

NEWSLETTER MAY 2000

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Affiliations

Australian Federation for Medical and Biological Engineering
International Federation for Medical and Biological Engineering

SMBE (SA)/Drager Biomedical Engineering Encouragement Award

As mentioned in the last newsletter Ian Hill was the winner of the inaugural award. Now is time to start thinking about nominating people for the 2000/2001 award. We surely all know someone who has contributed to our discipline and is worthy of such a nomination. You may even wish to get yourself nominated so now is the time to put pen to paper. Nominations will be called in the not too distant future. If you need more information about the award contact any of the Council or look on our web site.

The award is truly a valuable one, not only in monetary terms, but also in the value to the winner in attending the seminar.

The following comment received from Ian Hill after attending this year's seminar attests to this.

"The SMBE 2000 12th Annual Country Biomedical Engineering Seminar was to be my

first introduction to this type of gathering of Professionals. I use the word "Professionals" in every sense as it so rightly deserves. The Seminar was of an extremely high calibre, most informative and enjoyable, certainly not to be missed and I would encourage all to attend next year if possible."

Christmas Dinner sponsorship

In the last newsletter I thanked all those companies who sponsored our Christmas Dinner. Council also wish to thank MEDTEL for their generous support for the 1999 dinner.

Technical Meetings

Unfortunately I do not have a meeting to advertise at the moment. However on June 6 2000 the joint program with IEAust etc will feature Ian Hill and John Stevens who will both be talking about their experience in PNG. From reading Ian's article this will be a meeting not to be missed. John Stevens also spent 3 months in various parts of PNG with AusAid and from discussions with him since he has been back his talk will be very interesting and entertaining. More information will be posted closer to the meeting.

Part 2 Twinning Project "Biomedical Engineering" in PNG by Ian Hill

CSSD

There were two large wall mounted steam sterilisers, one of which had a faulty temperature gauge.

Tobias seemed to think that he was getting to the bottom of it and would have it up and running again fairly soon.



Theatre 1

The main operating room had a new Datex-Ohmeda Excel Anaesthetic Workstation with Halothane Vaporiser, 4700 Oxicap, 7000 Anaesthetic Ventilator and a Hewlett Packard MiniShot 78352C Monitor. The oxygen concentration couldn't be measured and naturally wouldn't calibrate on the Oxicap and there were no back up gas cylinders what so ever. The oxygen and nitrous oxide cylinders were free standing in the corner and there was no scavenging system. There was also a new Fisher and Paykel open resus. cot with Neopuf, Twin-O-Vac and two oxygen flowmeters (different makes, Precision and CIG). The suction unit had a clogged gauge and had low suction only. The aging operating table would not hold its height setting. The Valleylab SSE2L ESU had only a small sticky back plate electrode that was well past its usefulness and a box full of broken diathermy pens, it was in a positively dangerous state. The pens were "hot" in either cut or coag depending which was plugged in and the only control was via the output setting knobs or turning the whole unit off. The Sigmoidoscope had a blown bulb and the Surgeon didn't know how to assemble it. The Wisap Insufflator was adorning the cupboard with no CO2 cylinder.



The Hospital asked me to convey their sincere thanks to Kevin O'Brien for the generous donation of back plates and pencils for the ESU. The GP's, now taking on the role of Surgeons, were also extremely pleased as it made their difficult task somewhat easier!! There are now no Surgeons at Mendi therefore the elective surgery list is performed by Doctors.

Theatre 2

Sterility with a boarded over broken window was non existent in our standards of healthcare and the only effort was in maintaining the number of people in either operating room to the basic minimum.

An old non pin indexed N2O Regulator connected to a very basic Boyles Anaesthetic machine hovered in the corner. The LifeScope OEC-6102K had flat



batteries and the Millenium Bug; not that anyone would even notice if they used it. One of the two Halothane vaporisers was not working, the pulse oximeter needed a new probe and again the laryngoscopes were lacking a range of blades. There was a small bench mounted autoclave and a Storz Light Source with a blown bulb but no light lead. The Bird Respirators Mk7, Mk8 and Mk10 were still chuffing away but would require a major service. I found the Olympus Gastroscope in the Administration Department but no light source apart from a Fujinon unit that had a rodent population lurking inside. The Midget Anaesthetic machine was in suprisingly good condition considering the number of times it was thrown into the back of a twin cab to attend a RTA.



Theatre 2 (note the stained linen)

Dental Department

The Ainsworth Whetstone only had one grade of grit wheel, which was not suitable. The remaining laboratory equipment was in a serviceable condition. The Ultrasonic Scaler didn't work, the motor didn't work on the belt driven polisher, the mouth rinse taps had no water flow due to blocked venturi jets. All the remaining equipment was just satisfactory.

Tobias arrived the next day and his office hadn't changed apart, from his desk, which had grown leaving even less floor space. The office was again filthy and needed cleaning out before a start could be made on servicing the well overdue oxygen regulators and flowmeters. All the oxygen regulators were serviced and I am surprised they didn't explode with the amount of contamination inside. I had noticed a marked improvement in the ward areas as we serviced each area throughout the hospital. There were isolated pockets that needed to be worked on, but in general I hadn't noticed the stench that I remembered from my last visit.

The equipment was beginning to look grubby again and hadn't been kept clean. There was no ECG cable for this machine and the appearance was indicative for most of the equipment.

This time round, I was observing and correcting how the staff were actually using the equipment plus stressing the importance of keeping everything looking like new.

The humidifiers were all full of algae and badly stained and still being passed from patient to patient. The supply and introduction of oxygen "T" piece connectors enabling two flowmeters and humidifiers to be connected to the regulator alleviated this problem, after all the bottles were scraped clean and sterilised.

I was constantly monitoring the use of the flow therapy equipment and I think that the message finally sank in after a tutorial with all the senior nursing staff, where I invited them to choose which of the "good", "bad", or the "ugly" humidifiers they would use for themselves.



The senior nursing staff decided on the best positions to mount the sphygmometers on the walls, 2 in ICU, 2 in A/E, 1 in Surgical, 1 in Delivery and 1 in the Children's Ward. I found an old mobile sphygmometer stand discarded in a cupboard and this was added to one of the A/E units. During the weeks, I found more of these stands but left Tobias to sort out the remounting should he be asked. All of the laryngoscopes were repaired as too were the combination Otoscopes mainly all needing new bulbs, luckily I remembered to bring a selection of spares, or minor adjustments to make them work. The defibrillator in ICU worked, was still plugged in and covered in dust. Unfortunately due to the huge voltage fluctuation of 185 to 250 plus the lightning storms that appeared every lunchtime both fuses had blown plus damage to the battery charging circuit resulted in having to send the defib to Lae for repair as it was not possible in Mendi. The cost of spare parts in PNG is astronomic and you could pay just over \$1,100 for a pulse oximeter finger probe costing only \$400 here in Australia.

I have shown Tobias how to look after the Theatre instrumentation and to do minor repair work and cleaning. With regards to cleaning, the area behind the sterilisers was a dumping ground, as too were any non inhabited areas, and was cleared before we even attempted to start to repair the non-working steriliser also covered in decades of dust and droppings of the rodent type. The sterilisers seem to eat up heating elements at an

alarming rate, they do not throw out the replaced ones and not having any service records it is hard to determine when anything had been done.

I was all set to be driven to Mount Hagen at the crack of dawn, the first weekend during my second visit, to collect the visiting AusAid/MEMP Biomedical Technician but nobody turned up. The phones were out so I assumed we weren't going and went for a walk up the road to Tari where I was welcomed by friendly locals wanting to take me off into the mountains to a cave full of bones! I wanted to see the waterfall that I had heard about and was escorted by the land owner to the spot and no further.



I was informed by the young boys that appeared (as if from thin air) and were happy to talk to me every step of the way in very good English that there were some "Rascals" about and that the land owner's daughter worked at Kiburu Lodge. She actually arranged a guided bus tour for the following week-end which was fascinating, breath taking and exciting at the same time. The driver knew everybody and we were invited into peoples homes, shown how they make fire, the lattice work for the walls of their huts and spears and arrows. We even came across a few young men with red mud stripes on their faces and carrying the biggest bush knives I've ever seen. I am glad the driver knew them as I could sense a bit of tension in the air and definitely cameras hidden out of sight was recommended.

Fire Equipment

Joseph (CEO) went off to Medang for a meeting and asked me to look at the fire fighting apparatus around the hospital which, at a courtesy glance, looks very good, but on closer inspection was non existent. The covered fire hose reels were empty, the fire extinguishers were empty even though some indicated that they were full and there was no means of turning on the stand pipes to get any water.

On inquiring "what if ...?" the answers were that they would fetch buckets of water and put the fire out. However, nobody could find me a bucket nor a water supply. I did eventually find one hand wheel that fitted the stand pipes but was not game enough to



try turning it on in case I couldn't turn it off again. The hoses or what remained of them had been dumped in a door way near to the cafeteria.



The biggest threat would be the resident rodent population of 300+ chewing through an electrical cable causing a fire and the whole place would be raised to the ground. The electrical fire alarm system has already been eaten away. This was a fairly well equipped and built Bush Hospital for its time but through neglect and ignorance is hanging on by its finger nails.

Steven Threlfo, the visiting AusAid Biomedical Technician finally turned up mid week on the last leg of his 5 month circuit tour of PNG and started an inventory check with Tobias. With the inventory check completed in a day and a half, it was time for an electronics and literacy skills test for Tobias. The test had been prepared by NSW TAFE for MEMP. Each selected local technician had to sit this in order to find a starting point for a future 42 week full time course in Port Moresby for a Biomedical Technician's Diploma.



Whilst Tobias was sitting his test, it gave me the opportunity to give some hands on computer tutorials to some of the staff. There is only one working computer and that was in the Inservice Coordinators Office, which I was told didn't have any more room on it. The desktop screen was covered in notepad letters, none of which had been filed in any sort of order, nor did anyone know how to. After tidying up the screen and filing it all

away, some of the staff had some idea how to use it. Joseph's computer had blown its hard drive but was still under warranty which meant shipping down to Port Moresby for repair.



There is a lot of equipment that has associated hardware for example the endoscopic light source and gastroscope, one works but not the other, and unfortunately in this instance the most expensive part needs repairing. It would cost around \$4000 for a total scope rebuild and needs to be sent to the manufacturer. The Ohmeda Excel Anaesthetic machine had no oxygen sensing device what so ever and no spare filters for the Oxicap, but boxes and boxes of gas sampling tubes. By the state of the one in use I am assuming it was the original and even more surprised that it was sampling at all due to the blackened filter, whether all these problems will be addressed by MEMP, remains to be seen.

One of the most moving moments that I experienced was the open vocal mourning at death, in this case it was unfortunately a young child, all the relatives joined in the moaning and crying lasting all day until the body was taken home in the evening. You soon get use to this ceremony as there are a great number of deaths.

Tobias and I designed a large wall cabinet to house all of the newly AusAid donated theatre instrumentation (46 medium sized boxes stashed away in the boardroom). There was a suitable wall in CSSD that could house them all. The carpenter was on holiday and hopefully the unit would be built when he returns. We were going to utilise some "new" glass fronted AusAid donated cabinets. These had been stored away for years and were buried under a pile of rubbish in what is going to be the new Biomedical workshop.

Unfortunately, all of the eighteen cabinet's glass fronted doors, through poor packaging (made in India), hadn't survived. Once uncovered and cleaned up, they were spotted by the real owners (Dept. of Health) and reclaimed. We managed to rescue 6 new adjustable beds also buried and got them into use before the Department of Health had spotted them and laid claim to them.



Dept of Health

The last day seemed at first to be a bit of an anti climax as we had covered so much over the past four weeks until a truck brought in what was left of the victims and an injured 3 year old with gun shot wounds from a tribal massacre. The Biomedical workshop is next door to the mortuary and not wanting to be swept up in what was going on, I went for a final ward round. I was given very graphic details of what had taken place on my return.

A farewell afternoon tea was provided for my departure where much speech making and fond farewells were exchanged with a presentation of a wooden PNG bird of paradise carving for my office, a billum bag, some local basketry and a few trinkets for my wife (Dog's teeth necklace!).

I left Mendi feeling totally drained, emotional but extremely satisfied with what I had accomplished. I had made a lot of new friends and they had made me feel very welcome with their friendly hospitality and eagerness to learn.

Conclusion

The project was a huge success with the bonus of meeting with the visiting Biomed from MEMP in so far that I am confident that there will be continued support and training in this field. There are two full time training courses scheduled, the first for 26 weeks and the second for 42 weeks starting in February 2000.

All the staff were pleased to see me again, giving them the added confidence that they were not alone, and throughout the weeks working with them there was a marked improvement in their working practices. The ancillary staff were actually going round, without prompting, picking up rubbish and removing dust and cobwebs. The roaming dog problem still remains so to does the open rubbish tip.



Additional areas we touched on:

Health and Safety issues, which was non existent;

Infection Control, which was minimal;

Standard Operating Procedures, never heard of, but thought to be an excellent idea;

Fire Fighting, which was non existent and;

Basic computer skills, file handling and the Millenium Bug.

First of all my thanks must go to Chris Overland (CEO) and the Mount Gambier and Districts Health Service Board of Directors for allowing me to return to Mendi. My thanks to Joseph Turian and the Mendi General Hospital Board of Directors for the lavish accommodation and sustenance supplied by Kiburu Lodge during my stay in Mendi. Apparently my previous stay at the Lodge was free of charge, so I hope they get just as good a deal this time. I would also like to thank Yellerman (a reformed mass murderer!) for transporting me back and forth each day and hopefully he gets over his bite marks from his intended inlaws. Four Pigs and K4,000 was not enough for his chosen bride.

Kiburu Lodge



Ian H. Hill

Chief Biomedical Technician December 1999

The following article from the Papua New Guinea Weekend National newspaper of February 4-6 2000 gives a insight into he not so pleasant side of PNG.

CANNIBAL SHOCKER. Police reveal horror in Madang village.

A MAN killed another man and then ate his eyes, testicles and heart in a shocking act of cannibalism in a remote part of Madang province this week.

Angry relatives, shocked at the gruesome scene, attacked and killed the alleged killer and chopped the body to pieces. Police who were treating the situation as a double murder yesterday reported the gory story of how the 35 year old man, in a fit of anger, chased his victim, killed him and then ate the body parts.

"He gorged the eyes, testicles and heart out of his 58 year old man and ate them. The villages stood and watched in shock," provincial police commander Superintendent Ben Simanjon said from Madang yesterday.

Acording to Supt Simanjon, an argument had erupted bewen the two men, Yakamp Makatu and Moropia Silkapi, at the Ono Works camp.

Mr Simanjon said Silkapi had gone to Makatu's village and burnt down his house after an argument. Makatu retaliated by chasing Silkapi into the bush where he chopped him in the face with a bushknife.

"Though Silkapi was injured and covered in blood he managed to fend off Makatu and chased him," Mr Simanjon said. He said when Silkapi eventually caught up with Makatu, he got a rock and smashed it on his head, killing him instantly.

Mr Simanjon said after killing him Silkapi committed the act of cannibalism. He said after seeing this grueome attack, the vilagers chased the killer into the bush and tied him up after catching him. He said Makatu's relatives learnt of his death and took revenge by chopping up Silkapi into pieces while he was still tied down. Police were called in to investigate the incident but the villagers had all fled into the bush taking with them the bodies.

Travelling Fellowship to USA

John Kirby, North Western Adelaide Health Service

Houston

The Texas Medical Centre (TMC) campus is the world's largest medical and health centre for patient care, research and education. The TMC is an organisation of 42 non-profit health care providers.



John Kirby, Dr. Yadin David, Jim Shanahan

The Texas Children's Hospital (TCH) is located within the Texas Medical Centre and is the largest paediatric hospital in the United States and the primary teaching hospital for

the Baylor College of Medicine. Dr. Yadin David is the Director of the Biomedical Engineering Department and Director of the Centre for Telehealth at the TCH, who hosted my visit. The Texas Children's Centre for Telehealth provides doctors and patients from around the world access to the diagnosis skills of Texas Children's paediatric specialists and sub-specialists.
www.texaschildrenshospital.org/Telehealth/CenterInfo.htm

Through use of video, audio, and Internet technology, Texas Children's specialists can consult on difficult cases, read X-ray film, view specimen samples under a microscope and watch children interact with developmental education specialists. The centre was established in 1993 and was the world's first paediatric based Telemedicine program to go live.

The hospital has five separate campuses which have been fibre optically cabled through out between all clinical departments. The infra structure is set up with a total of 165 separate fibre channels from a video server within the hospital, 30 of these are for patient cable TV, this helps defray the cost of cabling. This cabling is separate to the I.T. data network as it only transmits video. Any relevant clinical equipment with a video output is connected to this video network, enabling clinicians from anywhere within the campuses to view the real time clinical information on one of the 135 channels designated for that department. This enables diagnosis to be undertaken remotely by specialists from their own local video monitor and can talk to the examining physician by phone while viewing the real time data. Typical areas would include foetal ultrasound, cardiac ultrasound and catheterisation lab, endoscopy, PACS and any monitoring stations.

The hospital is in the process of publishing a paper where an evaluation was made of remote diagnosis verses local diagnosis, it appears that the remote consult has detected clinical problems that the local physician had not seen. The remote physician has control of the camera and is able to see within the incubator from 4 different cameras. This has been a surprise result to most at the hospital. The majority of physicians would normally think that they could diagnose more clearly with the added "touch and feel" of a patient. The main aim of using this technology is to avoid transportation of the patients, as that may introduce trauma in a neonate.

There is a permanent 2 Mb/sec (T1) telecommunication line to a remote community hospital about 500km west of Houston, near the Mexican boarder. Staff at this community hospital have been trained in the clinical use of Telehealth technologies. One of the technologies used, has been taking clinical pictures with a digital camera of skin and other clinical problems, then emailing the image together with the patient information back to the Centre for Telehealth at the TCH. This technology is known as "Store and Forward" and is normally used for the transmission of static images, including Radiology and Dermatology images. This hospital also has a document camera and a General Examination camera, which has the ability to combine power zoom, auto focus, frame capture and electronic polarisation in one device (not available in this country yet).

All clinical consultations to overseas hospitals are connected at 384 Kb/sec bandwidth or

higher, as they consider most diagnosis is not good enough below that bandwidth. There is a relationship with Russian, Polish and Malaysian hospitals, where fee for service specialist consults are conducted on a fairly regular basis. All consultations outside of the hospital are on a fee for service basis, which has enabled the overall service to be cost neutral.

One instance of a consultation was during a realtime hook-up into a Russian operating theatre, where the cardiac specialists at the TCH were giving advice during this complex procedure to the surgeons operating.

Strategically, the organisation will be designing and building a telehealth control centre for the NASA manned flight to Mars in 2007. A full telemetry monitoring system will be designed, together with a self-help software package, due to the time difference of any transmission requiring help. Currently all monitoring is done from the main Houston Space Centre, but it is considered more efficient to have the medical communications direct to a hospital that specialises in telehealth.

It is interesting to get a perspective of what other countries are doing. Each State is spending large amounts of money on telehealth activities, particularly with their rural communities to enhance the quality of care provided to them.

I found spending time in the USA a cultural shock, as there was money freely spent, even in health. USA State Governments spend considerable sums on systems infrastructure to ensure that they are technologically up to date. One of the main advantages of these types of trips are the contacts made, I have been in constant contact with Yadin David since arriving back to Australia and hope to provide each other with different information.

Telecon 99 West, Anaheim.

The conference Telecon 99 West held in Anaheim was very dynamic (as only the Americans can do), as it is the largest conference and exhibition on telehealth in the world. My presentation titled Telehealth - A Tool That Enhances Health Service Delivery, The North Western Adelaide Health Service Experience, was well received with an audience of approximately 150.

There were about 200 exhibitors at this year's Telecon 99 West, all directly or remotely related to the teleconferencing industry. The main highlights of the conference were video conferencing over Internet Protocol and Streaming Video. Companies are incorporating streaming and H.323 into their products.

Voice over I.P. was considered to be a major application that could boost the Internet, the only major concerns are the Quality of Service aspects, which is the same with video. New protocols are being developed to cope with the massive expansion expected of Internet use.

The main new VC products were 2 new releases from Vtel's Galaxy which appeared to

be a good multi media platform with joystick remote and PictureTel / Intel's Teamstation release, which appeared to be a big improvement on the earlier version, improving connectivity and features.

The new General Examination Camera from AMD AMD-2500 video imaging system is the first camera to combine power zoom, auto focus, frame capture, and electronic image polarisation in one device. www.americanmeddev.com. This camera is currently only in NTSC, but by April/May there will be a unit with PAL format available.

These general examination cameras were very popular in the USA health units, due to their versatility. Another new release was the AMD-3875 12-Lead Interpretative ECG for PC combines unparalleled ease-of-use, flexibility and portability. The AMD-3875 converts any Windows 95/NT platform into a real time 12-lead ECG machine with Interpretation when connected to the serial port of a PC.

I was disappointed to find that the POTS unit ViaTV 8*8 units are no longer manufactured, the company is now using the same chip set for security systems, where there is a higher demand; they only sold around 200,000 units. Some units are still available. There were three new POTS units on display that I saw, the C-Phone is a combination POTS or ISDN with a US price of around the \$800. Fully standards compatible for both methods of communication, a good low cost solution.
www.cphone.com.

World Wide Video Inc. www.wvv-usa.com had a small unit positioned on small 4 legs, it looked a little fragile but the image

was good. The TeleEye 324TV sold by PicturePhone <http://picturephone.com> seemed a similar unit to the 8*8, with good image properties.

Wireless video conferencing was interesting, with the ability to transmit over 100metres to a codec, while maintaining full duplex conversation with the remote site.
www.premierwirelessinc.com

There were a large number of broad-band video companies with streaming video from many sources including satellite, cable and the Internet. Quality of service is the main issue with the lower bandwidth units

Sessions

Some of the Telehealth sessions were interesting in the mind-boggling amount of money being spent on the programs.

Arizona Telemedicine Program at Phoenix www.ahsc.arizona.edu/atp/program has had state wide funding for 3 years using T1 links to Tuscon and ATM switching up to T1 for all other lines. Mainly links with small under served areas, also rolling out to all prison services. Each local site has a paid co-ordinator 0.5FTE and a ¼ FTE Medical Director. There are 270 specialists involved with the project at this time.

At this stage 59% of cases have been store and forward using a digital camera, 2100

teleradiology cases. The break-up of links were:

Routine Diagnostic 42%

2nd Opinion 15%

Medication Check 18%

Psychiatry 15%

Adult 55% and Geriatric 14%

Turn around time 1 day - 12%, 2 days - 6%, 3-7 days - 40%.

6 Home patients using POTS technology.

They have created a full training room to teach Telehealth good practice with an instructional CD ROM. The room can simulate all equipment in a consulting room.

Oklahoma State University gave a talk on low cost solutions, but very little detail about what they actually did. They used standard equipment with ADSL communications technology rental of US\$40 - \$150 / quarter, depending upon use for a T1 bandwidth. ISDN T1 costs around US\$200 / month.

Marshfield Clinic Wisconsin, comprises of 38 regional clinics and two community based hospitals. The clinic is currently providing services Psychiatry, Dermatology, Occupational Medicine, Haem/Oncology, Emergency Services, Radiology, Nurse Triage and Disease State Management. The 8 main centres are connected at T1 although 384Kb is the normal communication bandwidth, with occasional full T1. They have 5 rural sites that use POTS technology due to their location.

It has been important for them to standardise patient records across all sites. They have not used Store and Forward technology as there is no method for them to get paid for the service. Their protocol says that a medical/nursing practitioner must be with the patient during the consultation. The main types of Telehealth have been :

Patient assessment/evaluation.

Intervention (clinical care).

Counselling

Supervision and Preceptorship.

Professional to Professional.

Streaming Video that Cornell University have developed, is designed for a large number of roving clinicians between campuses, to enable them to view the Medical Rounds on their Intranet. A partnership was formed with Microsoft to design the software required. The main software is Netshow 3.0 and Media Player, they found that Real Player was not reliable enough to be used. There is currently 30 sessions stored on the Intranet video server. www.distancelearning.cornell.edu

International Survey of Clinical Engineering Departments

Twelve years ago an international survey of clinical engineering departments (CEDs) was

conducted by Monique Frize. Due to the important changes introduced to the sector it was felt that updating the information on the current situation worldwide was needed. The present survey, launched in July 1998, was performed in two successive stages, using structured questionnaires. The first stage involved a questionnaire aiming to identify the structure, personnel, responsibilities and resources of the departments in different countries. More than 1000 questionnaires were distributed all over the world, both by regular mail and through Internet. The second stage has the objective to investigate trends in current practices and addresses selectively those institutions, identified from the first stage, as having well established clinical engineering services. The results from the first stage are shortly presented below.

In total 150 valid responses were received and were grouped in regions as following: North America (USA and Canada), Nordic countries (Norway, Sweden, Finland, Iceland and Denmark), West Europe (Germany, the Netherlands, UK), South Europe (Italy, Greece and Cyprus), Australia and Latin America (Argentina, Brazil, Cuba and Mexico). The samples from Eastern European countries, Asia and Africa were considered inadequate and were excluded from the analysis. Figure 1 shows the regional distribution of answers.

Figure 1: Regional distribution of answers

A good range of hospital sizes from about 100 up to more than 1500 beds was obtained. The predominant are teaching institutions. Generally, irrespective of the hospital type, a problem in handling financial data by CEDs was observed. Questions related to replacement value of biomedical equipment in hospitals, approximate budget for new equipment per year, replacement value of biomedical equipment under the CEDs management, were not always answered.

The majority of responses are coming from departments, that exist as separate units. Few answers came from hospitals where the clinical engineering services function as a part of another department, revealing this to be 'plant operation' or 'engineering services' in North America, 'technical department', 'medical physics' or 'medical physics and bioengineering' in Australia, 'clinical physics' or 'technical service' in Europe, 'engineering' or 'maintenance' department in Latin America. More than 70 % of all respondents however are satisfied with their reporting authorities despite the fact that they vary greatly in the different countries.

In all regions CEDs are staffed predominantly with BMETs (biomedical equipment technicians). However in some departments in the Nordic countries and Latin America, the number of engineers is equal or sometimes higher than the number of BMETs. In North America and Australia the number of engineers is relatively small compared to the number of BMETs. In Europe, very high percent of the CEDs employ engineers with Ph.D. degrees, in North America the majority hold M.Sc. degree, while in Australia and Latin America the predominant degree is B.Sc. In North America and Australia, all BMETs have 2 year technical education following high school. Nevertheless, there are BMETs with B.Sc. degrees and some in USA and West Europe hold even M.Sc. degrees. In Latin America all departments employ engineers, while in all other regions studied there are departments identified without any engineers. On the other hand, there are departments in Latin America and in Europe that do not employ any BMETs. CEDs in all regions still remain predominantly male work place however more than half of them have

at least one woman employed. Most departments, in all regions report inadequate staffing levels.

Training and continuous professional development of CED personnel appears to be a common practice in most regions with the exception of Latin America. The highest frequency of training courses is in North America, Nordic countries and West Europe, where engineers and BMETs follow courses on the average every 6 months. In South Europe the majority follow courses once per year, while in Australia, once or twice every two years. Few departments in North America and South Europe report no training at all, while this is true for the majority of CEDs in Latin America.

CEDs in North America and Nordic countries usually support larger number of devices than the departments in other regions. In the majority medium-sized (501-1000 beds) hospitals in North America and Nordic countries and in the large (more than 1000 beds) hospitals in all regions, CEDs support more than 4000 devices and equipment valued more than US\$ 20 millions. In the most large hospitals, CEDs support even more than 10000 devices. More than half of the large hospitals in North America, Nordic countries and West Europe support equipment valued more than US\$ 40 millions.

In assessing resources available to CEDs, comparisons were based on the value of test equipment, spare parts inventory and budget as a percentage of the replacement value of the equipment under CED management. Quite a number of respondents did not answer these questions. Based on the responses received however, it seems that the available test equipment and spare parts inventory are considered adequate, except in Latin America. Budget allocations are higher in teaching hospitals. Space allocations appeared to be most generous in the Nordic countries, followed by Australia.

Finally the survey showed that computerized systems for equipment management and quality assurance have widely penetrated the CEDs. The majority of them feel well accepted and recognized in their institutions. The main problems faced, are lack of highly qualified personnel and cost constrains. Both engineers and BMETs responded that a harmonized worldwide certification scheme would be useful.

In an attempt to collect more answers and therefore more representative results, we would like to invite biomedical/clinical engineers currently working in hospitals all over the world, to participate in the present survey by filling out the attached survey form or contact us.

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