Retrograde Extrapolation of Blood Alcohol Concentration
A theoretical and practical approach

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The influence of high blood alcohol levels in vehicle drivers involved in car accidents is a growing process, despite the legal punishments which have been already increasing in severity. Therefore, determining the level of blood alcohol concentration at the moment of the car accident is essential in establishing the legal responsibility of the driver. However this exact determination is in most of the cases difficult, due to the fact that between the moment of the car accident and the collecting of the blood in a medical unity a varying time frame passes, depending essentially of the distance from the place of the car accident and the hospital. Even more, from a juridical point of view, at the moment the blood is taken from the driver in the hospital, this is not representing a social danger anymore because he is not driving. Hence, the retrograde extrapolation of blood alcohol concentration is and should be the legal tool of providing the juridical system a valid answer at the question implying the value of the blood alcohol concentration at the moment the antisocial deed (car accident) had been made. The aim of this article is to theoretically present the scientific method of retrograde extrapolation of blood alcohol concentration and also to highlight its strong and weak points.

Keywords: blood alcohol concentration, retrograde extrapolation, car accidents, forensic medicine

According to Article No. 336 of the Romanian Penal Code [1], driving on a public road of a vehicle for which the law requests the compulsory possession of a driving license by a person who, at the time of collecting the biological samples, had a blood alcohol concentration of more than 0.80 g/L of pure alcohol, involves a punishment by imprisonment from one to five years or by judicial fine. Statistically [2], annually, around 2.000 drivers drive under the influence of alcoholic beverages. Legal medicine, by establishing blood alcohol concentration, allows the judiciary officials to make a correct juridical assessment of the driver's antisocial deed. Retrograde extrapolation is the process of estimating an alcohol concentration at an earlier time from a measured alcohol concentration at a later time.

In 2017, a number of 2161 medico-legal expertise have been carried out for the retrospective calculation and interpretation of blood alcohol concentration. There is a *collapse* in the number of such requests (compared to 3722 in 2013, or 3898 in 2012), explained by the implementation of the New Penal Code [2]. Of the 2161 medico-legal expertizes, in 152.17% of cases it has been calculated that the alcohol level at the time of the road traffic event had been greater than 0.80 g/L [2].

Evidence of intoxication induced by alcohol can be determined by several methods [3]:

a. by clinical examination [4, 5]

b. by detecting the presence of alcohol in the expired air

c. by detecting the presence of alcohol in saliva

d. by detecting the presence of alcohol in the blood [6]

In most cases, drivers are tested with breath alcohol analyzers in the event of road accidents or in other cases such as: committing other driving offenses, offenses in connection with them, and random checks. It should be mentioned that this test is not valid in justice.

After a pre-test with a breath alcohol analyzer, in the case of positivation, it will be necessary to collect biological samples (blood) and establish the blood alcohol concentration. From a legal point of view, the problem to be solved relates to the determination of blood alcohol concentration at the time of the antisocial deed and not at the time of biological sampling. This result can be obtained by collecting two blood samples at an hour interval and then using the Widmark formula in order to assess a retrograde extrapolation of the obtained result.

Experimental part

The biological samples obtained in order to establish blood alcohol concentration involve the collecting of two blood samples (venous) of 10 mL each (in a time interval of one hour from each other), which immediately after collecting will be equally distributed in a quantity of 5 mL into two separate vacuum tubes containing an anticoagulant. There are several kits utilized in Romania.

Those biological samples must be collected with standard kits, the prototype presented by the manufacturer having previously obtained the approval of the Superior Medico-Legal Council and the content can be inscribed and sealed so that the kit can be assured.

The forensic expertise for the retrospective assessment of blood alcohol concentration can determine the true value at a time prior to collecting the biological blood samples only during the elimination phase of alcohol in the human body and only within a period of 6-10 h of elimination. The alcohol elimination phase in the human body is objectively detected by using the blood alcohol concentration values previously obtained, the first having to be greater than the second with at least 0.10 g ‰. The subjective driver's statements are irrelevant, and do not contain useful working parameters.

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For the retrospective estimation of retrograde blood alcohol concentration, the phase of elimination on the simplified Widmark curve is graphically reconstructed, determining the moment of the road traffic event and the moments of the two alcohol obtained from the analysis.

The blood alcohol concentration at the moment with legal relevance (the moment of the road traffic event) is calculated by the formula:

$$A_e = \beta \times t(\beta_{60}) + A_1$$

where:

A_e -blood alcohol concentration (g ‰) at the time of the road traffic event

A_1 - blood alcohol concentration (g ‰) of the first collected sample

A_2 - blood alcohol concentration (g ‰) of the second collected sample

β - individual blood alcohol elimination rate (g‰/ h), = $A_1 - A_2$

$t(\beta_{60})$ - the time in the hours, elapsing between the moment of legal relevance and the time of the first blood alcohol sample collection.

Therefore we can determine the real value of blood alcohol concentration at the time of a road traffic event, always situated before the time of the collecting of the two blood samples.

In this article, we would like to draw attention to a major legal impact of a forensic examination, the retrospective calculation of blood alcohol, and the impact that a decision may have on it, decision that establishes certain conditions for carrying out this type of expertise.

Experimental part

Material and method

For this study, the blood alcohol calculated according to the retrospective method, was taken into account, during the period 2012-2018 from the Institute of Forensic Medicine Cluj-Napoca. This type of determination is requested by the investigation or prosecution institutions, to establish the defendant's alcoholism at the time of the offense. The vast majority of cases involve drivers who were driving on public roads after drinking alcohol or having been involved in various road accidents.

The parameters analyzed in these cases were represented by the total number of examinations carried out each year, the value of blood alcohol, specifying the cases that had an alcohol level below 0.8g°/$_{oo}$, the cases of withdrawal of the case file, on considerations related to the applicant or impossibility to perform the required analysis due to lack of data. At the same time, the study also included cases where the judicial institutions asked for the same patient a recalculation of alcohol, after the change of the investigation data present in the case file from the last examination. A statistical interpretation with practical applications in the field of forensic activity has been carried out.

Results and discussions

The retrograde extrapolation of blood alcohol concentration based on the two alcohol values previously established, taking into account the toxicokinetic - elimination phase, related to the time interval between the road traffic accident and the first taking of venous blood sample, can determine that at the time when the antisocial deed occurred, the blood alcohol concentration was higher or lower than 0.80 g/L of pure alcohol. A close value of that concentration will be also provided. This are the latest regulations required by the Superior Medico-Legal Council decision to conduct a forensic toxicological expertise. All this are detailed in the Discussion section.

The results of this study refer to the change in the number of requests for the retrospective calculation of blood alcohol over the years, noting the variations that occurred after certain legislative or internal changes related to this topic.

Thus, the yearly distribution of the cases reveals in 2012 that were requested 322 toxicological forensic expertise for the retrospective estimation of blood alcohol, for 2013, 304 cases were requested, 2014 with 74 requested cases, 2015 with 99 cases, and 2016-2018 were maintained at a close relative value, respectively 114, 118, 119 cases. These changes, especially after 2013, were largely due to legislative changes, to the Criminal Code from the beginning of 2014, and the strict forensic legal regulation of the conditions in which retrospective blood alcohol value can be calculated by the decision of the Superior Medico-Legal Council in 2015. A decrease in the number of cases has implicitly led to a drop in the incomes of the forensic institutions, but the degree of impartiality and interpretation of the results of this toxicological expertise has increased.

Compared to the number of expertise for each year in table 1, we have displayed a breakdown of blood alcohol levels by taking the legal limit of 0.8 g°/$_{oo}$ and the value of 1.5 g°/$_{oo}$ as landmarks.

In this conditions, along with the total decrease of such evaluations during this 7 years, we note a sharp decrease, a visible discrepancy, of the blood alcohol values up to the value of 1.5 g°/$_{oo}$ occurring consecutively to the legislative changes and the procedural norms from 2014 and 2015. The most prominent change is visible in the values below 0.8 g°/$_{oo}$, the impact due to the strict regulations, the conditions for performing the retrospective calculation provided in the decision of the Superior Medico-Legal Council. These conditions as well as other aspects will be detailed and interpreted in the Discussion section of this article.

However, the major effect of these procedural changes is the alarming increase of cases that were rejected by the medico-legal institution, because the retrospective calculation was impossible due to the fact that the conditions of the new regulations for performing this type

Year	The value of blood alcohol- under 0.8 g%0	The value of blood alcohol between 0,8-1,5%0	The value of blood alcohol over 1,5 g %0 including in the right column the cases with values over 2 g %0	
2012	37	233	47	18
2013	39	205	43	13
2014	12	38	10	4
2015	7	51	19	6
2016	2	41	18	5
2017	2	42	20	7
2018	1	37	26	9

Table 1
BREAKDOWN OF BLOOD ALCOHOL VALUES CALCULATED BY THE RETROSPECTIVE ESTIMATION METHOD

of expertise were not met. In this respect, the average of cases refused until mid-2015, when the decision of the Superior Medico-Legal Council came into force, was 11. These refusals to carry out the retrospective estimation blood alcohol were largely due to incomplete data in the files made available by the judicial institution. Subsequently, after the regulation of the forensic toxicological expertise in 2015, the average of the rejected cases, up to 2018 included, increased to 44, most of them by failing to meet the minimum criteria set out in that decision.

The negative effect of this aspect is represented by the unnecessary activity of the forensic expert, who after a long study of the file concludes that the retroactive calculation of the blood alcohol is impossible because the conditions stipulated in the decision from 2015 are not fulfilled, having to return the file with an address, for motivation. At the same time, we notice a lack of communication and information between the medical and the legal system, as the last one seems to have no knowledge of the internal regulations of the legal medicine activity.

We mention that in this study were also taken into account the cases in which repeated evaluation were requested, for the same defendant, after any change of a statement file or after the appearance of some new documents, that could have influenced the initial value of blood alcohol established by the retrospective calculation method. In this case, following the changes implemented by the Superior Council of Legal Medicine, the number of these requests decreased exponentially. If in 2012 there were 39 such requests where almost any change occurred in the files gave the defendant the opportunity to request a new estimation of the blood alcohol level, after 2015 protocol implementation, in 2018 there was only one such request.

Concluding the results, the legislative and internal changes in the medico-legal activity brought both positive and negative aspects in the procedural way of carrying out the toxicological forensic expertise on the retrospective calculation of the blood alcohol level.

At national medico-legal and juridical level, the retrograde extrapolation of blood alcohol analysis has been and it is still a problematic topic from a medico-legal point of view. In the opinion of a large amount of involved persons, this kind of expertise was too often accepted. Probably that is why the Superior Medico-Legal Council issued a decision detailing the forensic activity related to this topic. This has imposed certain conditions to be fulfilled cumulatively in order to consume the type and amount of alcoholic beverages recorded in the police statement, which can only be accepted as an estimation based on a mathematical calculation without being able to perform a certain scientifically validated medical examination. Factors that can influence the blood alcohol concentration are extremely numerous, ranging from the type and amount of alcohol consumed, the time elapsed, food consumption, body weight-to metabolic reactions specific to each organism [7]. Also the blood samples must comply with certain storage and sampling conditions wich, if not complied with, may lead to changes in the alcohol concentration. [8] The forensic activity must be kept within the limits of the law and here we include de decisions of the Superior Medical-Legal Council [9].

The forensic expertise on the basis of the above-mentioned conditions should lead to a single result each time, irrespective of the commission that performs this expertise, so a new forensic expertise report is not justified and the judiciary institution should be informed of this every time. At the same time, on a forensic expertise report that has the purpose of retrospective assessment of blood alcohol concentration, the opinion of the Superior Medical-Legal Council can be requested. [7]

Conclusions

Based on the presented information we can draw the following conclusions:

- the retrograde extrapolation of blood alcohol concentration using the simplified Widmark curve can be a reliable scientific method of blood alcohol estimation.

- this method can estimate whether blood alcohol concentration was above, below or close the legal threshold for the assertion of *driving while having a blood alcohol concentration of more than 0.80 g/L of pure alcohol.*

- an important fact for any retrograde extrapolation is for the subject to be in the pure elimination phase of ethanol kinetics, which cannot be established for sure because there are large population differences in how long full absorption of alcohol may take.

- the elimination rate of alcohol for a certain subject can also vary, because there are also large population differences and elimination rates.

A new report of forensic expertise is not justified regarding the retrograde extrapolation of blood alcohol concentration because there should be only one result indifferent of the commission that performs this kind of expertise.

The implementation of the Superior Medico-legal Council's decision has led to a decrease in the number of toxicological expertise for the retrospective calculation of blood alcohol concentration in relation to the amendments from 2014 to the Criminal Code.

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