Alcohol intoxication in the emergency room: effect on some common laboratory tests

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Background. Excessive alcohol consumption and alcohol abuse may lead to a variety of diseases. Many changes in biochemical and hematological laboratory parameters have been observed in alcoholic subjects. The present paper evaluates the serum concentration of some common laboratory tests in subjects with acute alcohol intoxication.
Methods. Blood alcohol concentration (BAC) levels were determined in 877 subjects treated in the emergency room; 774 (93.1%) of them, 631 (81.52%) males and 143 (18.48%) females, had a detectable alcohol concentration (>10 mg/dL). Erythrocyte mean corpuscular volume (MCV) and serum glucose, urea, creatinine, sodium (Na^+), potassium (K^+) and aspartate aminotransferase (AST), alanine-aminotransferase (ALT), creatine phosphokinase (CK), lactate dehydrogenase (LDH), amylase (AMY) activities were also measured.
Results. 462 males (73.21%) and 100 females (69.93%) were alcohol intoxicated with BAC levels higher than 80 mg/dL. 142 (22.9%) males and 27 (20%) females were alcoholics with a MCV value higher than 97 fL. The mean value of BAC levels was not significantly different in alcoholic *versus* non-alcoholic males and females. However, significant differences were observed in AST, ALT, AMY values. In non-alcoholic subjects significant changes of urea, AST, ALT, LDH values in males and AST and ALT in females were associated with BAC levels higher than 80mg/dL and significant glucose changes. AMY and Na^+ changes were observed where BAC levels were higher than 200 mg/dL in both males and females; significant MCV and glucose changes were associated with the highest BAC levels in both males and females. In alcoholic subjects significant changes for urea, AST, ALT and Na^+ values were observed for BAC levels higher than 200 mg/dL in both males and females. AST levels in both alcoholic and non-alcoholic males and females and LDH activities in non-alcoholic males were outside the reference interval.
Conclusions. Acute alcohol intoxication significantly affects the above laboratory tests in both alcoholic and non-alcoholic subjects. Acute intoxication affects more tests in non-alcoholics than it does in alcoholics; moreover the significant changes that take place in alcoholics occur at lower BAC levels than in non-alcoholics.

Introduction

Excessive alcohol consumption and abuse are widely observed around the world and contribute to high health care and social costs in developed as well as in developing countries (1,2). Excessive consumption of alcohol may lead to a variety of gastrointestinal, neurologic, cardiovascular and malignant diseases, being also a high-risk factor in all causes of death (3-5). However, alcohol related diseases are not observed in every individual who drinks hazardous amounts of alcohol. Many changes in biochemical and hematological laboratory values have been observed in habitual heavy drinkers. Some of those tests, such as MCV (6-8), serum GGT (9, 10) and AST (11) have been widely used as markers of alcohol abuse. MCV has emerged as the most specific commonly available laboratory marker (12) and as the best single discriminant test in identifying heavy drinkers (13). Chronic alcohol abuse is related to the risk of cirrhosis (14) and other physical harm and in alcoholics the risk of complication after trauma increased twofold with longer hospital stays (15, 16). In subjects referred to an emergency room, with suspected clinical signs of alcohol intoxication, systematic blood sampling was performed to determine the BAC together with other routine tests. The purpose of this study is to evaluate the serum values of some commonly used laboratory analytics in both non-alcoholics and alcoholics with different BAC levels. We also evaluated the clinical diagnoses by comparing non-alcoholics and alcoholics.

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Material and Methods

Between 1993-1997, 877 subjects (719 men, 158 women) admitted to the emergency room of the Medical Service at Umberto I Hospital, suspected of being under the influence of alcohol through subjective assessement of acohol abuse, were tested for BAC levels. We studied 841 subjects with clinical diagnoses of alcoholism, nervous impairment or trauma while 36 patients (26 men and 10 women) with other diagnoses unrelated to alcohol intoxication were not considered. Plasma samples were analyzed within one hour after collection. BAC tests were performed using a colorimetric method (analytical sensitivity=10 mg/dL) on the Vitros 700 analyzer (Ortho-Johnson, Clinical Diagnostics, Rochester, NY, USA). This was done to provide a diagnostic tool, the use of which was strictly for medical purposes. Simultaneous sequential routine laboratory tests were performed. Data from the information schedules, clinical diagnoses, BAC test results and laboratory tests for each patient were stored on a computer file; MCV was measured with a Coulter counter STKS (Instrumentation Laboratory, Lexington, MA, USA); levels of serum glucose, urea, creatinine, AST, ALT, CK, LDH, AMY Na^+, K^+, were measured with the Vitros 700 analyzer. MCV was used to classify subjects as either non-alcoholics or alcoholics on the basis of its high specificity. Reference interval values for MCV ranged from 78 to 97 fL. Patients with BAC level higher than 80 mg/dL were defined as acutely intoxicated; in Italy the legal definition of intoxication of 80 mg/dL or greater is related to the relative probability of crash involvement and appears to be a reasonable cutoff for examining the effects of intoxication on laboratory tests. Non alcoholic and alcoholic subjects were grouped by BAC levels. Serum laboratory test results were coded, compiled and analyzed for each subject on a computer-data base. Data were expressed as the mean±SD. Statistical analysis was performed using the no paired-sample t-test; significance was defined at a p=value of less than 0.05.

Results

Of the 831 patients tested for BAC levels, 774 (93.1%), (631 (81.52%) males and 143 (18.48%) females), had a detectable alcohol concentration. A group of 462 (73.21%) male subjects were alcohol intoxicated with a BAC level higher than 80 mg/L and 142 (22.9%) were alcoholics with a MCV value higher than 97 fL; these percentages were slightly lower in females, where 100 (69.93%) had BAC levels higher than 80 mg/L and 27 (20%) had a MCV value higher than 97 fL, as shown in Table I. The non-alcoholic and alcoholic subjects grouped by clinical diagnosis are summarized in Table II: among

Table I. Number and percentage of alcohol intoxicated and alcoholic subjects.

	males	females
BAC No (%)	631 (100)	143 (100)
Mean	194.17	196.66
SD	90.02	80.33
No (%) >80 mg/dL	462 (73.21)	100 (69.93)
MCV No (%)	620 (100)	135 (100)
Mean	92.82	91.42
SD	7.45	6.45
No (%) >97 fL	142 (22.9)	27 (20)

Table II. Clinical diagnoses in subjects with a positive BAC test.

	non-alcoholics			alcoholics		
	n (%)	age mean±SD	BAC mean±SD	n (%)	age mean±SD	BAC mean±SD
males						
diagnosis	478 (100)			142 (100)		
trauma	186 (38.91)	34.33±21.64	152.8±77.66	29 (20.42)	37.67±11.93	237.53±75.7
nervous	165 (34.52)	30.9±12.1	193.77± 81.3	61 (42.96)	48.6±19.32	243.94±84.51
impairment ethanolism	127 (26.57)	32.5±11.5	209.36±92.93	52 (36.62)	50.6±12.6	232.07±89.29
females						
diagnosis	108 (100)			27 (100)		229.25±64.85
trauma	23 (20.80)	30.5±6.81	166.17±72.71	7 (25.93)	36.5±15.4	262.4±54.49
nervous	48 (44.55)	56.83±24.37	193.66±77.62	11 (40.74)	69±19.52	258±27.54
impairment ethanolism	37 (34.65)	47.25±12.17	177.36±70.4	9 (33.33)	59.1±15.61	

males the highest percentage (38.91%) of non alcoholics showed trauma and the highest percentage (42.96%) of alcoholics showed nervous impairment; among females, the highest percentage (44.55%) of non alcoholics and the highest percentage (40.75%) of alcoholics showed nervous impairment. The mean age of alcoholics was higher than that of non alcoholics for both male and female subjects. Results of laboratory tests obtained simultaneously with BAC determinations are indicated in Table III. The mean value of BAC levels was not significantly different in non alcoholics *versus* alcoholics. The mean value for almost all of the tests was within the normal reference interval used in our laboratory, for non-alcoholic and alcoholic men and women; however AST and LDH activities in alcoholic males and AST activity in alcoholic females for high BAC levels didn't fall within the reference interval. Comparison of test results from non-alcoholics and alcoholics showed statistically significant differences of AST, ALT, AMY activities in males and females; Table IV shows laboratory data in non-alcoholic subjects grouped by various BAC levels. Among non-alcoholic males, urea, AST, ALT and LDH values were significantly different where BAC levels were higher than 80 mg/dL and glucose, AMY and Na^+ values where BAC levels were higher than 200 mg/dL; among non-alcoholic females AST and ALT values change significantly where BAC levels were higher than 80 mg/dL and glucose, urea, AMY and Na^+ values for BAC levels were higher than 200 mg/dL. MCV changes were statistically significant for BAC levels higher than 300 mg/dL in both males and females. Table V summarizes laboratory data in alcoholic subjects with different BAC levels; among alcoholic males and females, urea, AST, ALT, Na^+ values change significantly for BAC higher than 200 mg/dL. MCV didn't change in alcoholics with different BAC levels. The mean value of AST activities was outside the reference interval in alcoholic males with low and high BAC levels, in alcoholic females with BAC levels higher than 200 mg/dL, in non-alcoholic males where BAC levels were higher than 80 mg/dL and in non-alcoholic females where BAC

Table III. Biochemical results in non-alcoholic and alcoholic subjects.

test	reference interval	n	mean±SD	n	mean±SD	p values A vs B
males		A: non-alcoholics (n 489)		B: alcoholics (n 142)		
Alcohol (mg/dL)		489	181.29±83.85	142	237.81±84.5	NS
Glucose (mg/dL)	60-110	444	107±21.37	136	100.43±22.3	NS
Urea (mg/dL)	20-45	445	27.11±8.57	136	20.53±7.88	NS
Creatinine (mg/dL)	0.6-1.4	459	1±0.51	130	0.9±0.42	NS
AST (U/L)	<40	459	39.51±26.95	130	79.03±50.6	<0.01
ALT (U/L)	<40	450	27.68±21.98	130	37.41±38	<0.01
CK (U/L)	<170	380	245.43±161.45	130	233.43±211	NS
LDH (U/L)	<450	379	394.83±174.9	125	435.86±196	NS
AMY (U/L)	65-225	350	161.78±61.25	107	195.37±82	<0.01
Na^+ (mEq/L)	136-148	457	144.11±5.56	135	143.22±4.25	NS
K^+ (mEq/L)	3.6-4.9	457	3.91±0.45	135	3.95±0.55	NS
females		A: non alcoholics (n 116)		B: alcoholics (n 27)		
Alcohol (mg/dL)		116	177.83±77.1	27	250.92±57.4	NS
Glucose (mg/dL)	60-110	98	99.01±11.87	25	92.6±12.4	NS
Urea (mg/dL)	20-45	98	23.88±8.55	25	20.3±6.5	NS
Creatinine (mg/dL)	0.6-1.4	98	0.9±0.44	25	0.81±0.4	NS
AST (U/L)	<40	99	32.46±17.75	26	54.25±29	<0.01
ALT (U/L)	<40	98	20.04±14.07	26	28.62±9.03	<0.01
CK (U/L)	<170	99	150.1±120.52	22	162.12±167	NS
LDH (U/L)	<450	97	341.83±99.29	23	380.85±114	NS
AMY (U/L)	65-225	97	150.02±39.47	21	171±55.7	0,01
Na^+ (mEq/L)	136-148	100	141.62±3.83	25	143.84±4.79	NS
K^+ (mEq/L)	3.6-4.9	100	3.87±0.93	25	3.8±0.4	NS

NS: not significant

levels were higher than 300 mg/dL; the mean value of LDH activities was outside the reference interval for non-alcoholic men alone with BAC levels higher than 300 mg/dL.

Discussion

The majority of subjects who presented medical problems associated with alcohol consumption were males, as reported by other workers (17, 18), which is consistent with the higher prevalence of alcohol abuse among males (19, 20). The percentage of alcoholic males with a MCV higher than 97 fL, was slightly higher than the percentage of females. The method of classification used to differentiate between non alcoholics and alcoholics, based on MCV, was a substitute for the actual daily consumption of alcohol, which could not be obtained reliably under the conditions of the study and was influenced by the sensititvity and specificity of the test we used. Thus, the final number of alcoholics was probably underestimated. We must emphasize that the method used in this study is appropriate for describing a population, or comparing different groups, but is unreliable for accurately assessing the individuals alcohol consumption. Among alcoholics, the highest percentages, 42.68% and 40.75% in males and females respectively were diagnosed far a nervous impairment resulting as chronic deterioration from alcohol induced neuropsychological deficit (21-23). Among non alcoholics the highest percentage, 38.91%, in males had trauma and the highest percentage, 44.55%, in females were diagnosed for a nervous impairment. The present results show no association between blood alcohol concentration and a chronic drinking habit since BAC levels were slightly higher in alcoholics *versus* non-alcoholics. Focusing solely on measured blood alcohol concentration may, therefore, disguise a relationship between chronic, rather than acute, alcohol abuse (24). The present study documents that the results of some tests differ significantly in alcoholics *versus* non alcoholics thus confirming how a habit of usual ex-

Table IV. Laboratory test results in non-alcoholic subjects with different BAC levels.

BAC levels range, mg/dL		A:10-79		B:80-199			C:200-299			D:300+		
Test (unit)	reference interval	n	mean±SD	n	mean±SD	p values B vs A	n	mean±SD	p values C vs A	n.	mean±SD	p values D vs A
males												
MCV (fL)	78-97	74	89.56±4.32	158	89.37±3.87	NS	186	90.47±3.69	NS	71	92.51±2.68	<0.01
Glucose (mg/dL)	60-110	66	110.6±25.81	143	107.34±26.85	NS	170	103.31±18.53	<0.01	65	106.26±16.4	<0.01
Urea (mg/dL)	20-45	66	29.91±10.64	144	24.54±6.8	<0.01	170	23.1±6.53	<0.01	65	21.8±6.65	<0.01
Creatinine (mg/dL)	0.6-1.4	66	0.9±0.28	148	0.92±0.22	NS	175	0.87±0.19	NS	65	0.83±0.23	NS
AST (U/L)	<40	69	39.42±26.31	148	48.18±41.81	<0.01	175	47.01±37.3	<0.01	67	82.7±54.9	<0.01
ALT (U/L)	<40	65	27.72±21.02	145	38.23±31.62	<0.01	174	32.8±28.24	0:01	66	39.34±31.52	<0.01
CK (U/L)	<170	50	220±170	123	256±195	NS	155	207±114	NS	65	247±132	NS
LDH (U/L)	<450	52	338.9±87.41	123	427.6±221.89	<0.01	151	427.64±182.54	<0.01	65	515.5±166.7	<0.01
AMY (U/L)	65-225	44	130.53±41.73	115	162.13±46.34	NS	140	161.98±64.42	0:01	65	166.22±70	<0.01
Na^+ (mEq/L)	136-148	69	141.83±2.9	148	143.27±3.2	NS	175	143.85±3.7	0:01	66	146.46±5.1	<0.01
K^+ (mEq/L)	3.6-4.9	69	3.47±0.44	148	3.68±0.47	NS	175	3.82±0.38	NS	66	3.89±0.45	NS
females												
MCV (fL)	78-97	19	89.45±3.9	49	89.57±3.78	NS	38	91.7±3.91	NS	10	92.6±1.14	0:01
Glucose (mg/dL)	60-110	15	115.25±25.93	42	108.4±33.31	NS	34	96.62±16.32	0:01	7	102.3±25.2	0:01
Urea (mg/dL)	20-45	15	27.66±10.32	42	25.58±7.57	NS	34	21±5	<0.01	7	20.6±5.3	<0.01
Creatinine (mg/dL)	0.6-1.4	15	0.89±0.3	42	0.88±0.25	NS	34	0.8±0.21	NS	7	0.82±0.24	NS
AST (U/L)	<40	15	30.25±12.44	42	34.1±25.7	0:01	34	33.62±28.77	<0.01	8	67±35.24	<0.01
ALT (U/L)	<40	15	21.57±6.21	41	28.17±10.57	0:01	34	31.93±20.37	<0.01	8	38.66±22.8	<0.01
CK (U/L)	<170	15	129.07±51.94	42	132.7±63.3	NS	35	134.35±62.6	NS	7	160±87.9	NS
LDH (U/L)	<450	14	318.27±66.27	42	304.61±45.59	NS	34	305.41±77.74	NS	8	400.2±127.6	0:01
AMY (U/L)	65-225	11	150.75±47.87	43	157.6±37.18	NS	35	209.45±94.68	0:01	8	197.65±69.73	NS
Na^+ (mEq/L)	136-148	15	142.45±1.87	42	142.8±2.6	NS	34	143.55±4.5	<0.01	7	145.8±2.63	<0.01
K^+ (mEq/L)	3.6-4.9	15	3.74±0.41	42	3.67±0.54	NS	34	3.91±0.28	NS	7	3.95±0.26	NS

NS: not significant

cessive alcohol consumption determines permanent changes in some hematologic parameters. Some test results change with BAC levels in both alcoholics and non alcoholics. Our data show significant changes in biochemical test results for BAC levels higher than 80 mg/dL *versus* those lower than 80 mg/dL in both alcoholic and non alcoholic subjects; high BAC levels affect more tests in non-alcoholics than in alcoholics. Non-alcoholics with acute alcohol intoxication whose test results underwent change may well have incipient tissue damage or inherent biological susceptibility to the tissue damaging effects of alcohol. The oxidation of alcohol generates species of free radical oxygen capable of damaging cell membranes (25) and acute short-term alcohol intake seems to increase membrane fluidity (26). The initial fluidizing effect and pronounced morphologic alterations in plasma membranes observed in erythrocytes (27) and in liver mitocondria (28) may be responsible, at least in part, for increase in MCV values as well as for increase in lability of plasmamembrane enzymes (29). In alcoholics long-term alcohol abuse leads to adaptive changes in the membrane which renders them resistent to the effects of alcohol (24,30). Non-alcoholics with high BAC levels had statistically significant lower level of glucose; alcohol induces some decrease in glucose level, but the mean glucose concentration was within the reference interval as previously observed by other workers (31). Changes in AMY activity, when statistically significant, may be related to a non-fasting state rather than the consequence of alcohol intake. Previous studies reported a low incidence of high total serum amylase activity in alcohol intoxicated subjects (32). Serum electrolytes concentration were not significantly different in the alcoholics compared to non alcoholics as observed by others workers (33). Increased Na^+ concentration was observed with high BAC levels in both alcoholic and non-alcoholic males and females, while serum urea concentration decreases significantly with higher BAC levels; these results are consistent with previous studies (31, 34). AST activity was significantly elevated and outside the reference interval in alcoholic

Table V. Laboratory test results in alcoholic subjects with different BAC levels.

BAC levels range, mg/dL		A:10-79		B:80-199			C:200-299			D:300+		
Test (unit)	reference interval	n	mean±SD	n	mean±SD	p values B vs A	n	mean±SD	p values C vs A	n.	mean±SD	p values D vs A
males												
MCV (fL)	78-97	15	102.83±4.13	19	101.7±5.89	NS	70	101.8±4.13	NS	38	102.83.±4.13	NS
Glucose (mg/dL)	60-110	15	115.11±30.74	18	103.5±27.22	NS	67	100.23±19.45	NS	36	101.2±26.09	NS
Urea (mg/dL)	20-45	15	20.6±12.31	18	20.5±10.35	NS	67	19.31±7.14	0:01	36	15.7±4.6	<0.01
Creatinine (mg/dL)	0.6-1.4	15	1.08±0.36	18	0.91±0.25	NS	67	0.85±0.29	NS	36	0.82±0.33	NS
AST (U/L)	<40	14	48.09±23.47	17	59.05±37.51	NS	65	64.44±37.62	<0.01	34	72.27±55.55	<0.01
ALT (U/L)	<40	14	31.66±11.38	17	38.05±18.7	NS	65	39.5±26.66	<0.01	34	39.8±31.48	<0.01
CK (U/L)	<170	13	202.6±199.16	17	256.54±252.98	NS	64	194.87±177.45	NS	32	246.69±223.22	NS
LDH (U/L)	<450	13	404±200.55	17	394.85±64.64	NS	64	398.59±119.9	NS	31	483.61±119.63	NS
AMY (U/L)	65-225	8	194.66±26.53	14	164.57±61.34	NS	63	184.86±78.35	NS	26	226.41±112.95	NS
Na^+ (mEq/L)	136-148	14	141.8±3.6	18	142.42±3.2	NS	67	143.95±4.86	<0.01	36	144±4.55	0:01
K^+ (mEq/L)	3.6-4.9	14	3.52±0.39	18	3.83±0.41	NS	67	3.91±0.43	NS	36	4.01±0.48	NS
females												
MCV (fL)	78-97	4	100±2.04	3	102.5±4.93	NS	15	102.5±2.92	NS	5	104.6±2.77	NS
Glucose (mg/dL)	60-110	3	102.15±2.21	2	90±8.48	NS	14	95±15.08	NS	5	92±6.55	NS
Urea (mg/dL)	20-45	3	25±1.41	2	19.5±5.41	NS	13	18±4.9	NS	3	15.66±4.93	0:01
Creatinine (mg/dL)	0.6-1.4	3	0.92±0.29	2	0.9±0.31	NS	14	0.86±0.28	NS	3	0.85±0.28	NS
AST (U/L)	<40	3	29.75±10.12	3	36.5±20.14	NS	14	59.14±25.28	<0.01	3	65.25±24.17	0:01
ALT (U/L)	<40	2	15.3±3.11	3	21.8±2.93	NS	14	31±11.54	<0.01	5	29.12±10.99	<0.01
CK (U/L)	<170	2	140.5±73.4	2	285±40.41	NS	12	158.75±66.16	NS	4	146.15±38.83	NS
LDH (U/L)	<450	2	368.5±101.9	2	398.5±52	NS	12	374.71±79.44	NS	4	411.3±96.77	NS
AMY (U/L)	65-225	2	143.33±59.81	3	154.5±29.44	NS	10	190.46±14.38	NS	3	167±53.34	NS
Na^+ (mEq/L)	136-148	3	139.2±2.66	3	140.2±4.66	NS	13	143.41±4.76	0:01	5	143.66±4.5	<0.01
K^+ (mEq/L)	3.6-4.9	3	3.97±0.35	3	3.92±0.15	NS	13	3.8±0.25	NS	5	3.75±0.4	NS

NS: not significant

subjects, as expected (35, 36) and in non-alcoholic subjects for very high BAC levels. Our data suggest that AST activity is effective enough to detect acute alcohol consumption but it has no diagnostic value in alcohol-intoxicated subjects in differentiating alcoholics *versus* non alcoholics. In conclusion, acute alcohol intoxication determines significantly changes in the above laboratory tests in both alcoholic and non-alcoholic males and females affecting more tests in non-alcoholics; however, the test values were within the reference interval for both groups. The mean value for almost all tests fell within the reference interval and this is consistent with the findings of other workers who observed that most social drinkers had normal laboratory results (37); nevertheless, there is a trend of test changes associated with BAC levels in both alcoholics and non-alcoholics.

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