

Johan Kofstad. Presentation Oct.14th. 2022.

First many thanks to my friend Professor Dr.Gustavo Zubieta Calleja for inviting me to the 8th Chronic Hypoxia Symposium Oct 2022. We met in Copenhagen when Gustavo was visiting professor in the medical faculty. We had many interesting meetings with prof. Poul-Erik Pavlev, the great Danish physiologist. I worked at the University Hospital in Oslo from 1962 to 2004. My specialty was «Inorganic Clinical Biochemistry» with a focus on blood gases. acid-base and electrolytes.

I got much of my special education in blood gases and acid-base in Copenhagen in the 1970s with prof. Poul Astrup and prof. Ole Siggaard-Andersen as teachers.

Is it great interest for high altitude medicine in Norway? I will answer yes. But we have no higher mountains in Norway than 2469 m.above sea level, so we have to travel to Himalayas, Andes, Alaska and Kilimanjaro in Africa to feel the hypoxia. In 1985 11 Norwegians reached the summit of Mt. Everest. They brought with them some equipment for measuring hematocrit and blood volume. One of the participants had 69% hematocrit and had to get much fluid intravenously. The other 10 were instructed to drink much water. They had no equipment for measuring blood gases. 1985 was to early for this. As a curiosity, I will mention that when they were at the top it was some interest in comparative physiology. How could the birds flying many hundred meters higher be so active? When back in Norway, it was done some research on the blood of that type of bird. Some years later the conclusion of the blood gases on the top was values of the alveolar gas to pO₂: 3,8 kPa (28,5 mmHg)and pCO₂:1,3

kPa (10 mmHg). These values were from extrapolating values from values measured at about 6500 m.a.s.l.

I was present at two world congresses in high mountain medicine in the Andes (Arica) in 2000 and Lhasa in 2004.

I will tell you a little about the mountain rescue service in Norway. We have 2 organizations for mountain rescue. The oldest is the Norwegian Red Cross Rescue service, which started in 1932, with about 18000 members today. They are organized into about 300 groups situated around Norway. They are educated in first aid and they are well-trained for heavy tours to help and save people. They will also turn out for accidents in the lowland. But we have very many mountains in Norway, in particular in the west and north of Norway. The other organization is new, started in 1982, and was called «The Norwegian Society for Mountain medicine». It is difficult to tell how many members. There are about 20 organizations as members. As examples are 1. Norwegian Medical Association with many specialities relevant to mountain rescue, 2. Air ambulance, 3. Groups in our military system with advice for relevant equipment and many other specialties. The Norwegian Society for Mountain Medicine is more theoretical than the other, and they send out much relevant information for traffic in the mountains.

The 2 organizations have cooperated to make the 9 mountain rules for traffic in the mountains. One example is: 1. You must always bring with you a compass and maps and you must know where you are on the map. 2. example: You do not need to be embarrassed or ashamed to turn back to where you started where you are safe!

We are also a member of an international organization called IKAR.

IKAR means International Commission on Alpine Rescue. It was started in 1948 in Austria with Germany, Switzerland, France, Italy, and Austria as members. Norway was a member from 1970. One of the subdivisions is the medical group. In 1984 we had a big avalanche catastrophe in northern Norway. 17 soldiers were killed. I had a presentation in the medical group in 1985 with the results of postmortem findings.

10 of the 17 were performed a postmortem examination. 9 of them had a very stiff heart. The heart had perhaps stopped in the systole.

This was a comfort for the family of the victims, as this finding indicated a sudden death and not a long-lasting time of suffering.

I will now present some highlights in blood gas and acid-base for mainly the period 1962 to 2022. We got our first Astrup instrument in 1962 and I got the job to instruct the daily users of this instrument.

pCO₂ was not measured directly with an electrode, but we had to do calculations and used the nomograms in the user manual.

Ole Siggaard-Andersen presented officially in 1964 how to quantify the non-respiratory component in acid-base imbalance. Schwartz and coworkers in Boston argued that Base excess (Blood) was not independent of pCO₂ in vivo. Siggaard-Anderssen modified later the Base Excess (B) to Base Excess (extracellular fluid) which later has been called standard base excess. In 1978, in the fifth meeting of International Federation of Clinical Chemistry

Expert Panel on pH and blood gases in Copenhagen, I showed that the four most used blood gas instruments at that time, AVL, Corning, Instrumentation Laboratory and Radiometer used quite different algorithms for calculating Base Excess. (both BE(B) and BE(ecf) were given out at that time on the instruments). All the instruments used pH, pCO₂, and ctHb in their calculations, IL used in addition pO₂.

I simulated 81 different acid-base disturbances and the calculations showed different values for both types of BE, in particular metabolic alkalosis. I proposed that the Expert Panel should work for better standardization for calculations of BE(ecf). The different manufacturers took in the new standardized algorithm, and we could later show that the results of BE (ecf) were very like on the different blood gas instruments. The standardization led to increased use of cBaseExcess (ecf) in clinical work.

I will now tell you about the «The Great Trans Atlantic Acid-Base Debate» which existed for many years.

The use of the «metabolic parameter» in acid-base disturbances is still under much discussion. The «Boston school» cannot accept BE. They use actual bicarbonate as the metabolic parameter. The «Copenhagenschools» answer that actual bicarbonate is a mixed parameter. It reflects both metabolic and respiratory changes in the acid-base balance. Professor John Severinghaus tried to calm down the discussion and bring the two schools nearer each other. He published «Acid-Base Nomogram. A Boston-Copenhagen Detente!» This article was turned down by the «Boston school».

At the beginning of the 1990s, I bought from the US a textbook about

Blood gases and acid-base. The author was prof. Martin. In the introduction, it was written:» There are four reasons why I do not use Base excess in blood gas interpretation. The terminology is confusing, particularly when BE is negative and one hears the term negative base excess. Some laboratories calculate BE for blood, while others calculate for extracellular fluid. The formulas are very complicated and nothing any clinician needs to know.»

In the year 2000, it was arranged a word conference in the town Elsinore, north of Copenhagen, where the castle Kronborg is situated. Here the famous figure Hamlet, whom Shakespeare wrote about, lived. The performance the last evening of that conference we were watching this play. I got the honor of the Danish committee next day to thank the congress and wish all delegates a nice journey home. BE was one of the main objects of this congress. My last words were: « To BE or not to BE, that is the question.» To Base excess or not to Base excess----- will all delegates perhaps remember from this congress, I hope!

I was pensioned in 2004, but I have tried to keep up with teaching blood gas the whole time. I wrote a textbook in blood gases with the title: «Blood gases, electrolytes, and hemoglobin.» in the Norwegian language. The book was sold in Denmark and Sweden also.

From 2020 to 2022 I have published about 40 articles on «Facebook» for medical students, and personnel in the laboratories which work with blood gas samples (105 participants). The title on Facebook is under Group: Blodgasser-PNA.

Thank you all for listening to my presentation. I am ready for questions! Johan Kofstad