Service and installation visit to Malawi August 2013

Evidence based visit report

Introduction

Following the sale and delivery of a further Glostavent anaesthetic machine to join the more than 70 already in the country and a request to go to the hospital to set it up it was decided to carry out a wider visit for servicing and maintenance as required. Hospitals known to have Glostavent anaesthetic machines were contacted and asked if they would like to be visited; more than expected replied positively to this request and a wider project than the original was developed.

In order to assist with this two local Anaesthetic Clinical Officers, Kenneth Kapatuka and John Gawanika were asked to assist. In addition Dr Goddia at QECH was made aware of the visit during the AAA Congress (All Africa Anaesthesia Congress) held in Cairo, and Dr Pollach and Dr Hans-Joerg Lang were also contacted; the former at Queen Elizabeth Central Hospital (QECH) and the latter at Kamuzu Central Hospital.

Diamedica UK Ltd has been supplying Glostavents to Malawi for almost a decade, although contact has been maintained with a number of hospitals and requests for parts have always been responded to the last visit by any representative was some years earlier.

Summary

The Glostavent anaesthesia system has been designed specifically for use in difficult situations, with or without electricity and compressed gases. It is the first anaesthetic machine that meets the WFSA Performance Standard for Anaesthetic Equipment for Low and Low-Middle Income (LMIC) Countries.

The Glostavent is currently operating in over 50 countries, 27 in Africa and in other harsh environment locations such as Iraq, Afghanistan and Bangladesh. It is the only anaesthetic machine that provides its medical gases, oxygen and air, from the integral oxygen concentrator, making it very economical and reliable. It also includes a gas driven mechanical ventilator, oxygen flush and power stabilisation / battery back-up.

In addition to anaesthetic equipment the company has also more recently supplied a number of oxygen concentrator based baby CPAP machines, principally to Dr Lang at
Kamuzu Central Hospital. Although only introduced last year these machines are deployed in 10 countries and are assisting with the reduction of neonatal mortality rates.

**Programme and findings**

The following hospitals were visited between 3rd August and 15th August.

- Mpingwe Hospital
- Palau Community Hospital
- Malamulo Hospital
- Adventist Hospital Blantyre
- Queen Elizabeth Central Hospital
- Partners in Hope Hospital
- Nkhamenya Mission Hospital
- Ekwendeni Mission Hospital
- Kamuzu Central Hospital
- Trinity District Hospital
- Nkhoma District Hospital
- Mulanje Mission Hospital
- Thyolo District Hospital
- Embangweni Mission Hospital
- St Johns Hospital
- Rumphi District Hospital
Glostavent overview:

During the programme 16 hospitals were visited and a further 4 contacted, between these hospitals there are a total of 31 Glostavent anaesthetic machines and 10 CPAP machines. The overall number of Glostavents physically examined was 26. Of those examined 17 required no work at all, although general servicing and updating was carried out. Three required minor work to make fully operational and 3 required more work and parts replacement and one required reassembly after being wrongly dismantled. Of the remaining 3, two of the machines at QECH needed new concentrators and one of those had a non-repairable ventilator, but as they were 8/9 years old they are unlikely to be re-commissioned. That left just one that had been dismantled in Lilongwe and too many parts had been lost or reused to even determine if or what the fault was. The pictures on the attached file show all those currently working and a few additional interesting items. It has also become clear on the trip that there is a need for an anaesthetic refresher course for the newly qualified operators and in addition training for technical staff who appear to have little understanding of the operating principles of some equipment, in particular oxygen concentrators.

The most common maintenance issues found related to filters on oxygen concentrators, leaks to patient circuits and UPS battery discharge. In addition 2 ventilators required replacement control boards, 2 required power board replacements and one required a new battery.

Further work replaced 2 working electronics boards with upgraded boards and all replacement of these boards was accompanied by upgrading of the ventilator solenoid valves to a more modern version.

All vaporisers were checked for thymol build up but none required servicing, although one sight glass needed changing and some filler caps replaced.

![Status of 26 Glostavent anaesthesia machines examined Malawi August 2013](image-url)

Note: The 26 machines serviced varied in age, some up to 10 years old.
Oxygen concentrators:

A number of the oxygen concentrators were cleaned and missing or dirty gross particle filters replaced. Two concentrators at QECH were beyond repair due to age (8/9 years old) and reports of oxygen concentrator ‘low oxygen output’ were found to be largely incorrect, except in 2 cases where filters were blocked. All OCSIs showed concentrations of oxygen above the level set by ISO 8359. In the cases where low oxygen was showing, replacement of the filters did solve the issue. Reports from technicians that the zeolite in concentrators had ‘run out’ shows a lack of understanding of the principles of the working of these machines.

Situation example: St John’s Hospital Mzuzu, the hospital has a 2007 Glostavent that we found disassembled. Technicians from Physical Assets Management (PAM) had told the hospital staff that the concentrator was not producing oxygen as the zeolite had run out and it had been removed from the workstation. Fortunately they had not removed it from the hospital. There followed a Glostavent scavenger hunt to find the other parts and the circuits. After checking the concentrator I could not find anything wrong with it and the OCSI was indicating normal oxygen production, so the machine was reassembled. Some alterations to the gas flow were required to overcome missing components. It all functioned normally, concentrator, vaporiser, circuits, control panel and flowmeters. We used the machine to provide oxygen to a spontaneously breathing patient and the saturation immediately rose from 94% to 99%, a fair indication of appropriate oxygen provision. To further demonstrate the machine we moved it to the adjacent theatre and took over the anaesthetic for the ongoing total abdominal hysterectomy. Using halothane the patient was ventilated for an hour with oxygen supplementation at 2 litres per minute and her saturation did not fall below 100%. Surgery finished, the patient was moved to recovery.

Electrical power and UPS:

Electrical power in Malawi can be variable with usually short interruptions, at Malumulo Hospital the voltage fluctuated between 180-260 volts. Voltage stabilisation is vital on equipment and lack of it contributes considerably to premature failure of equipment. Battery back is also very useful to overcome short interruptions. All Glostavents are supplied with on-line, double conversion UPS systems. However the batteries in these systems should ideally be replaced at 3-4 year intervals. There are also issues of lack of understanding with these devices, they must be switched to line or normal mode or they will either work in bypass or from battery mode, depleting the batteries early.
Conclusions

Oxygen concentrators are a very cost effective means of oxygen provision for the right application. One of the oldest Glostavents at QECH (2004) is in Obs/Gyn and is still working having done 26,190 hours, the equivalent of 8 hours a day, 365 days a year for 9 years. The concentrator was showing a low oxygen light but this was fixed by cleaning of the filters (it had done 7 cases the previous night). In its lifetime it would have produced at least 6,000,000 litres of oxygen, if that was purchased in cylinders what would have been the cost? With this type of saving over so many years it can be shown that the Glostavents have not only provided excellent service but they have done it in a very cost effective way.

Recommendations

1. Ventilation:
The surgical capacity in Malawi is increasing, with greater focus on specialist provision, plastic surgery, neurosurgery etc; the anaesthetic service in Malawi must keep pace with this growth and to do that it must have the appropriate equipment. Many of the hospitals visited are still heavily reliant on old manual systems using vaporisers such as the PAC and OMV together with manual inflating bellows. While these systems have served well and are appropriate for shorter more basic provision they become problematic for longer more complex cases. If the anaesthetist is tied to the machine ventilating the patient it is difficult for them to monitor the patient properly, administer drugs and deal with emergencies. In addition there is a limit to how long an anaesthetist can continue manual ventilation and it cannot be continued for long post operatively. Therefore mechanical ventilation should be available in all theatres in Central Hospitals and recommended in District Hospitals as well.

2. Patient Monitoring:
A further recommendation should be the greater provision of appropriate patient monitors. The most useful parameters would be NIBP, ECG and pulse oximetry with heart rate, with additional capnography monitoring in those centres where it is deemed necessary.

3. Anaesthesia Training:
Training was found to be a common area of discussion in most anaesthetic departments, many younger anaesthesia providers expressed an interest in refresher type courses that have in the past been facilitated by the WFSA and future courses of this type would indeed be of benefit.

4. Training of Technical Staff:
Technical staff training is also an important issue to ensure greater understanding of the common issues relating to anaesthetic and ancillary equipment. The vast
majority of problems and servicing on equipment such as the Glostavent and oxygen concentrators require limited tools and parts, but does need an understanding of the operating principles of the equipment and a logical approach to fault finding and repair. In addition greater communication between the users (anaesthetic staff) and the maintenance technicians would greatly improve the chances of accurate equipment intervention.

5. Oxygen Concentrators:
Oxygen concentrators provide an inexpensive and convenient alternative to cylinder or piped oxygen supply. Over the course of the visit to these 16 hospitals it became apparent that many of the hospitals have multiple oxygen concentrators, produced by a variety of manufacturers that are no longer functioning. This means that alternative sources of oxygen have to be sourced, mainly very costly cylinders of gas. The majority of these obsolete oxygen concentrators have been produced cheaply by manufacturers who have not designed them for such conditions as are found in Malawi.

A recent study has evaluated different models of oxygen concentrators and compares their performance under challenging conditions of humidity and high temperatures. A copy of this report is attached.

This study confirms that the Glostavent anaesthesia machine is supplied with the most reliable oxygen concentrator for the market. The origin, pedigree and suitability of oxygen concentrators should be determined before future purchases of oxygen concentrators for hospitals in Malawi are made.

Acknowledgements:
My thanks go to Kenneth Kapatuka and John Gawanika for all their help and introduction to anaesthetic staff across Malawi.

It was a pleasure to meet and talk with the many anaesthetic personnel in the hospitals that were visited, their professionalism and dedication to providing the best possible service for their patients was clear and it is of great importance to provide them with the appropriate equipment, support and opportunities for continuing professional development to ensure that continues.

We would like to also thank our many customers who give us so much support and positive feedback. Below are just two of the many thank you messages we have received following the visit to Malawi:
Ryan Hayton, Head of Surgery, Malamulo Hospital:
“Thank you for coming to Malamulo Mission Hospital yesterday. I truly appreciate it. The work you do makes a real difference in my work as a missionary surgeon and directly impacts the lives of the Malawian people. We did over a thousand surgeries last year. Zero deaths in the theatre. Zero anaesthesia catastrophes. Zero morbidities due to anaesthesia. Part of that success is due to you and the Glostavent.”

Bernadette Huyton, Feet First on behalf of Rhumpi District Hospital
“On the teams trip to Malawi in June they visited Rhumpi District Hospital in the north. While working there Dr. Allan Monks came across a Glostavent anaesthetic machine that sadly was not working. On Allan's return he contacted Diamedica the company that makes the anaesthetic machine to see if anything could be done. He was informed that Robert Neighbour of Diamedica would visit hospitals from the south to the north of Malawi including the Rhumpi District Hospital. Robert was able to fix the anaesthetic machine. Robert will now stay in touch with the hospital and follow the machines progress. ‘Feet First’ would like to say a huge thank you to Diamedica for their help in fixing the machine which will enable very essential life saving surgery and life changing surgery to be carried out once again.”

Robert Neighbour CEng MSc FIET

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Attachments: oxygen concentrator study paper (Anaesthesia July 2013)

Note: The following sample pictures provide are provided in support of the above document and the equipment condition and its location.
Ventilators from district serviced at QECH

QECH

QECH (EYE)

QECH (Obs)

Chickhwawa

Adventist Hospital
“Oxygen Concentrator grave yard”