Help for sustainable self-help.

Klaus Züchner

Employment of a team of medical technicians in the Black Lion Hospital
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Report and outlook for the future.

History

For more than 10 years close relations have existed between the Department of Anaesthesiology, Emergency and Intensive Care Medicine at the University of Göttingen, Germany (Zentrum Anaesthesiologie, Rettungs- und Intensivmedizin, ZARI), and the Department of Anaesthesiology at the Black Lion Hospital, University of Addis Ababa, Ethiopia. They were initiated by the anesthesiologist Dr. Reintraut Burmeister-Rother, who was working in Addis at that time and who founded the School of Anaesthesiology, educated nurses and established the 6 bed intensive care unit, ICU, at the Black Lion Hospital. In Germany Dr. Burmeister was and still is strongly supported by Professor Dr. Dietrich Kettler, acting director of ZARI. He and his colleague Professor Dr. Hans Sonntag not only went to Addis to supervise final examinations of anaesthesiologists, but they also made it possible for two Ethiopian anaesthesiologists, Dr. Kinfu and Dr. Manikule, to complete their medical education in Göttingen. Furthermore, intensive relationships developed in the field of anaesthesia engineering. Initially, in the years 1993 and 1995, Wilfried Fraatz, a senior medical technician of Göttingen, together with Dr. Rupert Pöschl serviced and repaired ventilators, anaesthesia machines, monitors, defibrillators, infusion pumps, etc. Starting in 1997 under the direction of Dr. Klaus Züchner, Head of Anaesthesia Engineering at ZARI, a step-by-step improvement of the medical gas supply for the ICU at the Black Lion Hospital was initiated. In 1999 a team of medical technicians (Wilfried Fraatz, Wolfgang Wollner, Johann Moser) subsequently installed an oxygen concentrator as the source of oxygen, and finally in 2003, after installing a duplex compressor system, performing extensive repair and upgrading work, the same team (reinforced by Horst Pfitzner) completed the gas supply for the ICU, and turned it over to the responsibility and competence of the Black Lion Hospital and a local medical technical company, the Pharma Share Co. This company is managed by the German born Addis resident Mr. Karl Hildebrandt and now also by his son Markos.

All those medical technical activities have been financially supported by an association called "Anaesthesiology in Developing Countries" (Anästhesie in Entwicklungsländern), founded and headed by Professor Kettler up to now. Additional substantial support came from the manufacturer of the oxygen concentrator, F. Stephan Medizintechnik GmbH (Gackenbach, Germany), Lufthansa Germany, Hope e.V., the German embassy in Ethiopia and countless private donations and activities.

Today, it is our legitimate hope that the supply of oxygen for the ICU, which is essential for intensive care patients, is sustainably ensured, that vital important lifesupporting machines can be used reliably, and that all necessary repair and maintenance work can be executed quickly by qualified technicians on site.

Now is the time to reflect on the experience gained with this project, to make it accessible and beneficial to other users, and to discuss future possibilities.

Why is the oxygen supply so important?

Oxygen is required to maintain the metabolism of the organism — no life can exist without sufficient oxygen! Ambient air contains approximately 21% oxygen, the remainder consists mainly of nitrogen (78%) and Argon (1%). For healthy people this is fully adequate for breathing; however, in many lung or circulatory diseases the supply of oxygen must be increased. The administration of oxygen is fundamental to many medical treatments.

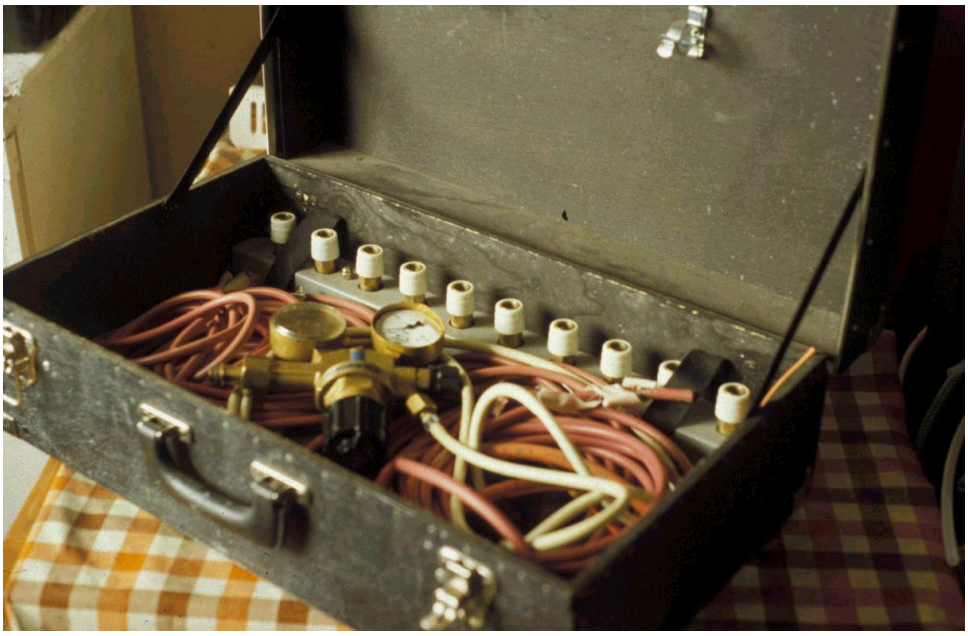
Addis Ababa, the capital of Ethiopia, is located on a high plateau about 2500 m above sea level. This in itself causes a distinct reduction in the barometric pressure and as a consequence a direct reduction of the oxygen availability for the organism. Thus, a supply of oxygen for the patient is even more important.

There are many methods of producing, transporting and storing oxygen. Cylinders of stainless steel and filled with oxygen under high pressure are well known. They are bottled in special factories under strict safety precautions and require special regulators and gauges for safe dosage of the oxygen. These heavy cylinders must be transported carefully and secured safely, and a sufficient supply must always be guaranteed. The reality we observed was very different. Fittings were often defect, the dosage and distribution of oxygen was imprecise, and the cylinders could only be filled to a maximum of 150 bar. They were sometimes positioned in the centre of the ICU, and we heard reports about falling cylinders and the resulting injuries.

Picture 1. Oxygen cylinder adjacent positioned to the patients bed (before 1997).

Picture 2. Defect oxygen pressure regulator (before 1997).

Summarizing the situation at that time was simple: There was no safe and reliable oxygen supply, and patients and personnel were endangerd by the improper equipment. Furthermore, this unsatisfying situation consumed a substantial fraction of the local health care budget that could have been better used for drugs or additional equipment.



Picture 3. Inappropriate distribution device (before 1997).

The step-by-step solution

The improvement was implemented in several steps. First, in 1997 the ICU was equipped with a safe and leak-proof distribution system for oxygen, terminal outlets for compressed air and electricity for all ICU beds were concurrently installed. Two manifolds were wall mounted on opposite sides of the room, and equipped with all necessary outlets for three beds on each side.

Picture 4. Wall-mounted distribution manifolds for oxygen, compressed air and electricity (1997).

Initially this distribution system was supplied conventionally with oxygen from the neighbouring room, which had been used as a storeroom until then.

A significant improvement was achieved in 1999. A state-of-the-art oxygen concentrator system was installed in the storeroom, providing the distribution system with both compressed air and oxygen of more than 90%. This concentration is excellent for medical purposes, the patient's individual oxygen concentration requirements are then made by blending oxygen with air.

Picture 5. Oxygen concentrator, buffer tank and reserve cylinders (1999).

The concentrator method

Producing oxygen from ambient air with a concentrator conforms to a simple but extremely effective principle, using the so-called “molecular sieve”, a crystalline compound made of aluminium and silicon oxides. It acts like a sponge with precisely defined pores, i.e. nitrogen is retained in these pores at a defined pressure of air; the former is thus separated from the remaining oxygen and argon. The oxygen content is therefore “concentrated” up to more than 90%, the residual mixture being predominantly argon and nitrogen. This oxygen enriched air or “concentrator oxygen” is fed into a buffer tank from which it can be distributed to the terminal units in the ICU as needed. Nitrogen is returned to the environment, which causes no problems if the room is sufficiently ventilated.

The particularly advantageous aspect of the concentrator method is the possibility of producing oxygen “on-site”, thus avoiding losses during transport or storage and producing only exactly the required quantity of oxygen. If the device's capacity is adequate, it provides a permanent, and always adequate source of oxygen. Natuarally, the availability of electricity required to drive the compressor is mandatory. Short-term power failures can be buffered by tanks. Other requirements — which can be easily achieved — are drying and filtering particles that could potentially clog the molecular sieve's pores out of the compressed air. Apart from this the molecular sieve will not be consumed or altered. Only the compressor requires regular service and maintenance.

Special problems involved in producing concentrator oxygen in a developing country

It soon became evident that the compressor is the crucial component in the process of producing concentrator oxygen. Unfortunately, due to limited financial resources, the initial installation in 1999 utilised only one compressor for both purposes, oxygen production and compressed air supply. This resulted in a continous work load and compressor failure at an early stage. This fault could not be fixed by sending a key component for its repair, and therefore a complete new compressor was shipped to Addis. Even this only solved the problem for a limited period of time until a concentrator valve malfunction caused new problems. The lack of knowledge and information about how to repair and maintain the whole system on site was evident. It was therefore necessary to ensure the availability of this knowledge in Addis parallel to integrating two compressors into a duplex system with equally distributed work load and back-up security.

Previous, unfavourable experiences with training of personnel in Göttingen were discouraging. At that time the trainees could use their newly obtained skills more profitably elsewhere and were soon no longer available for work at the hospital. Therefore, an excellent solution was to contract the local Pharma Share company established more than 40 years ago in Addis and now managed by father and son Karl and Markos Hildebrandt in second and third generations, respectively. They employ native technicians and especially Mr. Lakew Tiluhan, trained by Ethiopian Airlines, is now a highly experienced expert also in medical engineering. Before the group left Göttingen to perform the last service in 2003 he received special training at the manufacturing company for medical gas compressors, Atlas CopCo, and in oxygen concentrator technology at the F. Stephan GmbH. He is now skilled and experienced enough to fully maintain and service the compressor and concentrator unit, which is meanwhile adequately sized and equipped. Mr. Tiluhan is supported and assisted by Mr. Befekadu Mekonen, a high-

ly motivated technician at the Black Lion Hospital, who also has acquired extensive skills in this technology during both installation periods of the concentrator system.
The Göttingen association is working on obtaining a service contract with Pharma Share Co. to ensure the long lasting functionality of the system, guaranteed by the skilled and responsible work force of these two technicians and a supply of spare parts from Göttingen.

Picture 6. Duplex compressor system, compressed air buffer tank, filter assembly and switching unit together with Dr. Kinfu of the Black Lion Hospital.

Outlook

Utilizing concentrator technology to produce oxygen for medical use is not only beneficial for developing countries, but highly developed countries may also profit from this inexpensive alternative to conventional oxygen supply. Not only in remote or potential disaster areas like oil rigs, high mountain regions, clearing hospitals, hospital ships or aircraft can concentrator oxygen be produced safely and at low cost. Independent doctors or clinics and hospitals could use this technology to cut costs. However, the current stipulations of the European Pharmacopoeia impose severe restrictions on its use. The International Standard ISO10 083, Oxygen Concentrator Supply System for Use with Medical Gas Pipeline Systems, currently under revision with our participation, is not applicable for using concentrator oxygen in Europe. The concentration for medical oxygen (>90%) stipulated there is lower than that prescribed in the European pharmacopoeia (>99%) and may therefore not be used in Europe. No risks are

known; on the contrary, long-term experiences from other countries, such as Canada, clearly demonstrate the advantages of the method. The installation in Addis may therefore be of assistance in obtaining approval for this modern technology in Europe, as well.

In future, the installation of the oxygen concentrator in Addis may be the reference location for this technology in other countries of this region. In the near future, robust medical technology, developed for Ethiopia and similar countries could be proven at the Black Lion Hospital. This could well be the place where such adapted technology could be developed, proven and taught, thus adding a centre for medical engineering to the Black Lion Hospital.

At present Professor Kettler is discussing the future possibilities of securing long-term ties between Ethiopia and Germany with the German Association of Anaesthesiology and Intensive Care Medicine (Deutsche Gesellschaft für Anaesthesiologie und Intensivmedizin, DGAI). The experience with the Black Lion Hospital prove that they are of mutual benefit and should not only be continued but also strengthened and expanded in the future.

Dr. Klaus Züchner
Georg-August-Universität
Bereich Humanmedizin
Zentrum Anaesthesiologie, Rettungs- und Intensivmedizin
Robert-Koch-Str. 40
37099 Göttingen
Germany

Phone +49 551 39 8862/8820
Fax + 49 551 38 6421/8823
e-mail kzuechn@gwdg.de
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