Integration of the clinical engineering specialist at a high complexity children’s hospital. Our professional experience at a surgical center

M J Vargas Enríquez, B Chazarreta, D G Emilio, E Fernández Sardá
Surgical Center-Neurophysiology Division of Medical Tecnology Department, Garrahan Children’s Hospital
Combate de los Pozos 1881, Buenos Aires, Argentina
E-mail: mvargas@garrahan.gov.ar, bchazarreta@garrahan.gov.ar, demilio@garrahan.gov.ar, esarda@garrahan.gov.ar

Abstract. This document aims to find relating points between the current and future Clinical Engineer professional in order to discuss about the hospital environment, its characteristics and its realities which lead to our professional development. The main aim is to depict our experience through a retrospective analysis based on the underwriting experience and consequently to arrive at conclusions that will support the inclusion and active interaction of the Clinic Engineer Specialist as part of a Hospital’s Surgical Center.

1. Introduction
In the last decade the Surgical Center (SC) has added new technologies for the treatment of high complexity pediatric patients (HCPP). Our area, which was planned as a maintenance area, started an increasing process of integration to the assistance and administrative management areas. The technological advent promoted the diversification and differentiation of the specialties, the training of all the health team and interdisciplinary tasks. It also increased the complexity and uniqueness of certain activities, transferred some of the operating costs to maintenance and raw materials and induced to updating all the acquisition processes.

Our role as part of the Medical Technology Department (MTD) must have acquired other nuances and responsibilities in order to be able to respond to the new and urgent necessities of the institution, such as the development of common language and criteria with users at the operating room, the understanding of the medical technological requirements and the proper documentation at the moment of purchase, the assessment of the adequate vendor to our environment, and the consequences resulting from the integration of such technology, and the continuous adhesion of knowledge for the maintenance and training for the user of the equipment which we are in charge of.

All this complex procedures determine the main goal of the technological update, such as, to strengthen the promotion of medical services to become more efficient, reliable and safe for the patient and its environment.

1 To whom any correspondence should be addressed.
2. Characteristic of the SC at a high complexity children’s hospital: our physical integration.

The SC, since its very beginning, added procedures that were developed to have an integral management of the HCPP with surgical diseases, so as to meet the demands that stem from the services of its own and the ones provided by other centers, such as the scheduled and emergency services. This was carried out in different ways and stages through the acquisition of equipments, methods, medical and surgical strategies, and also organizational and support systems that will be adapted to the requirements and urgencies of the area.

The main issue faced that needed to be solved was the delay in the access and supply of support of the welfare technical support services (WTSS), among which the MTD was included, even though it was a member of the maintenance services. Taking into account the extension of the hospital, the centralized structure of services supply and deposits and the location of the WTSS and MTD (see table 1), the decrease of the answer time as a critical factor of the emergency services was one of the main goals of great importance to attain in order to assure the accurate performance of the surgical activity. Therefore, the physical integration at the SC was executed through the rearrangement and allocation of the WTSS and MTD. They acted as peripherals of their central dependencies in charge of responsible professionals and provisioned the supplies and assistance by means of adjusting their performance to the SC’s needs.

| Technical Support Services | Distance to SC (meters) |
|----------------------------|-------------------------|
| Central Pharmacy           | 250 m                   |
| Central Sterilization      | 230 m                   |
| Central Hemotherapy        | 60 m                    |
| Central MTD               | 200 cm                  |

It is important to point out that the space assigned to our department was consistent to what was initially expected. Our job was delimited to find obvious failures which did not need any kind of special measurements nor complex usage analysis, since we did not have the require tools nor the measurement instruments to perform our job, and we had little experience in the medical application of the equipment.

3. Surgical context with de HCPP

As a team, we had no great experience in the surgical context within the hospital except for one of the three technicians who had been developing some tasks in the SC before. Even though we had the knowledge concerning the equipment and the demands, we did not know the specific cause of the urgencies and necessities of the hospital, nor many other issues such as the regular workflow, the number of surgeries of each specialty, the transplant preparations, the variety of surgical services and certain raw materials and the human resources involved in each procedure.

We found an organized structure to carry out a rough amount of sixty daily procedures in three functional units: the central surgical unit (CSU) located at the SC equipped with twelve operating rooms prepared for transplants, programmed and emergency surgeries of high, medium and low complexity; the peripheral surgical unit (PSU) which includes five peripheral operating rooms for programmed surgeries of high, medium and low complexity and the peripheral anesthesiology unit (PAU) for anesthesia supply for programmed diagnoses and treatment procedures which need a full collaboration of the patient (see tables 2 and 3).

| Table 2. Yearly amount of procedures divided by specialties subject and functional unit of sc. year 2006[1] |
We gradually acquired the knowledge of the different strategies which were drawn up specifically for the treatment of the HCPP. This allowed us to size up our current and future professional development, where the daily activity of the SC (see table 4) is constantly determined by variables such as the number of daily consultations, the number of vacant hospital beds, the amount of surgical services and available operating rooms and the relationship between the technological and human resources needed per patient.

All this process, which gives rise to particular needs, is determined by the relationship between the hospital and the pediatric patient, defined as every children and adolescent from its birth to its sixteen years old, considering its biological, psychological and social aspects [3].

The services involved in SC work in an interdisciplinary way to adapt the environment in order to protect the physical and mental health of the HCPP during the surgical procedure according to his acute and base pathology, his collaboration and understanding level. As an example, we can mention what happens when a patient enters to the SC in the pre-anesthesia area, where a workshop is run by teachers. While waiting for the surgery, the patient does several complementary games and recreational activities which are also done at the presurgical internship room. The patient access to the operating room accompanied by one of his parents or other relatives. Once at the operating room the patient is received by the nursing team and gets in touch with the anesthesiologist and also with the

| Specialties        | Unit  | Procedures |
|--------------------|-------|------------|
| General Surgery    | CSU   | 2197       |
| Cardiovascular     | CSU   | 696        |
| Plastic Surgery    | CSU   | 753        |
| Neurosurgery       | CSU   | 857        |
| Opthalmology       | CSU   | 897        |
| Otorhinolaryngology| CSU   | 183        |
| Spine Disease      | CSU   | 252        |
| Liver Transplant   | CSU   | 130        |
| Traumatology       | CSU   | 1577       |
| Urology            | CSU   | 426        |
| Burned patients    | PSU   | 426        |
| Respiratory endoscopy| PSU  | 920        |
| Gastric endoscopy  | PSU   | 1268       |
| Hemodynamics       | PSU   | 598        |
| Interventional     | PSU   | 609        |
| Opthalmology       | PAU   | 1154       |
| Oncology           | PAU   | 595        |
| MRI                | PAU   | 62         |
| Radiation Therapy  | PAU   | 591        |
| CT                 | PAU   | 966        |

Table 3. Daily average procedures divided by functional unit of SC year 2006[2]

| Unit                          | Daily Average Monday to Friday |
|-------------------------------|--------------------------------|
| Central Surgical Unit        | 30.0                           |
| Peripheral Surgical Unit     | 15.3                           |
| Peripheral Anesthesiology Unit| 13.5                           |
| Total SC                     | 58.7                           |
anesthesia technician and the kinesiologist in order to assess the respiratory function. They talk to the patient and invite him to participate in some activities like painting or playing games. For the purpose of alleviating the fears and anguish the patient is entertained with these games according to the patient’s age. The anesthesiologist teaches the youngest how to blow into the anesthesia mask as if it were a balloon [4].

|                         | Total   | Daily Average | Days of assistance |
|-------------------------|---------|---------------|--------------------|
| Surgical diseases       | 247211  | 988.84        | 250                |
| consultations           |         |               |                    |
| Vacant hospital beds    | 471     | 420.87        | 365                |
| Procedures with         | 15120   | 41.42         | 365                |
| anesthesia              |         |               |                    |
| Surgical procedures     | 11789   | 32.30         | 365                |

**Table 4.** Total demand and daily average year 2006 [5]

4. **Surgical and anesthesiologist technology growth: Our functional integration**

In the last years several technological innovations were made in the SC as a result of the continuous search to minimize the invasion of the treatments, to increase the reliability of the procedures and optimize the surgical times of anesthesia and internship. The design of equipment and instrumental increasingly including more specifics and safety, along with the obtained results, encouraged the diffusion of new techniques in the different specialties. The growing improvement of the minimal invasive criteria for surgery and anesthesia for the HCPP stemmed from this uninterrupted process.

These new and available technologies allow us to analyze its different issues: technological, economical, maintenance and healthcare service. Technologically speaking, the relationship between invasive and applied technology is inversely proportional: the lesser the invasive a procedure, the more advanced the technological resources needed. In the economical field, if we consider that the cost of the technological development of the most reliable and safety processes will be transferred to the market price of the equipment and instrumental, we can say that the relationship between technology and costs is directly proportional. In other words, the more reliable the technology applied, the greater the initial investment. From the maintenance point of view, the budget spent in raw materials, spare parts and repairs keeps a tight relationship with equipment costs, so our maintenance cost will rise. And last but not least, we analyzed how helpful it would be for the patient, if his life quality is improved thanks to the application of these technologies.

This last issue will always be the starting point for a medical and technological choice, which is to fulfill the clinical needs but all the underlying issues cannot avoid the analyses. Faced with the budget increase for equipment acquisition, the Hospital handed over the purchase management to the MTD. The main purpose of this decision was to create bidding forms that guarantee a better understanding of the requirements and after-sale service for the useful life of the equipment, keep the relationship between the current market and the existing regulations, and take into consideration general and particular technical forecasts in the short, mid and long term.

This kind of management allowed us to promote the formal and informal communication with the medical and administrative services and also with the equipment and raw material vendors. These management activities helped us to enforce to keep up to date with our medical, technological and administrative knowledge, which gave us the chance of broadening our picture and make better
forecasts in the mid and long term, allowing us to plan future purchase of spare parts, equipment and specific tools essential for the new equipment functioning.

Once the administrative circuit was defined, the medical services started a purchase process to acquire all the equipment that would fulfill all the current raised needs. In most of the cases, we were given the responsibility of writing the bidding conditions due to the number of offers, vendors, products, specifications, functionalities and raw materials. The bidding conditions depicts the user’s technical requirements which describes the equipment, the minimal essential features, the accessories’ details, the necessary raw materials for its usage, the MTD’s technical requirements where we express all the particular and general conditions referring to the technical forecast, the training and the existing national standards and regulations.

As an example of the result of these processes we can name the anesthesiology and surgical acquisitions such as high complexity anesthesia workstations, electrosurgical units, defibrillators, a stereotactic neurosurgery system and a neuronavigator (both with TC scan and MRI image assistance), neurosurgical and ophthalmology microscopes and digital systems for video assisted surgeries such as laparoscopy, neuroendoscopy, thorascopy and rhinoscopy.

Our increasing participation in surgery was due to the features of the new equipment, its functionalities, alarm levels and the lack of knowledge of handling the equipment of the users. Aiming to minimize the halting possibilities and to reduce the times of response a new area was added to the SC where a laboratory was installed with equipment in order to assess the performance and security of the critical equipments. The spare parts, raw materials and critical accessories stock were enlarged meanwhile gradually we were adding career training, usage and maintenance courses of the acquired equipment to our gathered experience.

To remedy the usage difficulties, refresher courses were developed with the collaboration of the SC’s Coordination and the suppliers. These courses were destined to the surgical nurses who concentrate a great part of the maintenance and usage responsibility.

5. Results
The operating result, which is directly related to our performance, is the number of halted surgeries due to lack of equipment. Based on the above, we show the SC Coordination’s statistics in relation to the number of halted surgeries due to lack of equipment (LOE) for the period 2000-2006 at the CSU and PSU.

| Year | Surgeries CSU y PSU | Halted. LOE | I_{LOE} |
|------|--------------------|-------------|---------|
|      | Major | Medium | Minor | Total |             |           |
| 2000 | 2,613 | 4,558  | 1,203 | 8,374 | 4           | 0.7       |
| 2001 | 2,588 | 4,950  | 1,041 | 8,579 | 4           | 0.7       |
| 2002 | 2,517 | 5,015  | 897   | 8,429 | 5           | 0.9       |
| 2003 | 2,518 | 4,700  | 882   | 8,100 | 0           | 0.0       |
| 2004 | 2,553 | 4,919  | 745   | 8,217 | 5           | 0.9       |
| 2005 | 2,520 | 4,552  | 865   | 7,937 | 11          | 2.1       |
| 2006 | 2,784 | 5,073  | 891   | 8,748 | 8           | 1.4       |
| 2000/06 | 18,093 | 33,767 | 6,524 | 58,384 | 37         | 1.0       |

In order to analyze the most unfavorable case, the PAU has been excluded since it has not registered any halts during this period and it only shows the performance of the Anesthesiology Service.

The halted surgeries due to lack of equipment index (LOEI) is defined as the number of halted surgeries per 1,600 surgeries carried out (we took the average of the period as the reference parameter).
The low indexes and the low impact over the total of surgeries are indicators of our daily work. However, the index defined in this way allow us to show in an appropriate dimension way the increasing trend of halted surgeries due to LOE. In 2005 when the maximum value of the index was perceived (LOEI = 2.1), surgeries were halted per each 1,600 surgeries carried out. In 2006, a decrease was observed (LOEI = 1.4), but yet over an average of the period (LOEI = 1). Despite of the increment, we consider that the index is still enclosed in a security range over the global context and it stays within the acceptable values for unforeseen circumstances or when coming beyond control. Even though we insist on analyzing the reasons and propose improvements to minimize haltings due to these circumstances.

6. Conclusion
According to our experience, the integration process as Clinical Engineer professionals in the SC was based on two essential stages: physical and functional integration, both conditioned by the context and the technological insertion.

Even it was initially motivated as an operative solution to minimize the response times of the welfare technical support services (WTSS) and the medical technology department (MTD), the physical integration helped us to gradually start a learning and rewarding experience which motivated us to adopt a decentralized criteria of the technical assistance and raw materials and spare parts administration supply. It also gave us the possibility to coexist with the anxiety and urgencies and turned this integration into the required channel to the gradual development of a common language and priorities criteria according to the characteristics of the surgical context of a high complexity pediatric patient (HCPP).

The application of new technologies to the surgical environment required a budget increase: medical equipment, raw materials, spare parts and accessories. Due to the great investment, the hospital needed to professionalize the purchase procedures of technological products and accomplish from each of the surgical team the specification of their functions, such as usage, preservation and sterilization, maintenance and control. Both aspects allowed communication channels to be more fluid which made easier our insertion not only in the technical fields but also in the management and planning fields. These channels also provided the means to adapt the innovations to the environment and to train more qualified users.

Our performance within each stage of the high complexity medical equipment’s life cycle provided us the essential basis for the functional integration to the Surgical Center.

The integration, both physically and functionally, as Clinical Engineer professionals has encouraged us to developed not only technical but also strategic attitudes. According to the results obtained, we believe that our role regarding to the technological information along with the development of a clearer knowledge of the context, its needs and a common language, places us as a driving force of the proposed institutional goal: to provide medical services that are more efficient, reliable and safer for the patient and his environment.

References
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