



Availability of pediatric and neonatal intensive care units in the city of São Paulo

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Abstract

Objective: To describe the health care service provided in pediatric intensive care units in the city of São Paulo, by identifying and describing the units and analyzing their geographic distribution.

Methods: A descriptive cross-sectional study was carried out during a two-year period (August 2000 to July 2002). Data were collected through questionnaires answered by medical directors of each pediatric and neonatal intensive care unit.

Results: São Paulo is served by 107 pediatric and neonatal intensive care units, of which 85 (79.4%) completed and returned the questionnaire. We found a very unequal distribution of units as there were more units in places with the least pediatric population. Regarding to pediatric intensive care units specialization, 7% were pediatric, 41.2% were neonatal and 51.7% were mixed (pediatric and neonatal). Regarding hospital funds, 15.3% were associated with philanthropic institutions, 37.6% were private and 47% were public. A total of 1,067 beds were identified, of which 969 were active. The ratio bed/patient aged 0-14 was 1/2,728, varying from 1/604 at health districts - I to 1/6,812 at health districts - III. The units reported an average of 11.7 beds (2 to 60). The neonatal intensive care unit had a median of 16.9 beds per unit and pediatric intensive care units a median of 8.5 beds/unit.

Conclusion: In São Paulo, we found an uneven distribution of pediatric and neonatal intensive care units among the health districts. There was also an uneven distribution between public and private units, and neonatal and pediatric ones. The current report is the first step in the effort to improve the quality of medical assistance in pediatric and neonatal intensive care units in São Paulo.

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Introduction

Pediatric intensive care is a relatively recent medical specialty, having been consolidated around 50 years ago, after the poliomyelitis in Scandinavia. In Brazil, the first

pediatric intensive care units (PICUs) were opened during the seventies – at the *Hospital dos Servidores do Estado do Rio de Janeiro* in 1971 and at the *Universidade de São Paulo* in 1974. Even during the sixties there was a Pediatric Intensive Care Room at the “Professor Pedro de Alcântara” Children’s Institute, part of the *Hospital das Clínicas*, belonging to the Medical Faculty of the *Universidade de São Paulo* (HC-FMUSP). This was annexed to the Emergency Room of the *Instituto Central do Hospital das Clínicas* and there the most critically ill children were cared for by the doctors, pediatricians from a number of different subspecialties, with no specific training in intensive care. In 1974, the PICU was born at HC-FMUSP and pediatricians trained in intensive care were integrated with the Pediatric Intensive Care Room team.

Nowadays PICUs have gained recognition and are widespread. Little, however, is known about the distribution of these units, their infrastructure and the means by which they deliver intensive care to our region.

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In the light of these circumstances we designed the present study which aims to characterize the care provided in pediatric and neonatal intensive treatment in the city of São Paulo. Specifically, this equates to identifying working units, verifying the geographic distribution of the units found and comparing the numbers of operational beds with the needs of the relevant populations, or, to put it another way, evaluate the equity, access and adequacy of intensive care provision in São Paulo city.

Methods

This was a cross-sectional, descriptive study in which the PICUs and neonatal intensive care units (NICUs) of São Paulo city were studied during the period from August 2000 to July 2002. The units were identified by searching the records of the Brazilian Association of Intensive Medicine (*Associação de Medicina Intensiva Brasileira - AMIB*), the São Paulo State Regional Medical Council (*Conselho Regional de Medicina - CREMESP*), the São Paulo State Health Department (*Secretaria Estadual de Saúde - SES/SP*) and the São Paulo City Health Department (*Secretaria Municipal de Saúde - SMS/SP*). To complete this "census" a systematic consultation was made of the 2002 São Paulo business telephone directory, in which subscribers are indexed according to the trading name given when the service contract was first signed and the accuracy of which is the responsibility of the directory's publisher.

Units that had been closed or were temporarily inactive during the study period were excluded as were units opened after January 2001.

After contact had been made with the PICUs/NICUs by telephone, questionnaires relating to the intensive care units' infrastructure were delivered to a member of the ICU team, preferably the medical director or head nurse, and a time limit of 30 days was set for their return.

The answers provided by each ICU and their respective parent institutions were represented exclusively in aggregated forms and anonymity was therefore preserved throughout the project with data presentation and analysis being characterized by alphabetical order.

Data was described by means of proportions and averages for the statistical analysis. When information was stratified by source of funding and age group treated, we applied the chi-square test to compare proportions.

The research protocol was submitted to the Ethics Commission for Research Project Analysis at the HC-FMUSP, which approved it.

Results

One hundred and nine PICUs and NICUs were listed at 80 different hospitals in São Paulo city. Thirty-four (31.2%) were identified by the AMIB, whose list was taken as the starting point because it was the most up-to-date at the beginning of the study. After filtering out duplicates, a further nine (8.3%) were identified at the CREMESP, eight (7.3%) more were listed by the SES/SP, 11 (10.1%) were

on the books of SMS/SP and 47 (43.1%) were found by consulting the 2002 business telephone directory.

Two units were excluded. One hundred and seven were invited to participate in the study by voluntarily filling-out the questionnaire. Eighty-five (79.4%) ICUs returned the questionnaire and these constituted the study population.

The ICUs' characteristics, in terms of participation, geographic location, age group and source of funding are shown in Table 1.

Assessing the geographic distribution of the PICUs/NICUs across the five Regional Health Nuclei (RHN) into which São Paulo city is divided,¹ it was observed that RHN-I and V, the most central of the nuclei, had the lowest pediatric populations in São Paulo city, and yet, these were also the RHN with the greatest numbers of ICUs. Regional Health Nucleus III, the most populous in the city and also the nucleus with the largest pediatric population had the lowest number of ICUs (Figure 1).

At the time of the study, the city of São Paulo had a pediatric population (0 – 14 years) of 2,643,928,² working out to one bed in intensive care for every 2,728 children. Overall these beds were unevenly distributed across the five regions, varying from one bed/604 to one bed/6,812 pediatric patients, in RHN-I and RHN-III, respectively (Table 2).

With respect of the age groups, 44 (51.7%) units treated mixed populations, 35 (41.2%) cared for neonates and six (7%) treated pediatric patients exclusively (Figure 2). With respect of source of funding, 40 (47.1%) units were within public hospitals and 32 (37.6%) in private hospitals. The remaining 13 (15.3%) were in philanthropically maintained hospitals (charity hospitals hereafter). Fifteen (37.5%) of the 40 public units were run by the State, 16 (40%) by the city and nine (22.5%) were part of public universities. It was observed that neonatal and exclusively pediatric units predominated in the public sector, while mixed units predominated at the private services (Figures 3 and 4).

The majority of the 85 ICUs assessed were located within general hospitals (82.4%). The remaining ICUs were distributed as follows: eight (9.4%) in pediatric hospitals, five (5.9%) in maternity hospitals and two (2.4%) in hospitals for both women and children. With respect of the size of the parent hospitals, it was observed that more than half (67.1%) of the ICUs were located within large or "special" sized hospitals (more than 151 beds). Around a quarter (26.9%) were located in medium-sized hospitals (51-150 beds) and a small proportion (6%) were within small-scale hospitals (50 beds or less).

Two of the 85 units did not provide information either on the number of beds planned nor on the number that were operational. Taken together, the 83 units that did provide this information had 1067 ICU/NICU beds (installed capacity). There were 104 inactive PICU/NICU beds (9.7%). One of the units had six more active beds than the number planned for and so the total number of operational beds in the city of São Paulo was 969.

Four hundred and fifty-seven of the operational intensive care beds (47.2%) were in public hospitals, 345

Table 1 - Characteristics of the intensive care units participating and not participating in the study

	Participant n (%)	Nonparticipant n (%)	Total
Information source			
AMIB	30	4	34
SMS	7	2	11 †
CRM	7	2	9
SES	7	1	8
Other	34	13	47
Geographical location			
RHN-I	35 (77.8)	10 (22.2)	45 (100)
RHN-II	13 (72.2)	5 (27.8)	18 (100)
RHN-III	9 (90.0)	1 (10.0)	10 (100)
RHN-IV	12 (92.3)	1 (7.7)	13 (100)
RHN-V	16 (76.2)	5 (23.8)	21 (100)
Age group cared for, n (%) ‡			
Pediatric *	50 (83.3)	10 (16.7)	60 (100)
Neonatal	35 (74.5)	12 (25.5)	47 (100)
Source of funding, n (%) §			
Public	40 (87.0)	6 (13.0)	46 (100)
Private	32 (69.6)	14 (30.4)	46 (100)
Philantropic	13 (86.7)	2 (13.3)	15 (100)
Total	85 (79.4)	22 (20.6)	107 (100)

n = number; AMIB = Brazilian Association of Intensive Medicine; SMS = São Paulo City Health Department; CRM = São Paulo State Regional Medical Council; SES = São Paulo State Health Department; NRS = Regional Health Nucleus.

* Mixed, exclusive and specialized intensive care units.

† Two units excluded.

‡ p value (0.38) for participant and nonparticipant units regarding the age group cared for (pediatric or neonatal).

§ p value (0.09) for participant and nonparticipant units regarding the source of funding (public or private).

(35.6%) were in private hospitals and 167 (17.2%) were in charity hospitals. It is worth pointing out that these proportions are in line with those calculated for installed

Table 2 - Distribution of PICU/NICU beds in the city of São Paulo according to the pediatric age group or RHN

RHN	Pediatric population (0-14 years)*	ICU beds	Ratio bed/ pediatric population	Ratio bed/ pediatric population†
I	250,113	414	1/604	1/471
II	616,133	146	1/4,220	1/3,020
III	674,349	99	1/6,812	1/6,075
IV	538,075	126	1/4,270	1/3,899
V	565,258	184	1/3,072	1/2,335
Total	2,643,928	969	1/2,728	1/2,156

PICU = pediatric intensive care unit; NICU = neonatal intensive care unit; RHN = Regional Health Nucleus; ICU = intensive care unit.

* Estimate of the population of São Paulo city on July 1st 1998.²⁵

† Ratio bed/pediatric population including nonparticipant intensive care units.

capacity. A statistically significant difference was observed in the proportion of operational beds in relation to the source of funding ($p < 0.001$) (Table 3). The 969 beds were divided by age group into 556 neonatal beds (57.4%), 371 (38.3%) mixed age group beds and 42 (4.3%) exclusively pediatric beds.

The number of operational beds per unit varied from 2 to 60, with a mean of 11.7 and a median of 10. The neonatal units had a mean of 16.9 beds each (median of 16) and the mixed pediatric units had a mean of 8.5 (median of 7.5). The exclusively pediatric ICUs had a mean of seven beds each (median also 7).

Only 5 (6%) of the 83 units that provided bed information had less than 5 beds. Almost half of the ICUs had between 5 and 10 beds (37/44.6%), and the other half had having more than 10 (41/49.4%). Fifty-three point seven percent of the ICUs with more than 10 beds were part of the public network, 29.3% were private and 17% run by charities. Forty-eight point six percent of the ICUs with 5 to 10 beds were private, 37.8% were public and 13.5% were philanthropically supported. The distribution of the ICUs by number of beds and age group can be found in Figure 5.

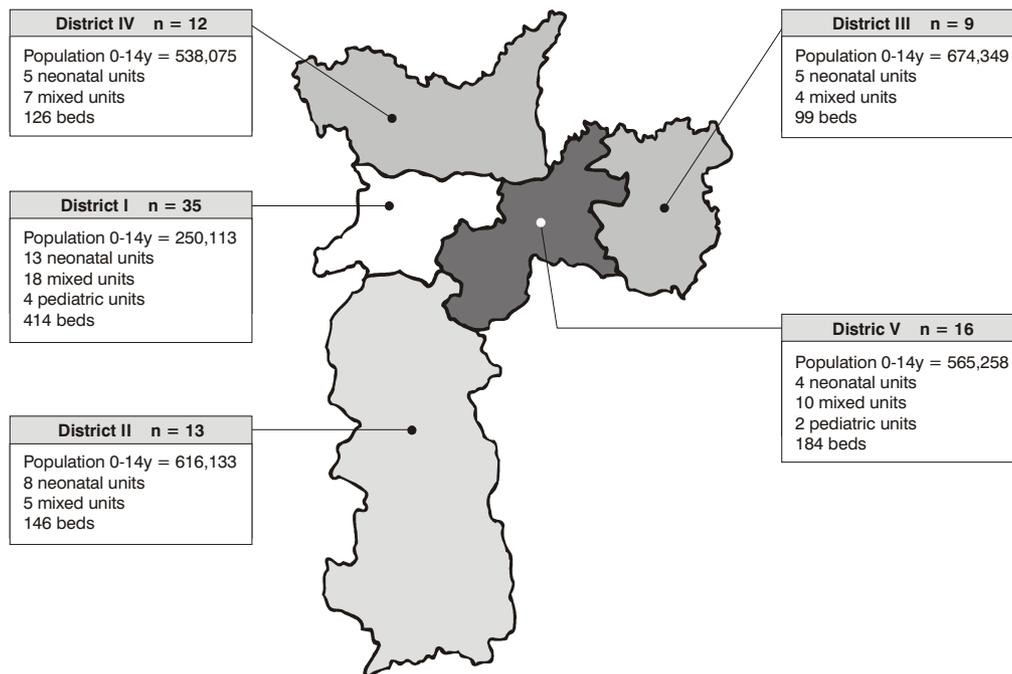


Figure 1 - Geographic distribution of the PICUs/NICUs across the five Regional Health Nuclei into which São Paulo city is divided according to age group (n = 85)

Discussion

Better intensive care provision can be achieved by identifying those variables that are significantly associated with a greater chance of survival. The results of the present study indicate that there is a substantial variation in operational PICU and NICU bed availability in São Paulo city: there was a disproportionate distribution of intensive care units and beds across the city with respect of each district's pediatric population. In general there was an excess of private beds and a deficit in the public sector and also a disproportionate division between neonatal and pediatric beds, with a lack of neonatal beds.

The distribution of PICUs and NICUs across the city of São Paulo was disproportionate with greater concentrations in the central regions (RHN-I and V: 61.7%) and lower concentrations in peripheral regions of the city (RHN-III: 9.3%), which, in turn, have the largest pediatric populations, resulting in a failure to regionalize these services in São Paulo city.

The same distribution pattern was also found by other authors.³⁻⁵ Kimura³ observed that 46% of the ICUs in São Paulo state were concentrated in the metropolitan region and that 73.4% of these were located in São Paulo city itself and that of these 39.7% were in the city's central zone. She

Table 3 - Number of beds of intensive care units in relation to the source of funding in the city of São Paulo and the proportion of operational beds

	Public n (%)	Private n (%)	Philanthropic n (%)	Total n (%)
Installed capacity	529 (49.6)	364 (34.1)	174 (16.3)	1,067 (100)
Operational beds by source of funding	457 (47.2)	345 (35.6)	167 (17.2)	969 (100)
Operational beds by installed capacity *	457/529 (86.4)	345/364 (94.8)	167/174(96)	969/1,067(90.8)

* p < 0.001

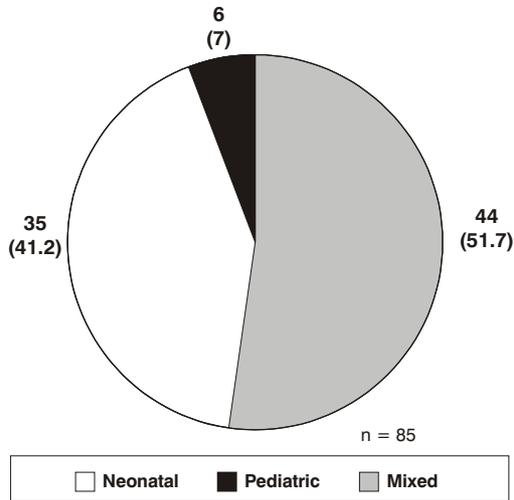


Figure 2 - Types of intensive care units with respect of the age groups - n (%)

states that this pattern of distribution suggests that when one discusses intensive care in Brazil, one is dealing with the situation in the Southeast of Brazil, specifically the State and the city of São Paulo.

In an analysis of PICUs, Barbosa⁴ observed that 75.8% of the PICUs in the metropolitan region of Rio de Janeiro state were located within Rio de Janeiro city. Of these 50 units, 28% were located in the city’s South Zone and 20% in the Center and the Docklands area, leading to the conclusion that in the city of Rio de Janeiro there is also a tendency to concentrate PICUs in the central regions and in the regions with the most financial resources (the South Zone).

These observations lead us to question several aspects of pediatric intensive care in São Paulo and even Brazil overall: does every child in need of intensive care have access to it? Once admitted to an ICU, do patients receive the best available treatment, both in terms of human resources and in terms of technology? Taking into account the lack of ICUs in certain regions and the need for locomotion between different services, is patient transportation being performed in an adequate and safe manner?

Regionalization is an organized process of utilization of a geographical area’s resources which assures patients access to the required level of care, maintaining efficient use of available resources without unnecessary duplication. It requires statewide coordination and evaluation and, regionally, depends on the participation of the emergency services, transportation and intensive care.^{6,7}

A number of different authors have already demonstrated that tertiary services, with large patient volumes, doctors who are both more experienced and more specialized in pediatric intensive care and suitable transport for more critically ill patients obtain the best results. Similarly, the access that more critically ill patients have to more specialized centers depends upon the availability of services in every region, upon a formal regionalization facilitating patients’ entry to necessary services and upon the distance between patients’ residences and these specialized centers. The overriding objective is to assure specialized care for every patient who requires this type of care.⁸⁻¹⁸

In addition to the regionalization of services with an efficient referral and cross-referral system, the availability of specialized patient transportation is another aspect that is known to improve pediatric intensive care provision. Edge *et al.*,¹⁹ writing about the transportation of critically ill pediatric patients, observed that these patients transported by specialized teams presented a significantly

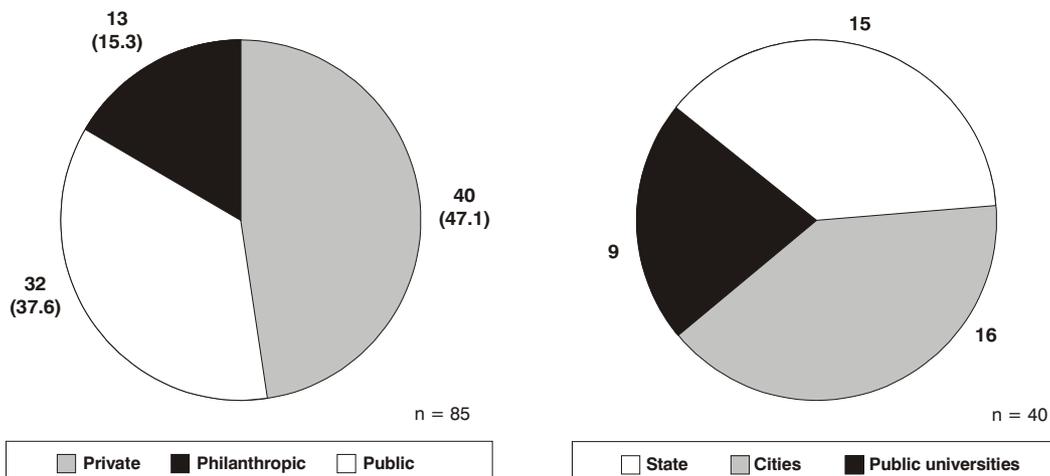


Figure 3 - Types of intensive care units with respect of source of funding - n (%)

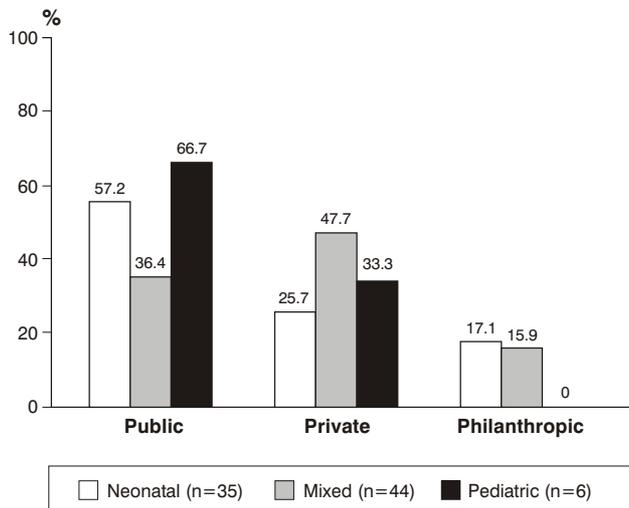


Figure 4 - Distribution of intensive care units according to the age group cared for - n = 85

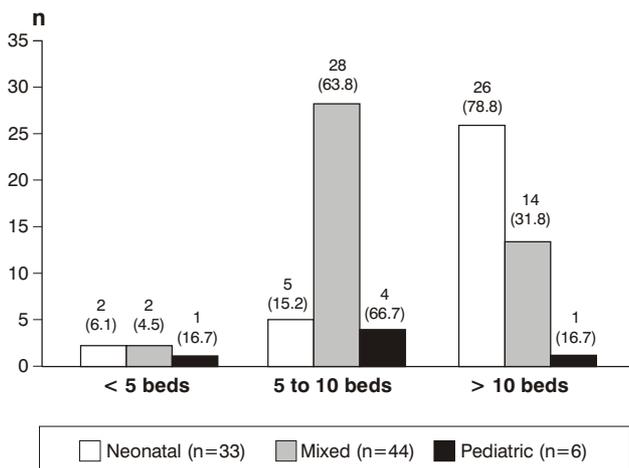


Figure 5 - Distribution of the intensive care units according to the number of beds and age groups (n = 83) - n (%)

reduced morbidity, with a reduction in adverse events related to intensive care.

It is well known that in São Paulo city, at least within the public sector, there is no specialized pediatric transport system, nor one for the transport of critically ill children, who are taken to ICUs by doctors who have not been familiarized with such patients. This being so, in addition to problems with access to the pediatric intensive care services because of the poor distribution of units across the city, critical patients may have their clinical condition worsened by inadequate transportation.

There are yet other factors to be analyzed with respect of pediatric intensive care provision, such as the number of beds available to the population, the type of source of funding and the level of care by age group.

When intensive care bed requirements are being calculated certain factors must be taken into account, such as average length of stay, the percentage of pediatric hospital admissions and that for PICUs, the region's pediatric population and the number of hospital admissions for the general population and the pediatric one, which varies from region to region.^{20,21}

Taking all of these factors into question, Barbosa⁴ came to the conclusion that, in the State of Rio de Janeiro the ratio of intensive beds to pediatric population should be of the order of 1:3,000.

Both the ratio of 1:2,728 (calculating based on only the 969 beds of which we were informed) and the ratio of 1:2,156 (extrapolating to adjust for non-responding units) are comparable with the ratio suggested in literature of 1:3,000.

In a similar manner to the disproportionate distribution of ICUs across the five RHN, there is also a disproportion in terms of beds per RHN, varying from 99 beds in RHN-III to 414 for Nucleus I. The ratio of beds/pediatric population is highly heterogeneous: varying from 1:604 in RHN-I (43% of the beds for 10% of the pediatric population) to 1:6,812 in RHN-III (10% of the beds for 26% of the population). A concentration of beds was observed in central regions that are more highly developed in socioeconomic terms (60% of the beds for 30% of the population). The same distribution has been reported by other authors.^{4,18}

With respect of source of funding, it was observed that around half of the beds in PICUs and NICUs were in the public sector. According to data from the Brazilian Association of Health Maintenance Organizations (*Associação Brasileira de Medicina de Grupo - ABRAMGE*) from June of 2002, the private health system in Brazil, provides care to a quarter of the population (41.6 million) through pre-paid plans. Taking these data into account, the number of pediatric intensive care beds in the private sector should be 25% of the total for the city, i.e. there should be around 240 private PICU beds. What was actually observed in this study was an excess of PICU beds (35.6%) in the private sector and a shortage of public sector beds (a requirement for 725 *versus* 457 actually in existence), i.e. there is a public intensive care bed deficit of 37% in São Paulo city. This is based on just the 85 ICUs that participated.

Barbosa,⁴ writing about age-groups cared for, proposes that 80% of intensive beds should provide care for neonates and 20% to patients beyond the neonatal period. The observed distribution by age group for the State of Rio de Janeiro was not adequate (52% neonatal beds *versus* 48% of pediatric ones). What was observed in the city of São Paulo was a disproportionate distribution of beds by age group, with an excess of pediatric beds (43%) and a deficit of neonatal ones (57%). It is worth pointing out that the current study did not permit the

percentage of beds destined for neonatal care at mixed units and that this proportion may be closer to the recommended.

The requirement for neonatal beds varies from country to country and region to region depending upon the number of live births, the percentage of admissions to NICUs, the average length of stay and the frequency of premature and low birth weight cases.²²

The frequency of low weight births varies from less than 5% in some European countries to rates as elevated as 15 to 20%. In São Paulo, this number is around 9%.¹ Based on this, the literature puts the need for neonatal intensive beds at from 0.4 to 1.5 for every 1,000 live births,^{23,24} which has increased in recent years in virtue of advance in the care of high-risk newborns. This number also varies depending on prenatal care: regions that put emphasis on prenatal care will require less investment in intensive units; which doesn't appear to be the case with our country.

In the USA, Goodman *et al.*,²⁵ found that the provision of neonatal intensive care beds varied substantially from region to region, (1.4 to 5.93 beds for every 1,000 live births, with an average of 3.37). These authors did not find any consistent relation between the number neonatal intensive care beds and neonatal mortality. However, since the only outlook that they assessed was mortality, question could be asked in relation to the babies' morbidity.

Barbosa⁴ assessed the requirements for intensive neonatal beds in the State of Rio de Janeiro, taking into account an average length of stay of 20 days and a percentage of 7% of births requiring admission to an ICU concluded that in that State there was a need for 3.8 beds for every 1,000 live births and that one third of these would be intensive.

Adopting the bed requirements calculation used by Barbosa⁴ gives a requirement of 790 NICU beds for a total of 207,462 live births in the city for the year 2000.² This study identified a total of 556 neonatal beds. Extrapolating to account for the non-participating centers, São Paulo city had around 700 NICU beds, which corresponds to a deficit of 11.4% (90 beds).

The average of 11.7 beds per unit was a little below the North American average, reinforcing the Brazilian tendency towards a greater number of units with smaller numbers of beds each. Analyzing the exclusively neonatal and pediatric units, the average number of beds per unit (16.9 for NICUs and 8.5 for ICUs) was also below the North American average.¹² For a country like Brazil, in financial difficulties, this distribution does not appear to be adequate when dealing with intensive care, which represents a large proportion of the costs of a hospital. In addition to the lower patient volumes cared for in such units, as was pointed out earlier, there may be a negative effect on the progress of these patients.

A greater concentration (82.4%) of the PICUs was found at General Hospitals, which is a positive factor for the quality of medical care since such hospitals have a wider range of support, diagnosis and treatment services.

The same tendency was also observed by Barbosa⁴ in the State of Rio de Janeiro.

The ICUs found in teaching hospitals accounted for 10.6% of the participating units, double the proportion found in Rio de Janeiro,⁴ but still very different from North American data. Pollack *et al.*¹² reported that 76.6% of North American PICUs were affiliated to medical schools.

This situation: lack of planning in respect of pediatric and neonatal intensive care services in São Paulo city, can be explained by the disorderly growth of the health services during the 70s and 80s. Knowledge of the real status of pediatric and neonatal intensive care will make more adequate health planning possible, together with a better distribution of investment and resources with more efficient and effective results and also facilitate the execution of multicenter research projects. Changes must be implemented so that we can ensure intensive care provision for every child that needs it. This study has been the first effort in a push to achieve improved quality in pediatric and neonatal intensive care provision in the city of São Paulo.

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