.01	33.09					13.63			
Aceton [mg/l]	6.81	7.74					13.82			
Ethanol [g/l]	3.92	3.63					0.02			
2-Propanol [mg/l]	2.08	2.16					1.27			
1-Propanol [mg/l]	1.19	1.22					0.00			

Methanol elimination is prolonged in alcoholics due to high ethanol concentration [7]. The authors' findings confirmed this in some of the patients (see Figure 1). In some patients SMC oscillated and dropped by the end of the period of analysis when ethanol concentration likewise dropped.

Methanol elimination independent of ethanol was not found in any of the 25 patients.

Acetonaemia occurred in 8 patients (specifically patients 5, 7, 8, 9, 10, 11, 12 and 13). This indicates a metabolic disorder. Thus acetone could not be used as a marker, except for its initial value, in the case of acute metabolic disorder (such as diabetes and dehydration).

Change in the level of 2-propanol is similar to methanol, though it is absorbed more slowly (Figure 1).

Acetone + 2-propanol concentration exceeded the pathological limit of 10 mg/l in six of the patients.

Elimination of 1-propanol was found to be quick in five patients irrespective of the blood ethanol concentration (patients 2, 3, 4, 7, 8). At the same time there was a slow rise in methanol concentration in the same patients (Figure 1).

CONCLUSIONS

- 1. An elevated SMC exceeding 10 mg/l can be indicative of regular intake of drinks rich in methanol [2].
- 2. Prolonged methanol elimination was observed in some patients.
- 3. In the 25 patients no methanol elimination occurred independently of ethanol.
- 4. Some patients showed quick 1-propanol elimination unrelated to ethanol metabolism.

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