

# A Method to Identify New Needs for Medical Equipment

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**Abstract**— This paper presents a Method to identify new needs for medical equipment based on the Availability Matrix proposed by the World Health Organization. This Matrix is an instrument to map new medical devices for the care of high incidence diseases. The Method considers information on the epidemiology of the patients attended, the demand for health care services and the available medical equipment. It was applied to the main cause of morbidity: congenital malformations, deformities, and chromosomal abnormalities, attended at the National Institute of Pediatrics from Mexico for 2014-2018 period. The four diseases with the highest incidence were chosen. The Method identified thirteen new medical equipment for the care of such diseases. Three for diagnosis and ten for rehabilitation.

**Clinical Relevance**—Medical equipment purchase must solve clinical needs related with the highest incidence diseases. This is translated into effective and safe care for a greater number of patients with such diseases, and the hospital will have the most appropriate medical equipment to take care of patients with the best health technology.

## I. INTRODUCTION

The National Institute of Pediatrics from Mexico (INP, its Spanish acronyms) is a third-level Mexican public health institution that develops models of care for children and adolescents, through basic, clinical, and epidemiological research. It has twenty-two specialties and 350 beds. It has a total of 6165 medical equipment. Sixty percent (3699) are in clinical and research laboratories, and the other 2466 (forty percent) are in the healthcare area. Of the total medical equipment, twenty six percent (1603) is less than or equal to ten years old, twenty two percent (1356) are between eleven and twenty years old, and fifty two percent (3206) are more than twenty years old [1]. In this sense, the Institute needs to renew its technological inventory and requires a tool to detect new needs for medical equipment. The objective of this work was to develop a Method to identify new needs for medical equipment for diagnosis, treatment and/or rehabilitation of diseases, based on the construction of an Availability Matrix [2], which is an instrument developed by the World Health Organization (WHO) to map the need for new medical devices for the care of high incidence diseases. The Method was applied to the main cause of morbidity during 2014-2018 [3]: congenital malformations, deformities, and chromosomal abnormalities.

## II. METHODS

The Method proposed considers information on the epidemiology of the patients attended, the demand for health care services, and the medical equipment available at the

Institute. As a reference it also was considered information from some Clinical Practice Guidelines of the Mexican Ministry of Health. This information was integrated into an Availability Matrix for each disease analyzed.

### A. Identification of diseases with the highest incidence at the National Institute of Pediatrics from Mexico

For the purposes of this study, only the main cause of morbidity during 2014-2018 period was considered [3]: congenital malformations, deformities, and chromosomal abnormalities. The four main diseases within this category were: cleft lip and palate malformations, urinary tract malformations, craniosynostosis, and congenital cataract.

### B. Identification of medical equipment used in patient care

Clinical Practice Guidelines (CPG) are statements that include recommendations intended to optimize patient care that are informed by a systematic review of evidence, and an assessment of the benefits and harms of alternative care options. To promote the efficient use of the medical technology available at the Institute, and contribute to the effective and safe clinical procedures based on evidence (not only on the experience of physicians), six Mexican CPGs related to the four selected diseases were consulted: Orthopedic and surgical treatment of cleft lip and palate in children under two years old [5]. Diagnostic approach to urinary tract malformations in children [6]. Diagnosis, treatment, and rehabilitation of non-syndromic craniosynostosis [7]. Diagnosis of congenital cataract in the newborn [8]. Surgical treatment of congenital cataract [9]. Visual rehabilitation of patients with congenital cataract [10]. On the other hand, to know the procedure of patient care (diagnosis, treatment and/or rehabilitation) at the Institute, as well as the medical equipment used, various interviews were conducted with the medical personnel from eight clinical services involved in the care of the four chosen diseases: plastic surgery, audiology, phoniatrics, otorhinolaryngology, stomatology, urology, neurosurgery, and ophthalmology.

### C. Construction of the availability matrix

After analyzing the CPGs and the Institute's patient care procedure, the Availability Matrix (AM) corresponding to each disease was constructed. Each AM was made up of three columns. The first one, describes the clinical studies needed for the patient. The second column identifies the medical equipment on the CPG. The third, describes the medical equipment available at the Institute. The Matrix, as well, is divided into three sections according to diagnostic, treatment, and rehabilitation procedures.

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#### D. Identification of new needs of medical equipment

Once the Availability Matrix for each disease was built, a comparative analysis was made between the medical equipment on the CPG, and the medical equipment available at the Institute. This analysis allowed identifying the gaps in medical equipment, and these results the new needs of medical equipment for the National Institute of Pediatrics.

### III. RESULTS

#### A. Diseases with the highest incidence at the Institute

The main causes of morbidity at the National Institute of Pediatrics (INP) in the 2014-2018 period were congenital malformations [3], such as metabolic disorders that occur during intrauterine life and are detected during pregnancy, in childbirth or later in life. These diseases are in Chapter seventeen of the International Classification of Diseases (ICD-10) "Congenital malformations, deformities and chromosomal abnormalities" [11]. The total of patients attended at the INP for these causes were: 2021 in 2014, 1404 in 2015, 2629 in 2016; 2323 and 2398 in 2017 and 2018 respectively. The four specific diseases with the highest incidence in the considered period were: 1) Cleft lip and palate malformations (582 patients); 2) Urinary tract malformations (556 patients); 3) Craniosynostosis (304 patients); and 4) Congenital cataract (111 patients) [12].

#### B. Medical equipment used in patient care

The clinical studies and medical equipment recommended by the Clinical Practice Guideline (CPG) were identified, as well as the clinical studies carried out, and the medical equipment used in the Institute, for the care of the four diseases considered. The findings are presented as follow.

*Cleft lip and palate malformations.* The CPG [5] recommends two clinical studies that can be carried out with six medical equipment. The Institute [13] carries out thirteen clinical studies using eleven different medical equipment. The reason that the CPG only mentions two studies is because it only covers the first two years of the child's life, while the Institute covers from birth to seventeen years of the patient. In total, sixteen different medical equipment was identified for the care of these patients.

*Urinary tract malformations.* The CPG [6] recommends ten diagnostic studies that can be carried out with six medical equipment. The Institute carries out five diagnostic studies with four medical equipment [14]. In the case of treatment and rehabilitation there are no Mexican guidelines for these processes. That is why we just analyze the Institute's patient care procedure. The Institute carries out the treatment with five medical equipment and the rehabilitation with two. A total of thirteen different medical equipment is used in the care of these patients.

*Craniosynostosis.* For the diagnosis the CPG [7] recommends five clinical studies that are carried out with five medical equipment, and the Institute carries out seven clinical studies with six medical equipment [15]. For treatment, both the CPG and the Institute, use six equipment: five from the operating room (OR): surgery lamp, surgery table, anesthesia machine, electrosurgery unit and vital signs monitor, and a CT scanner. In total, eleven different medical equipment were identified to care for these patients.

*Congenital cataract.* The CPGs for diagnostic [8], treatment [9] and rehabilitation [10] of this disease recommend carrying out eight and three clinical studies respectively, using twelve medical equipment. The Institute [16] carries out four diagnostic studies with four medical equipment, and one rehabilitation study. In the case of treatment, both the CPG and the Institute's clinical procedure mention two medical equipment. In total fourteen different medical equipment were identified for the care of patients with congenital cataract.

#### C. Availability matrix for cleft lip and palate malformations

The diagnosis of these malformations is made at birth and does not require clinical studies. Treatment is surgical (Table 1), and the required medical equipment can be a dental unit and/or the basic operating room (OR) equipment. In the rehabilitation stage, a fluoroscope is used to determine the degree of velopharyngeal insufficiency. The hearing level is determined with an audiometer. It is also performed a study of auditory evoked potentials, and a cranial tomography. For diagnosing and monitoring of velopharyngeal insufficiency, the Institute uses a nasofibroscope. However, the CPG [5] suggests a video-nasofibroscope, since it can record a video that can subsequently be observed by the multidisciplinary medical team who cares for these patients [13]. The nasofibroscope is also used to assess the vibrations of the vocal cords, but the CPG suggests the stroboscope. The evaluation of the movement of the glottis and the analysis of the voice are currently performed clinically, but the equipment recommended by the CPG are the electroglottograph and a voice analyzer, respectively. The last two studies (cephalography radiography and orthopantomography) are carried out outside the Institute because it does not have the medical equipment needed.

#### D. Availability matrix for urinary tract malformations

For the diagnostic of these malformations Matrix (Table 2) shows that the first four equipment are shared by the Guide [6] and the Institute [14]. According to the CPG, for the diagnosis of urinary tract malformations there are three more imaging equipment: gamma camera, computed tomography (CT), magnetic resonance imaging (MRI). Note that the Institute only performs a renogram with a gamma camera, to provide the necessary information to the urologist. The identification of the equipment used in treatment and rehabilitation was carried out through an interview with the urologist [14]. The basic operating room equipment is also used for surgical treatment. For rehabilitation, two gaps of electrostimulation equipment were identified, one for the pelvic floor and the other, for reeducation of urination function (biofeedback).

#### E. Availability matrix for craniosynostosis.

A total of fifteen medical equipment was identified. Six are for diagnosis, seven for treatment (including the five basic medical equipment for the operating room), and two for rehabilitation of craniosynostosis (Table 3). Note that five equipment for diagnosis, and all the equipment for treatment are shared by the Guide [7] and the Institute [15], except the electroencephalograph (EEG) used for diagnosing, and the EEG and CT used for rehabilitation by the Institute. Observe that there are no gaps of medical equipment for treating this disease.

TABLE 1. AVAILABILITY MATRIX FOR TREATMENT AND REHABILITATION OF CLEFT LIP AND PALATE MALFORMATIONS (ICD-10: Q35-Q37)

Clinical studies	Medical equipment (CPG and INP)	
<b>Treatment</b>		
1. Presurgical orthopedics	Dental unit	
2. Surgery (corrective or reconstructive surgery)	Basic OR equipment (surgery lamp, surgery table, anesthesia machine, electrosurgery unit and vital signs monitor)	
<b>Rehabilitation</b>		
3. Determining the degree of velopharyngeal insufficiency	Fluoroscope	
4. Determine the hearing level	Audiometer	
5. Auditory evoked potentials	Auditory evoked potentials	
6. Cranial tomography	CT	
<b>Rehabilitation</b>		
	Medical equipment CPG	Medical equipment INP
7. Velopharyngeal insufficiency diagnosis	Video- nasofibroscope	Nasofibroscope
8. Monitoring the degree of velopharyngeal insufficiency	<i>Medical equipment gaps</i> <b>Video- nasofibroscope</b>	Nasofibroscope
9. Assess the vibrations of the vocal cords	<b>Stroboscope</b>	Nasofibroscope
10. Evaluation of the movement of the glottis	<b>Electroglottograph</b>	Performed clinically
11. Analysis of the voice	<b>Voice analyzer</b>	
12. Cephalography radiography	<b>Cephalostat machine</b>	Carried out outside the Institute
13. Orthopantomography	<b>Orthopantomograph</b>	

TABLE 2. AVAILABILITY MATRIX FOR DIAGNOSIS, TREATMENT AND REHABILITATION OF URINARY TRACT MALFORMATIONS (ICD10: Q60-64).

Clinical studies	Medical equipment (CPG and INP)	
<b>Diagnosis</b>		
1. Renal ultrasound	Ultrasound	
2. Cystourethrography		
3. Identify presence of vesicoureteral reflux	Fluoroscope	
4. Urine cultures	Automatic microbiology analyzer	
<b>Diagnosis</b>		
	Medical equipment CPG	Medical equipment INP
5. Renogram	Gamma camera	Gamma Camera
6. Renal Tomography	CT	
7. Visualize complex malformations and renal scars.		
8. Identify acute renal infections	MRI	
9. Identify abnormalities in the excretory system from the calyces to the bladder		
10. Intravenous urography	CT/Fluoroscope	Not carried out
<b>Treatment</b>		
11. Surgical treatment		Basic OR equipment
<b>Rehabilitation</b>		
12. Pelvic floor electrostimulation		<i>(Medical equipment gaps)</i> <b>Electro stimulator for the pelvis floor</b>
13. Electrical stimulation for reeducation of urination function		<b>Electro stimulator for urination function reeducation</b>

TABLE 3. AVAILABILITY MATRIX FOR DIAGNOSIS, TREATMENT AND REHABILITATION OF CRANIOSYNOSTOSIS (ICD-10: Q75.0).

Clinical studies	Medical equipment (CPG and INP)	
<b>Diagnosis</b>		
1. Skull radiography	Equipment of x-ray	
2. Cranial tomography with 3D reconstruction	CT	
3. Bone scintigraphy	Gamma camera	
4. Cranial ultrasound	Ultrasound	
5. Molecular genetic study	Genetic Analyzer DNA sequencer	
<b>Treatment</b>		
6. Surgical treatment	Basic OR equipment Craniotome Mayfield head holder	
<b>Diagnosis</b>		
	Medical equipment CPG	Medical equipment INP
7. Electroencephalogram		Electroencephalograph
<b>Rehabilitation</b>		
8. Electroencephalogram		Electroencephalograph
9. Cranial tomography with 3D reconstruction		CT

F. Availability matrix for congenital cataract.

In total, thirteen different medical equipment were identified for this disease. Nine for diagnosis, two for treatment and three for rehabilitation (Table 4). Note that there are six common equipment between the CPG [8] and the Institute: four for diagnosis: ophthalmoscope, slit lamp and tonometer autorefractor (the last is also used for rehabilitation) and two for treatment (phacoemulsification equipment and automated vitrectomy equipment. In the case of diagnosis, the Institute does not have three medical equipment suggested by the CPG: ophthalmic ultrasound, corneal topographer, and rotary camera. The patient is requested to carry out these studies externally. Note also that the CPG requests a CT and an MRI that is not performed by the Institute [16], because the ocular ultrasound, corneal topography and penta-camera studies provide the information that the physician needs. On the other hand, the Institute does not have a YAG laser for rehabilitation so, the patient refers to another health institution to perform the subsequent capsulotomy. Finally, lensometry is performed manually with a manual lensometer.

G. New needs for medical equipment.

Thirteen new needs for medical equipment were identified for the care of three diseases: six, for cleft lip and palate malformations; two, for urinary tract malformations; and five, for congenital cataracts (Table 5). In the case of craniosynostosis care, as we said above, the Institute has all the necessary medical equipment. For the rehabilitation of cleft lip and palate malformations, the medical equipment required is, video-nasofibroscope, stroboscope, electroglottographs, voice analyzer, cephalostat machine, and orthopantomography. These represent forty six percent of the total. Two medical equipment are required for the rehabilitation of urinary tract malformations: pelvic floor electro-stimulator and electro-stimulator for the urinary function reeducation, and these represent fifteen percent of the total. In the case of congenital cataract, five medical equipment (thirty percent) are needed, three for diagnosis: ophthalmic ultrasound, corneal topographer, and rotary camera; and two for rehabilitation: YAG laser and automatic lensometer.

TABLE 4. AVAILABILITY MATRIX FOR DIAGNOSIS, TREATMENT AND REHABILITATION OF CONGENITAL CATARACT (ICD-10: Q12.0)

Clinical studies	Medical equipment (CPG and INP)	
<b>Diagnosis</b>		
1. Red eye reflex evaluation	Ophthalmoscope	
2. Visual acuity evaluation	Autorefractor	
3. Evaluation of the eye anterior segment	Slit lamp	
4. Intraocular pressure measurement	Tonometer	
<b>Treatment</b>		
5. Continuous circular capsulotomy of anterior and posterior lens	Automated vitrectomy equipment	
6. Cataract aspiration	Phacoemulsification equipment	
7. Intraocular lens implantation	Automated vitrectomy equipment	
<b>Rehabilitation</b>		
8. Visual acuity evaluation	Autorefractor	
<b>Diagnosis</b>	Medical equipment CPG	Medical equipment INP
9. Ocular ultrasound	<b>Ophthalmic ultrasound</b>	(Medical equipment gaps)
10. Corneal topography	<b>Corneal surveyor</b>	
11. Penta-camera study	<b>Rotary camera</b>	
12. Ocular tomography	CT	Not carried out
13. Ocular magnetic resonance	MRI	
<b>Rehabilitation</b>		
14. Subsequent capsulotomy with laser	<b>YAG laser</b>	(Medical equipment gaps)
15. Lensometry	<b>Automatic lensometer</b>	

TABLE 5. NEW NEEDS FOR MEDICAL EQUIPMENT FOR CLEFT LIP AND PALATE MALFORMATIONS, URINARY TRACT MALFORMATIONS AND CONGENITAL CATARACTS.

Disease	Medical equipment type	
	Diagnosis	Rehabilitation
Cleft lip and palate malformations (Q35-Q37)		1. Video-nasofibroscope 2. Stroboscope 3. Electroglottograph 4. Voice analyzer 5. Cephalostat machine 6. Orthopantomograph
Urinary tract malformations (Q60-Q64)		1. Pelvic floor electro-stimulator 2. Electro-stimulator for the urinary function reeducation
Congenital cataracts (Q12.0)	1. Ophthalmic ultrasound 2. Corneal topographer 3. Rotary camera	1. YAG laser 2. Automatic lensometer

#### IV. CONCLUSION

A Method to identify new needs of medical equipment using the WHO Availability Matrix concept was presented. It was very useful to identify medical equipment gaps in a health facility, according to a specific disease.

The Method was applied to identify the medical equipment gaps in the National Institute of Pediatrics from Mexico, for the care of four congenital malformations. It was identified that the Institute requires thirteen new medical equipment distributed as follows: three medical equipment for the diagnosis of congenital cataract, and ten for the rehabilitation of three diseases. For cleft lip and palate malformations, six medical equipment. For urinary tract malformations, two

medical equipment. For congenital cataract, two medical equipment. In the case of craniosynostosis care, the Institute has all the medical equipment needed.

The Method can be applied to any morbid entity that is of interest to a health institution. It is just required information on the epidemiology of the patients attended, the demand for health care services, and the medical equipment available at the health institution. It is also recommended to use an available Clinical Practice Guidelines in the region/country interested, as a referenced.

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