MEDICAL DEVICE LAYOUT GUIDE – SYSTEMIC APPROACH BASED ON PATIENT AND MEDICAL DEVICE TYPE

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Abstract— **The planning guides published by the Quebec Ministry of Health and Social Services (MSSS) greatly facilitate the work of the teams of professionals involved in developing functional and technical projects. Each project having its own particularities, this causes an eternal restart when the time comes to produce the list of medical equipment that will make it possible to establish the level of funding estimated for this project. With the new constructions that have taken place in Quebec in the last decade, we consider that these projects submitted to the MSSS by each institution have sufficient data gathered to issue guidelines that will accompany current and future development guides for the medical equipment component. Our work consists in demonstrating the feasibility of such an approach by developing a parameterized tool to know the quantity, the location, the attributes, the budget and the installation constraints of each medical device as well as its functional link of planning with other related equipment. This study could be extended to non-medical devices, furniture and consider estimating the operating costs of these new facilities, including human and material resources. This work is preliminary. We are counting on the collaboration of other health authorities to validate our data and develop a tool that will adapt to standards, technological developments, and medical practices.**

Keywords- **Layout guide, medical devices, facility attribute, technology planning, parametrization**

I. Introduction

Quebec has recently experienced many major projects for the construction or redevelopment of new hospital pavilions. These achievements require considerable time and effort. For example, at the CISSS des Laurentides, 20% of biomedical advisors are dedicated to functional and technical projects (FTP) with the possibility of full-time assignment on development projects during interview periods. However, with the data collected in other projects and other sites and with the help of the MSSS, we believe that it is possible to create a platform that will serve as a first draft for developing lists of equipment during FTP. Indeed, the purpose of this platform is to generate the list of required equipment, specifying the quantities, costs and locations of each device according to the type of unit chosen and considering a reference unit of measurement.

II. Materials and methods

Our approach is divided into 4 steps.

A. Choice of parameters relevant to capital and technological planning

As we aim to create a capital planning guide for the medical equipment component, we must take an interest in the parameters provided for the installation of each piece of equipment. The parameters sought should also make it possible to know which ones will influence the forecast of the spaces to be reserved, the costs, the environmental requirement of the equipment.

B. Medical rooms on the unit and their standardization

We think it would be beneficial to specify the room where each piece of equipment will be placed. The bedside of the patient could be configured according to the standardized layout in the treatment room. For rooms without patients, we want to make sure to provide a standard space to install or store them.

C. Recovery cycle or downtime of a medical device - special case of surgical instruments

For medical devices, in particular reusable surgical instruments, which will have to pass through the sterilization center for their reprocessing, the duration of the reprocessing cycle may influence the number of devices that will be necessary to ensure the continuity of services. We want to know the average dead time that an instrument will undergo between its exit from the operating room until its next availability to be reused on another patient.

D. Suitable quantity of equipment to be provided

The ultimate purpose of this study is to provide information on the optimal quantity of medical equipment to have according to the number of units planned and their level of offered service.

III. Results

A. Relevant parameters to capital and technological planning

1. Mobility

An attribute for equipment mobility has been implemented. For example: equipment that only serves as a back-up can be placed further apart. Attributes for mobility should consider if the equipment is **fixed** so it does not come out of place like the anesthesia table in the operating room, **mobile** if it is needed for specific procedures only (example: glucometer), **back-up** if it is a useful additional equipment in the event of breakage (blood bag shaker in the operating room).

2. Medical device footprint in the room

In a room, the equipment occupies the floor, the wall or the ceiling. In addition to this attribute, there are the dimensional constraints which ensure that all the required equipment fit suitably into the room. However, as on the wall and ceiling, only a few pieces of equipment are found there, our project considers them as equipment with **no footprint** in the room. Equipment that do not occupy space on the ground and are mounted on another one (tutor) are called **tutored** equipment. Figure 1 illustrates an example.

Fig. 1- Resuscitation cart and defibrillator

On the resuscitation cart in Figure 1, a defibrillator-monitor-stimulator (circled in yellow) is fixed all the time. This defibrillator does not take up space in the hallway since it is on the cart.

3. Type of equipment

An attribute concerning the type of equipment has been added. Indeed, as we must include all the equipment in our list to see their layout. Some **non-medical** and movable equipment are included. However, as this equipment is not purchased by the biomed department, an attribute is assigned to distinguish **medical** equipment from the others.

4. Sedentarization vs nomadization

Another attribute has been created to designate the **sedentarization** of equipment. Indeed, some equipment such as the stretcher can bring the patient to the operating room. This stretcher, unlike an ultrasound scanner, is not always in the operating room, so it's **nomadic**.

5. Use

Equipment can be present in a **therapeutic** activity unit such as an infusion pump or as a **support** for activities such as a ventilated cabinet.

6. Synonyms

Finally, a column containing the synonymous names that can designate the same equipment is put in place to ensure that the platform is **well understood** by any clinical and medical professional.

7. Standardization of medical care rooms

The room in which the equipment is located is identified. In addition, we have standardized the interior of the medical care room into **9 quadrants**. This represents a room with the unit of measurement of the room in the center (square in the center with bed). The patient is installed on this unit. For example, in a medical unit room, we would have a bed in the center on which the patient lies to receive the treatment. Boxes 1, 2 and 3 refer to the space at the bedside of the patient and boxes 6 to 8 correspond to the space at the foot of the patient. Box 9 is equivalent to the ceiling (Figure 2).

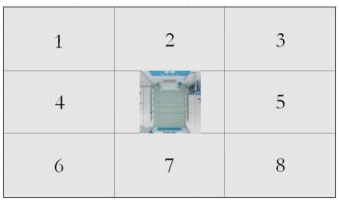

Fig. 2- Quadrants for spatial distribution around the patient

B. Recovery cycle or dead time of a medical device – example of surgical instruments

An attribute concerning the impact of medical device reprocessing has been thought out, but not integrated at this time. During the analysis of surgeries in the operating room, the cycles of reprocessing according to the surgeries and their duration were studied. The purpose of this study was to forecast the required quantities of surgical instruments to plan the

storage space accordingly. For this, we determined the average number of requests instrument per day for each type of surgery as well as the average time in the room and the average duration of intervention. If the number of daily requests is greater than 1 and the instruments do not have time to be reprocessed before returning, then we will need more than one set of instruments for this type of surgery. The reprocessing cycle was estimated as follows:

Verification and cleaning of the room (included in duration in the intervention room)
Duration in the OR Central sterilization unit (1:00)
Duration in the soiled Unit (1:00)
Duration in the clean Unit (1:00)
Duration in the sterile + cooling Unit (1:30)
Duration to reassemble the device and store it (30 minutes)
Duration taking into account the differences between different surgeons, sites and others (1:00).
The total duration is 6 hours for reprocessing.

As this analysis is not exhaustive because several assumptions and generalizations have taken place and as it is not very important in our study, it was not analyzed deeply.

C. Quantity of equipment needed

Based on the CISSS des Laurentides and according to the number of measurement units in the care unit, we have defined quantities of equipment. For example, in an operating theatre, each operating room has an operating table at a time. In this case, the ratio per OR is 1.

IV. Discussion

A. Feedback on results

The various parameters presented in the platform yield a great advantage in terms of managing equipment and projects. Indeed, with a generated list of needed equipment, it is faster and easier to plan a project without taking the chance of forgetting certain equipment or poorly planning certain aspects. It saves time and effort in the long term but also simplifies procedures.

B. General assumptions and limitations

The lists and choices made are based on the inventory and replacement values of Maximo, the CMMS of the CISSS des Laurentides, which are not updated as often as desired, so some inconsistencies could occur. In addition, the entire analysis is based on the CISSS des Laurentides only.

Bariatric equipment are not included in the equipment lists so you have to consider an average percentage to know the bariatric quantity to be purchased.

C. Choice of parameters relevant to capital and technological planning

With the different attributes to create, we come to better define a piece of equipment and give it more weight than its simple name. These attributes are very relevant to keep during large projects but also when buying equipment on its own because we can have information on the space allocated to it. Mobility can lead to calibration or wear issues, so it is possible to swap attributes to redistribute wear. For example, a stretcher that is a back-up can be switched with the one who begins to wear.

The premises that we have configured are patients bedrooms, operating rooms, pharmacy, the utility room, the storage. Ideally, floor markings would be an optimal solution to allow staff to know where to place each piece of equipment without having to look for it.

D. Recovery cycle or downtime of a medical device - special case of surgical instruments

It should be noted that the results of the reprocessing cycle calculations are based on estimated and non-validated reprocessing times. In addition, the human factor plays a role that can affect the results. Indeed, all surgeons work differently, so the duration of surgery varies according to the surgeon but also according to the complexity of the case being treated.

V. Conclusion

Our platform with different parameters that have been thought out could be very useful for biomedical advisors and managers when planning the opening of new units, modernizing existing ones or auditing them. It offers information relating to several values such as quantities, costs, equipment, and local environment.

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Conflict of Interest

The authors declare that there is no conflict of interest.

ABBREVIATIONS

CISSS: Integrated Health and Social Services Center
CMMS: Computerized Maintenance Management System
FTP: Functional and technical project
MSSS: Quebec Ministry of Health and Social Services .