

Effect of Time Interval between the Traffic Case and Alcohol Test on the Legal Blood Alcohol Limit in Traffic Accidents

Trafik Kazalarında Trafik Kazası ve Alkol Testi Arasındaki Zaman Aralığının Yasal Kan Alkol Limitine Etkisi

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SUMMARY

Blood alcohol concentration (BAC) of drivers (N:2865), who involved in traffic offences or accidents covering one year period (1992) in Ankara, was determined by Alcolmeter. As the alcohol analysis was performed in the Forensic Medical Office of Ministry of Justice, there was an elapsed time between the time of traffic case and the time of alcohol test. This time interval was found within a range from a few minutes to 7 hours with an average 90.78 ± 83.34 minutes, 82.4 % of the drivers had BAC's over legal limit (0.50 promille) and the incidence of traffic cases showed a peak when BAC was between 0.51-1.00 promille. Back calculation of BAC of the drivers, below 0.50 promille, using Widmark factor β and introducing elapsed time, showed a 8.5% increase in the drivers whose BAC's over legal limit.

Key words: Blood alcohol, breath alcohol, legal alcohol limit, traffic accidents and alcohol, Widmark factor.

ÖZET

Ankara'da bir yıllık bir sürede (1992), trafik suçu veya trafik kazasına kağan sürücülerin (N: 2865) kan alkol konsantrasyonları Alkolmetre ile ölçülmüştür. Alkol kontrolünün Ankara Adli Tıp Kurumunda yapılması nedeni ile, trafik kazası ile alkol testi zamanı arasındaki gecikme kaydedilmiştir. Bu zaman farkı birkaç dakika ile 7 saat arasında, ortalama

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90.78±83.34 dakika olarak bulunmuştur. Sürücülerin %82.4'ünde kan alkol konsantrasyonları yasal alkol limiti üzerinde olup, kan alkol konsantrasyonu 0.51-1.00 promil arasında olanlarda trafik kazaları insidansı en yüksek artışı göstermiştir. Kan alkol düzeyleri 0.50 promil altında olan sürücülerin, kan alkol düzeyleri Widmark faktörü (β) ve geçen zaman faktörü göz önüne alınarak hesaplandığında, yasal alkol limitini aşan sürücülerin sayısında %8.5'luk bir artış gözlenmiştir.

Anahtar kelimeler: Kanda alkol, solunum havasında alkol, trafik kazaları ve alkol, Widmark faktörü, yasal alkol limiti.

INTRODUCTION

Traffic accidents are still a serious problem in Turkey. The economic loss due to traffic damages was estimated to be over 68 million US dollars in 1990 (1). During the calendar year 1992, according to General Directorate of State Highway, 6214 persons were killed due to traffic accidents. Although there is a 1.87% decrease in fatalities, a tremendous increase in accidents (about 55% increase) and in injuries (17.57% increase), related to traffic between the years 1989 and 1992, have been reported (2).

The role of alcohol intake in all road accidents, including intercity and within the city province in Turkey between the years 1977 and 1983, showed that at least 2.5-3% of drivers involved in alcohol (3). According to 1992 statistics, about 6.98% of the traffic accidents were due to alcohol intake (2).

We have not much data showing the effect of alcohol on traffic accidents occurred on intercity roads, but several investigations have been published related to alcohol contribution to traffic accidents in some major cities, mainly in Ankara, the capital city of Turkey (4, 5). The incidence of alcohol use among drivers involved in crashes and committed a traffic offence have been reported as 51.9% and 97.3% respectively in Ankara in a recent survey (6, 7).

The Legal blood alcohol limit, 0.50 promille (50 mg/dl blood) has been set for private automobile drivers since 1983 in Turkey. But alcohol ingestion is prohibited for professional and heavy vehicle drivers.

In Turkey, breath alcohol analysis has been used to derive a corresponding blood alcohol concentration in connection with traffic law enforcement. Legislation gave the police power to request breath (blood) alcohol test from persons suspected of being under the influence of alcohol. As the forensic alcohol analysis of the drivers tested in the Forensic Laboratory of Ministry of Justice, there is always a time elapse between the

time of traffic offence and the time of obtaining blood or breath for alcohol measurement.

In recent years the status of alcohol absorption in drinking drivers, whether the blood concentration-time-curve is rising, on a plateau or declining have been reinvestigated from the view of medicolegal implications (8, 9). Some investigators propose legally permissible to back calculate of blood alcohol concentration to the time of accident depending on the concentration-time profile of alcohol in blood (10,11).

This paper presents the investigation of effect of alcohol use among drivers involved in traffic accidents, in Ankara; the frequency of time interval between the time of offence and blood alcohol analysis; and discussion the forensic importance of the time function on the legal alcohol limit.

MATERIALS AND METHODS

Experimental Subjects and Study Design

Subjects were selected among the persons (N: 31450) who were involved in criminal cases and sent by police to the Forensic Medicine Office (Ankara Region) the blood alcohol test during the one year period, 1992.

Subjects with positive alcohol test (N:3973) were categorized according to criminal cases suspected. Drivers with positive blood alcohol (N: 2865) were used the main experimental subjects.

Those drivers interviewed and asked to answer a questionnaire form including age, sex, occupation, type of traffic case and the time and location of traffic offence or accident; also the time of forensic alcohol analysis was recorded. The standard police protocol, which contains the name of the suspect, his or her address, time of arrest and location for each subject, was examined.

Measurement of Blood Alcohol Levels

Blood alcohol concentrations were measured using Lion Alcolmeter SD2/T. The instrument was calibrated with alcohol vapour standards. The breath alcohol concentrations were directly interpreted to blood alcohol concentrations (BAC) on the instrument. For the calculation, a constant blood/breath distribution ratio of alcohol of 2300 was accepted.

Data Analysis

2865 drivers, who have ingested alcohol, were grouped related to their BAC's.

The location of the traffic accident, the interval (as hours) between at the time of the traffic accident and at the time of alcohol test were estimated from the police protocols and from the questionnaire forms prepared for each subject. Those time intervals were grouped connecting with the BAC's of the drivers.

Back Calculation of BAC's

Back calculation of BAC's in drivers suspected of drink driving offences was carried out using Widmark's constant. In our previous survey, nearly 75% of the drivers reported that they have consumed alcohol at least 1 hour before the time of offence (5). Therefore the BAC-time profile of the drivers were suggested that in declining status (9). Widmark denoted the negative slope of the BAC elimination phase with the Greek letter β and reported a mean value 16 mg/dl/h (ranged between 10 mg/dl/h and 25 mg/dl/h) (10). Depending on the above considerations, BAC's of the drivers below legal limit (50 mg/100 ml) back calculated using Widmark's constant β :

$$BAC_2 = BAC_1 + (16 \times t) \text{ where,}$$

BAC₂: back calculated BAC of the drivers (at the time of traffic case)

BAC₁: BAC of the drivers measured by Lion Alcolmeter (at the time of sampling)

t: the time interval as hours between the time of offence and the time of blood alcohol test.

RESULTS

In one year period 31450 subjects have been sent for alcohol test to Forensic Medicine Office suspected from various crimes in the central region of Ankara. 12.6% of the criminal cases (N:3973), were found with positive alcohol test. Distribution of criminal cases in which alcohol intake was detected Table 1.

Frequency of distribution of BAC's in drivers who grouped related to traffic cases are shown in Table 2 and Fig 1. From Tables 1 and 2, it can be observed that traffic cases with alcohol intake are in the first order (72.11 % of the cases) and 82.4% of all the drivers have had BAC over the legal limit.

As can be seen from Table 2 and Fig 1, the incidence of traffic cases rises as the BAC increases. The percentage of all traffic cases (offence,

Table 1: Distribution of criminal cases in which alcohol was detected.

Cases	Case number (N)	% of cases
1. Traffic cases (total)	2865	72.11
-Traffic offences	877	22.07
-Traffic accidents		
Only car damage	1687	42.46
Personal injuries with car damage	301	7.58
2. Miscellaneous	940	23.70
3. Stokers	168	4.19
Total	3973	100

• Traffic offences • Only car damage* • Car damage and personal injuries

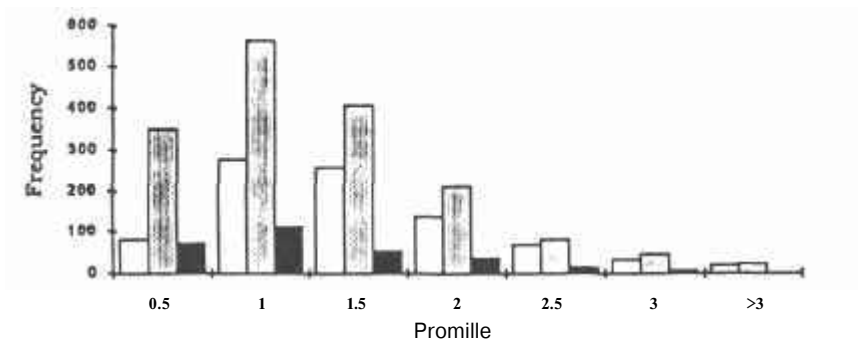


Figure 1: Frequency of BAC in drivers

injuries and/or car damage) shows the highest distribution frequency when the blood alcohol level is between 0.51-1.00 promille.

Distribution time interval as minutes between the time of traffic case and the time of BAC control at the Medicolegal Office is shown in Table 3 and Fig 2. The spread of values are focused between 30-60 minute and 60-120 minute time intervals (totally 62.2 % of the cases) with a mean 90.78 ± 83.34 minutes.

Back calculation of BAC's using Widmark constant β (16 mg/dl/h) of the drivers below legal limit (50 mg/dl:0.50 promille) is shown in Table 4. Change in numbers and %of the results can be seen from the

Table 2: Distribution of blood alcohol concentration in 2865 drivers.

Subgroups (N)	Promille						
	<0.50	0.51-1.00	1.01-1.50	1.51-2.00	2.01-2.50	2.51-3.00	>3.01
Traffic offences (877)	81 (9.2) * **	277(31,6)	259(29.5)	137(15.6)	69(7,9)	34(3.9)	20(2.3)
Traffic accidents							
Only car damage (1687)	351(20.8)	564(33.4)	407(24.1)	213(12.7)	81 (4.8)	47(2.8)	24(1.4)
Car damage and personal injuries (301)	73(24.3)	113(37.6)	53(17.6)	38(12.6)	15(5.0)	8(2.6)	1(0.3)
Total (2865)	505(17.6)	954(33.3)	719(25.1)	388(13.5)	165(5.8)	89(3.1)	45(1.6)

*: Number of drivers

** : % of drivers

Table 3: Distribution of interval (delay) between the occurrence of the traffic case and alcohol inspection of drivers.

Time period (minutes)	Total number of cases	% of cases
D - 30	454	15.8
31 - 60	858	30.0
61 - 120	923	32.2
121 - 180	343	12.0
> 180	287	10.0
Total	2865	100.0
Mean + SD	90.78 + 83.34 minutes	
Range	1 - 720 minutes	

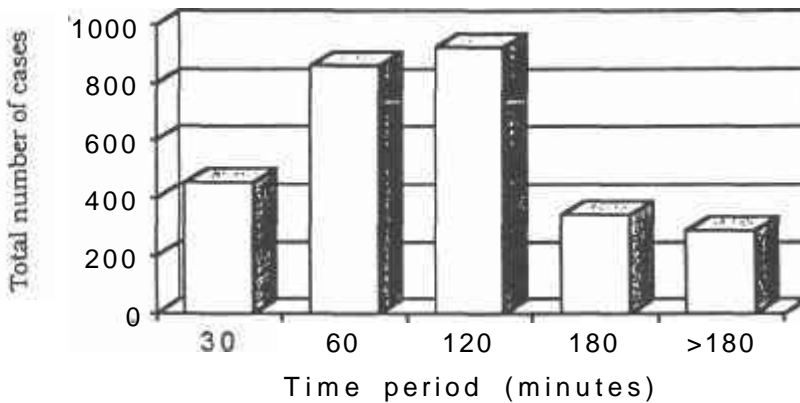


Figure 2: Frequency of interval between the occurrence of traffic case and alcohol inspection.

Table 4. The most important observation is on the drivers where BAC's is legally below the legal limit at the time of alcohol test. 47.9% of the drivers who do not seem committed traffic offence, must have committed traffic offence at the occurrence of the traffic case by the back calculation of BAC.

Table 4: Change in BAC distribution when Widmark factor was introduced in the calculation of blood alcohol levels of the drivers.

Subgroups(N)	Number of drivers		Change in number and % BAC's of drivers by widmark factor		
	BAC ₁ * < 0.50	BAC ₂ **^ 0.50	N	% in BAC < 0.50 promille	% of total
Traffic offences (877)	81	63	18	22.2	0.60
Traffic accidents					
-Only car damage (16B7)	35 [#]	169	182	51.8	6.40
-Car damage and personal injuries (301)	73	31	42	57.5	1.50
Total (2865)	505	263	242	47.9	B.50

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BAC. : Blood alcohol concentration (promille) determined by alcolmeter

2 : Back calculated blood alcohol concentration by widmark factor

DISCUSSION

Our results showed that 82.4% of the total drivers (N: 2865), who involved in traffic offences or accidents within the city centre of Ankara, had BAC's over the legal limit (50 mg/dl: 0.50 promille). The distribution of BAC at intervals 0.50 promille among drivers grouped as offenders and caused accidents (only car damage or personal injury with car damage) can be seen from Table 2 and Fig 1. The highest distribution frequency of BAC in all groups fell between 0.50-1.00 promille. The incidence of traffic cases has increased when the BAC's of the drivers exceeds 0.50 promille in the order of who committed offence (90.8%)> who caused traffic accidents only with car damage (79.2%)> and who involved in traffic accidents with personal injury and car damage (75.7%). As the probability of traffic cases begins to increase significantly over 0.50 promille (the highest frequency is between 0.50-1.00 promille) which we recommended the legal limit in Turkey and currently in law enforcement (5). Those results confirm our previous investigations (5, 6).

The newly formed European Transport Safety Council (TESC) has urged a draft EC directive on a common blood alcohol limit of 0.05% (or 50 mg/dl, 0.50 promille) be implemented (12). From the accident research evidence the Council argues that many European countries with a legal alcohol limit 0.08% or over are endorsing an "unsafe" limit. Only a few countries such as Netherlands, Portugal and Turkey currently have the recommended limit (0.50 promille).

Examination of police records for each drivers showed that there is always a time elapse between the time of offence and blood alcohol test. This interval was ranged from 1 minutes to 720 minutes and mean was 90.78 ± 83.34 minutes (Table 3). As the blood alcohol has been measured after the case and inquiry by the police, averagely 15 hours elapsed at the time of alcohol analysis by the Forensic Toxicology Laboratory.

The status of alcohol absorption in drinking drivers and back calculation of BAC to the time of an offence or accident have important medicolegal implications. "The rising blood alcohol" might be litigated by the suspected drinking driver which implies that the BAC was below the legal limit at the time of offence. In recent years the blood alcohol curve as a function of time, and other variables (beverage type, drinking habits, fasting and individual parameters) in drunk drivers have been reinvestigated (13-17). As the elimination rate of alcohol from the blood of drunk drivers shows a wide range some investigators reported the rate of change of BAC calculated from the blood specimens obtained 30-60 minutes intervals (8, 11). A large percentage of subjects and drinking drivers (90%) have shown peak BAC within 60 minutes (with an average 35 minutes) and they were usually in the postabsorptive state at the time of traffic of-

Table 5: Distribution of time interval between the alcohol ingestion and traffic case reported by the drivers.

Time interval (minutes)	Number of drivers	% of the drivers
Q - 15	5	5.7
15 - 30	6	6.3
31 - 60	9	10.3
61 - 120	16	18.4
121 - 180	17	19.5
181 - 21.0	13	6.7
>240	21	32.3
Total	87	100.0
Mean \pm 5D	143. 86 + 85.05 minutes	
Range	1 - 640 minutes	

fence (8, 11, 13). Range of elimination changes have been reported between 10 mg/dl/h and 25 mg/dl/h with a mean 16 mg/dl/h which is close to Widmark factor (β) (9-11). Although recent experimental results indicate considerably larger standard deviations in Widmark calculations, it is still accepted useful to back calculate BAC's by Widmark factor for evidentiary purposes in criminal cases (18).

In one of our previous survey as shown in Table 5, nearly 80% of the drivers have reported that they consumed alcoholic beverage 60 minutes before the time of case (5). We used Widmark constant β and the elapse time (as minutes) to back calculate BAC of the drivers to the time of arrest, assuming of the drivers in postabsorptive state based on the of above considerations. Our theoretical back calculation showed that 242 drivers (8.5% of the drivers) must have been added to the number of drivers whose BAC's were over the legal alcohol limit.

As a conclusion, the back calculation of BAC at the time of traffic offence or accident has a medicolegal importance for the defense or the criminality of the drivers. The delay between time of the arrest and the time of forensic alcohol test is averagely over 60 minutes as shown in our survey, which means the driver must be in the postabsorptive alcohol state. Therefore BAC of a suspected driver might be over the legal limit at the time of offence although forensic alcohol level was found below 0.50 promille. In recent years there have been some published studies demonstrating the status of alcohol absorption among drivers (13-17). As the elimination rate of alcohol from the blood of drivers show a wide

range, some investigators proposed to back calculate of BAC from the blood specimens obtained 30-60 minutes intervals from the drivers (9, 12). In Turkey there is no published or unpublished data concerning time function for alcohol absorption in drinking drivers and the possible effect of time delay on the forensic alcohol analysis concerning law enforcement. Therefore this survey can be considered as the initiating study in this area in Turkey.

REFERENCES

1. Ministry of Internal Affairs of Turkey: Traffic Accidents Statistics 1990, Publications of General Directorate of Police Dept., Ankara, (1990).
2. Ministry of Internal Affairs of Turkey: 1992 Year Book of Traffic Statistics, Publications of General Directorate of Police Dept., Ankara, (1992).
3. **Ege, R., Oner, R.**, Alcohol and Traffic Accidents, Turkish Foundation of Aid to Traffic Accidents, Ankara, (1986).
4. **Vural, N., Vural, D., Motaceded, Z.**, The Quaty of Alcohol in the Exhaled Air and Blood of the Drivers Causing Accidents, 2nd Int. Congress for Traffic Matters and Traffic Accidents, The Turkish Foundation of Aid to Traffic Accidents, 180-186, (1977).
5. **Vural, N., Saygi, Ş.**, The Effect of Alcohol on Traffic Accidents and Traffic Ofence, *J. Traffic Med.*, **12** (4), 61-65, (1984).
6. **Vural, N., Saygi, Ş.**, A Survey Blood Alcohol Effect on Drivers in Ankara, International Workshop on Drugs and Driving by ICADTS/CBFT/ARFI, Padova, Italy, 64, (1991).
7. The Newsletter of the International Committee on Alcohol, Drugs and Traffic Safety: Drinking and Driving in Turkey, ICADTS Reporter, 3(1), 1, (1992).
8. **Jones, A.W.**, Status of Alcohol Absorption Among Drinking Drivers, *J. Analy. Toxicol.*, 14,198-200, (1990).
9. **Martin, E., Moll, W., Schmid, P., Dettli, L.**, The Pharmacokinetics of Alcohol in Human Breath, Venous and Arterial Blood After Oral Ingestion, *European Journal of Clinical Pharmacology*, 26, 619-626, (1984).
10. **Jones, A.A.**, Disappearance Rate of Ethanol From the Blood of Human Subjects: Implications in Forensic Toxicology, *J. Foren. Scien.*, **38(1)**, 104-118, (1993).
11. Lewis, K.O., Back Calculation of Blood Alcohol Concentration, *British Medical Journal*, **295**, 800-801, (1987).
12. The Newsletter of the International Council on Alcohol, Drugs and Traffic Safety, Safety Council Urges Uniform 0.05 percent, BAC for Europe, ICADTS Reporter, 4 (3), 1, (1993).

13. **Neuteboom, W., Jones, A.**, Disappearance Rate of Alcohol from the Blood of Drunk Drivers Calculate from two Consecutive Samples; What Do the Results Really Mean, *Foren, Scien, Inter.*, 4, 107-115, (1990).
14. **Holford, H.G.N.**, Clinical Pharmacokinetics of Ethanol, *Clinical Pharmacokinetics*, 13,273-292,(1987).
15. **Vural, N.**, Effect of Alcoholic Beverages on the Absorption and Elimination Rates of Alcohol, *Doğa II: Turkish Journal of Medical Sciences*, 2(1), 68-72, (1987).
16. **Gustafson, R., Kallmen, H.**, The Blood Alcohol Curve as a Function of Time and Type of Beverage: Methodological Considerations, *Drug and Alcohol Dependence*, 27,243-246,(1988).
17. Jones, A.W., Jönsson, K.A., Neri, A., Peak Blood Ethanol Concentration and the Time of Its Occurrence After Rapid Drinking on an Empty Stomach, *J. Foren. Scien.*, 36 (2), 376-385, (1991).
18. Simpson, G., Uncertain Validity of Widmark Calculations for Estimating Blood Alcohol Concentrations, *J. Analy. Toxicol.*, 13, 374, (1989).