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A simple apparatus for measuring the blood urea, manufactured by Dr. Luigj Benusi in 1943 in Albania

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Abstract

The apparatus invented by Dr. Luigj Benusi in 1943, in Tirana, was a practical application of the Kowarsky technique and Ambard laws, helping in determining blood urea levels and very important to a variety of diseases, mainly kidney disorders.

The apparatus was invented and prepared from very simple laboratory materials, such as glasses, test tubes, corks and volumetric cylinders. Technologically, it was based upon the determination of blood urea through hypobromite, and, among the advantages of the apparatus of Benusi, were its extreme simplicity, the smaller amount of blood needed for producing results (2 milliliters), as well as an easiest way to clean up and to manage the apparatus from a practical point of everyday use.

Keywords: Blood urea nitrogen, Ambard law, Hypobromite, Kowarsky method

Introduction

It is well known that determination of nitrogen level and other organic liquids in blood is particularly important. The respective methods and the apparatuses are various, and, as per the expected results, they are more or less precise. In the everyday clinical practice, it may be sufficient even if being a very simple and quick method.

The simplicity of the apparatus we're describing in this article is very particular. Due to the historical conditions of the Second World War (SWW), it was impossible for Albania to import technologies; Dr. Luigj Benusi, at that time, invented a simple way to measure blood urea,

coining a very simple apparatus, made from ordinary materials and means that could easily be found in every clinical or biochemical laboratory of the time.

There are several methods proposed and applied for measuring blood urea. Almost all of them rely upon the application of the hypobromite reagent for ammonia and urea, as introduced by Knopf. The reagent has been prepared by dissolving bromine in strong alkali solution (1). Theoretically the methods conform to the law of Ambard, based upon his extraordinary work regarding urea concentration and output. According to Ambard's

work, the speed of carbamide (synonymous to urea) secretion is proportional to the square of the carbamide-concentration in the blood; and reversely proportional to the square root of the carbamide-concentration in the urine (2 - 4).

The situation of medical services in Albania, after the Second World War, was very problematic. The lack of devices was felt almost in every field. The apparatus described herein, invented by Dr. Benusi, helped a lot in the practical and everyday determination of blood urea nitrogen. The analyses were up to that moment, based upon the Kowarsky technique, but the simplicity of Benusi apparatus was striking, and the applicability in the everyday practice was decisive in the introduction of this simple invention.

The methods differ mainly on the amount of blood necessary for performing the analysis. There were also other methodologies, such as the urease method of Marshall (5) and the calorimetric method of Folin and Denis (6). Benusi apparatus uses the same procedure as applied with Kowarsky or Ambard apparatus and methodology, only the quantity of filter is decreased in 2 milliliter. Apart from that, results were obtained in a very brief period of time; the maintenance of Benusi apparatus was much more simple, and therefore, its everyday use was of great benefit to the Albanian laboratory services of the time.

The history of the apparatus

Dr. Luigj Benusi was specialized in clinical biochemistry and microbiology; in 1945, he was promoted as founder and chief of the State Bacteriological Laboratory in Albania. He was the first one to apply the typhus and paratyphoid vaccine in Albania. Figure 1 is a snapshot from his work in the above-mentioned Laboratory. Due to the severe conditions of the post Second World War in Albanian hospitals, the work of Dr. Benusi and his colleagues served as an incentive for reviving the medical system.

The small apparatus invented in 1943 at the State Bacteriological Laboratory in Tirana was composed of (numbers corresponding to the Figure 2):

1. A glass approximately 6-7 cm long and 3-4 cm wide.
2. A small test-tube 3 cm long, with a diameter approx. 1.5 cm. The tube was prepared cutting an ordinary bacteriological test-tube.
3. A cork of soft rubber, with 1 or 2 holes.
4. A tap obtained from a burette, to be used if the cork has 2 holes.
5. A long glass tube 4 cm in length, with a diameter approx. 7-9 mm, to be adapted to one of the cork's holes. A part of the tube remains in the upper part of the cork.

6. A tube of ordinary caoutchouc 30-35 cm long, a part of which will be adapted to the glass tube; the other end to the small pipe mentioned below.
7. A small pipe of 2 or 5 mm.
8. A volumetric bottle or a cylinder, with a narrow neck so that the small pipe will enter hermetically inside the cylinder. The cylinder will be filled with water mixed with an appropriate amount of sulfuric acid, to impede the contamination.

Methodology and results of the apparatus

The glass no. 1 (Figure 2) is poured with the filtrate (serum or probing solution), thereafter, 2 ml of sodium hydroxide (NaOH) is poured to obtain the whole solution and to assure the acting of NaOH as alkalifying and absorber of carbon dioxide (CO₂). The small test-tube (no. 2, Figure 2) is filled with hypobromite and carefully poured into glass no. 1.

The glass no. 1 communicates through the pipe with the volumetric cylinder; previously, the examiner ascertains that the level of water in the pipe corresponds to the beginning of the gradation. The two systems (glass no.1 and volumetric cylinder no. 8) at the time of the reaction should have no communication with the outer milieu. Complying with this condition, the glass no. 1 is inclined 140° to diffuse the hypobromite inside the glass, making, in the meantime, about 25 quick agitations. Due to the reaction taking place, the level of the pipe due to gas production will decrease.

The quantity of the gas in the pipe lifting it up, and decreasing the water level inside of it, is equal to that in the volumetric bottle, and therefore is measurable. The quantity of gas will indicate, through special formulas, the quantity of nitrogen contained inside the specimen of the glass no. 1 (serum or probing solution).

The system was based on the same procedure for determination of blood urea nitrogen (7, 8) as other similar apparatuses, like the Kowarsky apparatus (9), or the Ambard method [Ambard's or Ivon's hypobromite method apparatus for estimating blood urea] (1-3). The necessary reagents were a 3-chlor-acetic acid solution; NaOH solution 20%; hypobromide sodium solution 3-5%; carbamide solution 1%.

Prior to be applied in the clinical practice, the apparatus was tested using carbamide solution, serum and various urine specimens. The obtained results were compared with those obtained using Kowarsky apparatus. The first test was made through the determination of the quantity of nitrogen produced by standard carbamide solution of up to 1 ml. Other tests were made also using urine specimens of different individuals, diluted

with distilled water. Another test was performed using 5 serum specimens from diseased and healthy individuals.

Carbamide solution is used as a standard equalizing solution, in order to eliminate the use of small particular tables for the correction of nitrogen values according to the environmental temperature and the atmospheric pressure. Each day before starting work, a preliminary test with carbamide was made, serving as a standardizing curve.

In all cases, the results obtained with Benusi apparatus were very similar to those obtained with the Kowarsky one; this was verified through blood specimens, as well as through urine specimens.

Conclusion

Very serious attempts have been made since decades to determine blood urea nitrogen, as well as blood and urine chemistry (10). The results of

reactions obtained from the two apparatuses (Benusi's and Kowarsky's) are quite proportional, therefore, mutually inter-exchangeable.

The most valuable feature of Benusi apparatus is its practicability:

- It can be arranged through simple means that are overall available,
- The reaction develops in a few seconds, whereas Kowarsky method needs 10 minutes,
- The apparatus can be easily and quickly cleaned; the cleaning process of the corresponding Kowarsky apparatus is time-consuming.

We think that this apparatus, used for two decades in our hospitals and out-patient settings, has undergone the proof of time, and may substitute other analogue apparatuses for measuring blood urea nitrogen, based upon the hypobromite methodology.



Figure 1: Dr. Luigi Benusi during his pioneer work in the State Laboratory of Tirana, 1945. Courtesy of Tartari F., Albanian Society of Urology

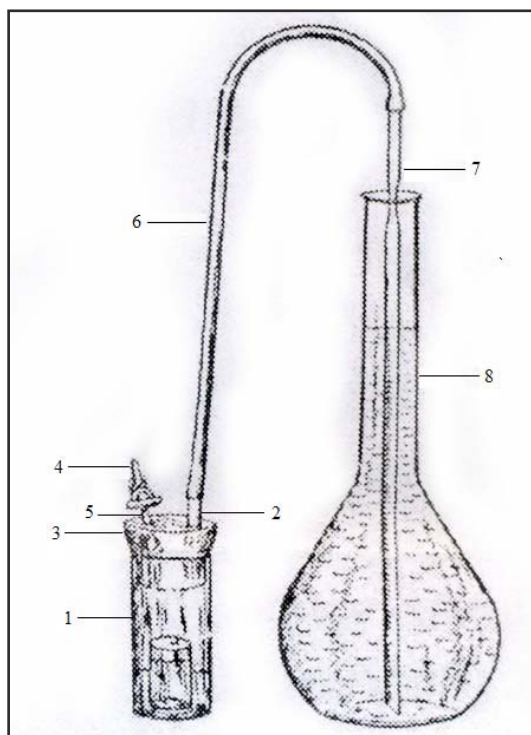


Figure 2: The composition of the apparatus

Numbers correspond to the above explanation.

When the small pipe (no. 7 in the Figure 2) is put inside the bottle, the water level must correspond to the beginning of the gradation of the small pipe.

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