Review of Pediatric Autopsies Performed at a University Hospital in Ribeirão Preto, Brazil

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• ***Context.*—Autopsy continues to provide important data for quality assurance, teaching, scientific purposes, and health planning, especially if performed according to a comprehensive protocol.**

***Objective.*—To describe and analyze data from all perinatal and pediatric autopsies performed at a university hospital in Brazil.**

***Design.*—Review of data from 1716 autopsies performed between April 1993 and April 1999, consisting of age at death, congenital defects, gender, and cause of death.**

***Results.*—Age at death distribution: early neonatal deaths, 31.7%; stillbirth, 25.7%; 1 to 11 months, 19.6%; 1 to 5 years, 10.3%; late neonatal deaths, 6.3%; 11 to 15 years, 4%; 6 to 10 years, 2.5%. Cause of death: perinatal conditions, 51%; congenital malformation(s), 24.4%; infection, 11.9%; neoplasm, 3%; hematologic/immunologic, 2.3%; neurologic, 1.6%; gastrointestinal, 1.5%; cardiovascular, 0.7%; respiratory, 0.6%; genitourinary, 0.3%; other disorders, 0.5%. Gender distribution: male, 54.31%; female, 45.22%; indeterminate, 0.41%; data unavailable, 0.06%. Congenital anomalies were found in 31.5% of the autopsies and were the cause of death in 24.41% of the autopsies.**

***Conclusions.*—High autopsy rates, combined with a comprehensive autopsy protocol, allowed the characterization of perinatal and pediatric deaths. The high proportion of perinatal deaths and stillbirths indicates the need for improvement in the prenatal care program. Congenital anomalies were highly prevalent because few pregnancies are interrupted in Brazil. The low number of cancer cases autopsied was attributed to the fact that most patients die at home, and to the high level of trust between the oncology team and the family, with the erroneous assumption that no relevant information would be provided.**

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Autopsy is an invaluable tool for medical teaching, research,[1] and quality control.[2] To achieve educational, quality control, and research goals, an autopsy protocol should be adopted and strictly followed. Because pediatric autopsies are performed on individuals within a broad age (from the fetal to teenage periods), such a protocol is essential.

At the Hospital das Clínicas da Faculdade de Medicina de Ribeirão Preto (HC-FMRP; the University Hospital of the Ribeirão Preto School of Medicine) in Ribeirão Preto, Brazil, greater than 90% of fetal, perinatal, and pediatric hospital deaths are submitted to autopsy[3] following a protocol established in 1993. This protocol needs to be re-evaluated in comparison to those used in other facilities.

OBJECTIVE

The main goal of this study was to analyze collected data from fetal, perinatal, and pediatric autopsies performed during a 6-year period.

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MATERIALS AND METHODS

The following data were retrieved from the autopsy reports and patient files related to all 1716 fetal, perinatal, and pediatric autopsies performed at the HC-FMRP from April 1993 to April 1999: patient and autopsy identification, age at death, gestational age (when pertinent), gender, any congenital defects, and the primary cause of death.

Autopsies were performed on stillborn fetuses weighing more than 500 g and on liveborn infants (independent of birth weight) dying in the hospital, as well as in cases of postnatal death occurring at up to the age of 15 years and 11 months. Deaths were categorized by age as stillbirth (SB), early neonatal (EN; those occurring between birth and 7 days of life), and late neonatal (those occurring between 8 to 28 days of life); later deaths were categorized by the age at which they occurred (in number of months up to 1 year, and thereafter in number of years).

Autopsies were also classified according to the categories defined in the *International Classification of Diseases, 10th Revision* (*ICD-10*) (Table 1).[4] Each case was counted only once.

Congenital anomalies were classified according to category, mechanism of production, and etiology, using the classification system described by Opitz and Wilson in 1997.[5]

Sex was assigned according to the phenotype as male, female, or indeterminate. In some cases, no data were available.

All autopsies were performed according to a working protocol. Macroscopic photographs and video were taken of the whole body and significant features. Body weight and individual weights of the internal organs (brain, thymus, heart, lungs, liver, spleen, adrenal glands, and kidneys) were determined. Anthropometric measurements (crown-to-heel, crown-to-rump, cranial perimeter, toe-to-heel, hand, middle finger of the hand, inner canthal distance, outer canthal distance, penis, and testis) were taken.

Table 1. Disease Groups of the *International Classification of Diseases, 10th Revision* (*ICD-10*)[4]

ICD-10 Category	Disease Group
I	Certain infectious and parasitic diseases
II	Neoplasms
III	Blood disorders, disorders of hematopoietic organs, some immune disorders
IV	Endocrine, nutritional, and metabolic diseases
V	Mental and behavioral diseases
VI	Nervous system diseases
VII	Diseases of the eyes and adnexa
VIII	Diseases of the ear and mastoid apophysis
IX	Diseases of the circulatory system
X	Diseases of the respiratory system
XI	Diseases of the digestive tract
XII	Diseases of the skin and subcutaneous layer
XIII	Diseases of the osteomuscular system and connective tissue
XIV	Diseases of the genitourinary tract
XV	Pregnancy, delivery, and puerperium
XVI	Certain disorders originating during the perinatal period
XVII	Congenital malformations, deformities, and chromosomal aberrations
XVIII	Symptoms, signs, and abnormal findings on clinical or laboratory examination not elsewhere classified
XIX	Lesions, poisoning, and certain consequences of external origin
XX	External causes of morbidity and mortality
XXI	Factors influencing health status and contact with health services

Blood cultures from the superior sagittal sinus and microbiological cultures from the percutaneous aspirate of the lung were obtained and processed. Cases in which there were congenital anomalies were also examined by a clinical geneticist who helped decide whether a cytogenetic study was indicated in cases of possible chromosomal or genetic origin. Samples were collected (blood from the superior sagittal sinus, skin from the abdomen, and tissue from the anterior fascia of the rectus abdominis muscle). A radiologic study was indicated in cases of skeletal involvement. When necessary, serologic tests were performed, and the composition of the vitreous humor was determined.

The placenta was examined as a surgical specimen after the autopsy.

The cases were also classified as with or without congenital anomalies, even if unrelated to the cause of death. The data were analyzed with the aid of the Epi Info 6 and Excel programs.

RESULTS

The distribution of cases by gender and by cause of death is shown in Table 2. In 1 case (0.06%) the gender was not recorded and could not be determined by any other means. Although not always the primary cause of death, congenital anomalies were present in 541 cases, 31.5% of all autopsies performed. The 4 most-common conditions accounted for 90% of all autopsied deaths. Most of the deaths were related to perinatal conditions (*ICD-10* category XVI = 876 cases; 51%), followed by congenital anomalies (*ICD-10* category XVII = 419 cases; 24.4%), infections (*ICD-10* category I = 204 cases; 11.9%), and neoplasm (*ICD-10* category II = 52 cases; 3%).

Age distribution by cause of death is presented in Table 3. Stillbirths (25.7%) and infant mortality up to 11 months of age (57%) accounted for 82.7% of all autopsied deaths. Most deaths occurred in the EN period (544 cases, 31.7%), and most of these, 72% (392/544), were attributed to perinatal conditions. Nearly an equal number of autopsies related to perinatal conditions were performed on SB (387

Table 2. Distribution of the Number of Cases According to the Category of Diagnosis, *International Classification of Diseases, 10th Revision* (*ICD-10*) Category, Gender, and Presence of Congenital Anomalies in the 1716 Pediatric Autopsies Performed at Hospital das Clínicas da Faculdade de Medicina de Ribeirão Preto From April 1993 to April 1999*

Category of Diagnosis	*ICD-10*	No. (%)	Sex, No. (%)				CA (%)
			M	F	Ind.	ND	
Perinatal	XVI	876 (51)	477 (27.8)	398 (23.2)	0	1 (0.1)	43 (4.9)
Congenital anomaly	XVII	419 (24.4)	213 (50.8)	199 (471)	7 (1.7)	0	419 (100)
Infections	I	204 (11.9)	117 (57.4)	87 (42.6)	0	0	17 (8.3)
Neoplasms	II	52 (3)	28 (53.8)	24 (46.2)	0	0	6 (11.5)
Hematologic and immunologic disorders	III	40 (2.3)	24 (60)	16 (40)	0	0	33 (82.5)
Nutritional disorders	IV	36 (2.1)	16 (44.4)	20 (55.6)	0	0	4 (11.1)
Neurologic disorders	VI	28 (1.6)	19 (67.7)	9 (32.1)	0	0	7 (25.0)
Gastrointestinal disorders	XI	25 (1.5)	14 (0.8)	11 (0.6)	0	0	6 (24)
Cardiovascular disorders	IX	12 (0.7)	99 (75.0)	3 (25.0)	0	0	2 (16.7)
Respiratory disorders	X	10 (0.6)	8 (80.0)	2 (20)	0	0	0
Genitourinary disorders	XIV	5 (0.3)	4 (80)	1 (20)	0	0	2 (40)
Others	XIX/XX	9 (0.5)	6 (6671)	3 (33.3)	0	0	2 (22.2)
Total		**1716 (100)**	**932†** (54.31)	**776†** (45.22)	**7** (0.41)	**1** (0.06)	**541** (31.5)

* Ind. indicates indeterminate; ND, no data; and CA, congenital anomaly.
† $P < .01$.

Table 3. Distribution of the Cases and Respective Percentages by Age Group and Category of Diagnosis*

Age at Death	Perinatal Disorders	Congenital Anomalies	Infectious Disorders	Neoplasms	Nutritional Disorders	Hematologic and Immunologic Disorders
SB	387 (22.55)	42 (2.4)	0	1 (0.05)	0	11 (0.6)
EN	392 (22.84)	128 (7.5)	12 (0.7)	1 (0.05)	0	11 (0.6)
LN	61 (3.55)	35 (2)	9 (0.5)	1 (0.05)	0	2 (0.1)
1–11 mo	30 (1.75)	136 (7.9)	87 (5.1)	8 (0.6)	28 (1.6)	6 (0.4)
1–5 y	6 (0.35)	63 (3.7)	63 (3.7)	12 (0.7)	7 (0.4)	5 (0.3)
6–10 y	0	3 (0.2)	16 (1)	10 (0.6)	1 (0.05)	1 (0.05)
11–15 y	0	12 (0.7)	17 (1)	19 (1.1)	0	4 (0.2)
Total	**876** (51.0)	**419** (24.4)	**204** (12)	**52** (3)	**36** (2.1)	**40** (2.3)

* Data are given as mean (SD). SB indicates stillbirth; EN, early neonatal (0–7 days); LN, late neonatal (8–28 days).

cases, 22.55%). Perinatal conditions in these 2 youngest groups accounted for 45.39% of all autopsies. Deaths attributable to perinatal conditions, however, were seen as late as 1 to 5 years of age (6 cases, 0.35%).

As seen in Table 3, congenital anomalies were found in all age groups. However, 81.4% of all deaths attributed to congenital anomalies occurred in cases younger than 1 year of age, including 10% in the SB group, 38.9% in the EN plus late neonatal group, and 32.5% at 1 to 11 months of age. Cytogenetic studies were performed in 32.2% (135/419) of the congenital anomaly cases, of which 78 (57.8%) were normal.

Perinatal conditions and congenital anomalies comprised 96% (520/544) of all EN deaths autopsied.

Most deaths from infection occurred in infants between 1 and 11 months of age (87/204 cases, 42.6%), although proportionally, death from infection was more frequent in the 6 to 10 years of age group (16/43 cases, 37.2%).

Neoplasm as the cause of death was more common in older patients, with the 11- to 15-year-old age group having the most cases (19 cases, 1.1%).

Each of the other categories accounted for less than 3% of the autopsied deaths. Nutritional disorders were more common in the 1- to 11-month-old age, whereas most deaths attributed to hematologic/immunologic disorders (52.5%) occurred in SB and in the EN period.

Perinatal causes of death are shown in Tables 4 and 5. Gestational age in the prematurity group ranged from 21 to 37 weeks and the cause of prematurity was not identified in the majority of cases. Among the defined causes, premature rupture of membranes ranked first, usually associated with chorioamnionitis.

Characterization and diagnoses of deaths from congenital anomalies are shown in Tables 6 and 7. In the category of isolated defects, the leading problem was congenital heart disease (186/268 cases, 69.4%); whereas, in the category of multiple defects, the leading problem was trisomy 21 (26/127 cases, 20.5%). Malformation was the most common mechanism of congenital anomaly (360/419 cases, 85.9%) and multifactorial congenital anomaly was the most common etiology (156/419 cases, 37.2%). Congenital anomalies were also seen in cases whose cause of death was not related to the congenital anomaly. Considering these cases, congenital anomalies were found in 31.6% of all autopsies (542/1716 cases). In the cases of nonimmune hydrops, the etiology was not defined and renal anomalies were included in the oligohydramnios sequence.

Deaths from infectious diseases are listed in Table 8. Infections were the cause of death mainly in the first year of life (108/204 cases, 53%) and, although it was the single largest category for autopsies performed on children 6 to 10 years of age (16/43 cases, 37%), this age group only accounted for 7% (16/204 cases) of all deaths attributed to infectious diseases.

Deaths from cancer were underrepresented and are listed in Table 9. Most of the deaths occurred in older children, older than 1 year of age (41/52 cases, 78.8%). Leukemia was the leading diagnosis (25/52 cases, 48.1%) represented by 14 cases of acute lymphocytic leukemia (14/52 cases, 27%) and 11 cases of acute myeloid leukemia (11/52 cases, 21%). Non-Hodgkin lymphoma was seen in the oldest age group (5/52 cases, 9.6%). One of the teratomas was sacrococcygeal and the other was located in the neck region.

Deaths from hematologic/immunologic, neurologic, and gastrointestinal disorders are shown in Table 10. All cases of Rh and ABO isoimmunization were seen in SB, EN, or late neonatal deaths. In the oldest age group, 11 to 15 years of age, there was 1 case of Fanconi anemia, 1 case of bone marrow aplasia, and 2 cases of systemic lupus erythematosus. No case of nonmalformative neurologic or gastrointestinal condition was seen at younger than 1 month of age, and most of the nonmalformative neurologic conditions remained undefined. All cases of extrahepatic biliary atresia were seen in the 1 to 11 months of age group, whereas hepatitis was found in children older than 1 year of age.

Deaths from cardiovascular, respiratory, genitourinary, and other disorders are listed in Table 11. Most of the cases of dilated cardiomyopathy and myocarditis were observed in the groups younger than 1 year of age, with the exception of 1 case of myocarditis seen in the 1 to 5 years of age group and 1 case of dilated cardiomyopathy in the 11 to 15 years of age. Bronchospasm/asthma occurred predominantly in children older than 1 year of age, and the 2 cases of glomerulopathy occurred in the 1 to 5 years of age and the 11 to 15 years of age groups.

The group of deaths from other causes (*ICD-10* categories XIX and XX) was composed of a variety of causes (Tables 3 and 11). Of the 9 total cases, 5 different causes were recognized, including 2 with scorpion envenomation. An etiology could not be determined in the remaining 3 cases, which represent 0.1% (3/1716 cases) of the entire autopsy population.

COMMENT

A large portion of the current medical knowledge regarding diseases, treatments, and consequences has been derived from autopsies.[6] It is, therefore, essential that we continue performing as many autopsies as possible. The

Table 3. Extended

Neurologic Disorders	Gastrointestinal Disorders	Cardiovascular Disorders	Respiratory Disorders	Genitourinary Disorders	Others	Total
0	0	0	0	0	0	441 (25.7)
0	0	0	0	1 (0.05)	0	545 (31.7)
0	0	0	0	0	0	108 (6.3)
7 (0.4)	13 (0.7)	5 (0.3)	5 (0.3)	0	1 (0.05)	326 (19)
9 (0.5)	5 (0.3)	4 (0.2)	4 (0.2)	1 (0.05)	6 (0.035)	185 (10.8)
6 (0.35)	4 (0.2)	0	0	2 (0.1)	0	43 (2.5)
6 (0.35)	3 (0.4)	3 (0.2)	1 (0.05)	1 (0.05)	2 (0.1)	68 (4)
28 (1.6)	**25** (1.5)	**12** (0.7)	**10** (0.6)	**5** (0.3)	**9** (0.5)	**1716 (100)**

Table 4. Primary Cause of Death in the Perinatal Disorders Group: *International Classification of Diseases, 10th Revision* Category XVI

Primary Cause of Death	No. (%)
Prematurity	343 (39.1)
Abruptio placentae	97 (11.1)
Perinatal asphyxia	54 (6.2)
Maternal hypertensive disorders	46 (5.2)
Placental disorders/placenta previa	24 (2.7)
Other maternal disorders	23 (2.6)
Infection	22 (2.5)
Multiple gestation	19 (2.2)
Umbilical cord disorders	12 (1.4)
Maternal diabetes mellitus	4 (0.5)
Delivery disorders	4 (0.5)
Not defined	228 (26.0)
Total	**876 (100)**

Table 5. Number of Cases According to the Primary Cause of Death in Cases of Prematurity

Primary Cause of Death	No. (%)
Premature rupture of membranes	51 (14.9)
Multiple gestation	23 (6.7)
Maternal hypertensive disorders	21 (6.1)
Infection	8 (2.3)
Cervical incompetence	2 (0.6)
Not defined	238 (69.4)
Total	**343 (100)**

Table 6. Category, Mechanism, and Etiology of Congenital Anomalies

Type		Primary Cause of Death, No. (%)
Category	Isolated defects	268 (64)
	Single major defect	186 (44.4)
	Sequence	82 (19.6)
	Multiple defects	127 (30.3)
	Syndrome	113 (27)
	Association	14 (3.3)
	Not defined	24 (5.7)
	Total	**419 (100)**
Mechanism	Malformation	360 (85.9)
	Disruption	18 (4.3)
	Deformation	0 (0)
	Dysplasia	2 (0.5)
	Unknown	10 (2.4)
	Not defined	29 (69)
	Total	**419 (100)**
Etiology	Multifactorial	156 (37.2)
	Chromosomal	55 (13.1)
	Mendelian inheritance	51 (12.8)
	Environmental	8 (1.9)
	Unknown	116 (27.7)
	Not defined	33 (7.9)
	Total	**419 (100)**

benefits of autopsy are not restricted to better defining the cause of death,[1] which is important enough for epidemiologic studies; autopsies also constitute an excellent tool for education,[7,8] quality control,[2] and scientific investigation.[9]

Ideally, all pediatric cases should be submitted to postmortem examination. An autopsy rate of at least 75%, especially in cases of perinatal death, is necessary to achieve educational, quality control, and research goals. At the HC-FMRP, a tertiary-care university hospital, autopsy was requested and performed in greater than 80% of all inpatient deaths, and postmortem examination was carried out within a few hours after death in greater than 90% of perinatal cases.[3] In the last 5 years, the autopsy rate among adults has fallen to 77.75%.[10]

In large part, pediatric pathology, and perinatal pathology in particular, is dependent on autopsy results[11,12] obtained using a comprehensive protocol.[13] Because we have been using such a working protocol, and because of the high number of cases studied (1716 cases), which represented nearly all cases of pediatric death at the HC-FMRP, the data obtained allows us to draw useful conclusions.

Perinatal conditions still constitute the most common causes of pediatric death in Brazil. This is true both at our institution (reflecting conditions in the city of Ribeirão Preto) and nationally, and were responsible for 41.08% of the deaths of Brazilian infants in the first year of life in 2002.[14] This rate is similar to the rate seen in other developing countries. Because most of these deaths are related to prematurity and its consequences, these high rates indicate a lack of adequate and comprehensive prenatal care and delivery programs.

Congenital anomalies ranked second in causes of death and corresponded to roughly a quarter of all pediatric deaths. In fact, congenital anomaly is currently the leading cause of death in infants from 1 to 12 months of age in the city of Ribeirão Preto and the second leading cause of such deaths in Brazil,[14] corresponding to 10.9% of all deaths of Brazilian infants in their first year of life in 2002. Because abortion is illegal in our country, early diagnosis does not benefit those mothers who will carry their pregnancies to term despite the diagnosis, resulting in perinatal deaths, at high emotional and hospital costs. Among

Table 7. Diagnoses in the Congenital Anomaly Group: *International Classification of Diseases, 10th Revision* Category XVII

Diagnosis	Primary Cause of Death, No. (%)
Isolated congenital heart disease	108 (25.8)
Sequences	57 (13.6)
Isolated neural tube defect	31 (7.4)
Isolated central nervous system defects other than neural tube defects	31 (7.4)
Trisomy 21	26 (6.2)
Nonchromosomal syndromes	26 (6.2)
Multiple congenital anomalies	23 (5.5)
Inborn errors of metabolism and monogenic diseases	20 (4.8)
Isolated congenital anomalies of the gastrointestinal tract	17 (4.1)
Associations	14 (3.3)
Trisomy 18	13 (3.1)
Nonimmune hydrops	11 (2.6)
Omphalocele and gastroschisis	10 (2.4)
Structural abnormalities of chromosomes	9 (2.1)
Conjoined twins	6 (1.4)
Diaphragmatic hernia	5 (1.2)
Trisomy 13	5 (1.2)
Isolated respiratory tract anomalies	2 (0.5)
Bone dysplasia	2 (0.5)
Isolated congenital skin diseases	1 (0.2)
Monosomy X	1 (0.2)
Triploidy	1 (0.2)
Total	**419 (100)**

Table 8. Diagnoses in the Infectious Diseases Group: *International Classification of Diseases, 10th Revision* Category I

Diagnosis	No. (%)
Respiratory tract infections	49 (24)
AIDS	41 (20)
Central nervous system infections	40 (19.6)
Digestive tract infections	28 (13.7)
Meningococcemia	20 (9.8)
Viral and parasitic infections	8 (4)
Infections of the skin	5 (2.5)
Syphilis	2 (1)
Osteoarticular infections	2 (1)
Unspecified infection	9 (4.4)
Total	**204 (100)**

Table 9. Diagnoses in the Group of Neoplasms: *International Classification of Diseases, 10th Revision* Category II

Type of Neoplasia	No. (%)
Hematologic	35 (67.2)
Central nervous system tumors	5 (9.6)
Adrenal carcinoma	4 (7.7)
Soft tissue tumors	3 (5.8)
Teratoma	2 (3.8)
Renal tumors	1 (1.9)
Retinoblastoma	1 (1.9)
Gonadal tumors	1 (1.9)
Total	**52 (100)**

the cases evaluated in the present study, a large proportion of deaths caused by congenital anomalies did not occur in the perinatal period but during the first year of life and beyond. This can be attributed to the fact that the HC-FMRP has a cardiovascular surgery unit to which infants and children with complex congenital heart disease are referred. This also explains the high prevalence of trisomy 21 in this study, because congenital heart disease is a common cause of death among patients suffering from this chromosomal aberration. In fact, a quarter of all deaths in the group presenting congenital anomalies were attributed to isolated congenital heart disease.

As typically reported in the literature, malformation was the most prevalent mechanism,[5] and multifactorial congenital anomaly was the most prevalent etiology.[15] Congenital anomalies caused by Mendelian inheritance were almost as prevalent as those of chromosomal origin. Using the working protocol, the category, mechanism, and etiology can be defined in most cases. In fact, the cases in which they were not defined were those in which the protocol was not followed exactly or completely. Cases for which only the category was defined were also classified as defined diagnosis because a thorough literature search was unable to provide a definition for etiology and mechanism.

Many deaths from perinatal conditions could be prevented by improving prenatal care. In addition, once a severe congenital anomaly is diagnosed in utero, interruption of pregnancy would be most likely indicated if permitted by law.

In the past, infectious and parasitic diseases constituted the leading cause of pediatric death in Brazil, representing 22.56% of the deaths in the first year of life in 1979, and dropping to 8.44% (fourth position) in 2002.[14] Although there are poor areas of Brazil in which infectious and parasitic diseases still predominate, these diseases corresponded to only approximately 12% of the cases in our study. It is of note that 20% of the deaths in the infectious diseases category were from AIDS. The HC-FMRP has the only specialized AIDS clinic in the region and hosts a successful program for prevention of the vertical transmission of HIV, offering free prenatal antiretroviral treatment. However, the unit was not yet in operation during the period analyzed, which may account for the high prevalence of AIDS deaths.[16–18] Since the inauguration of the clinic, the incidence of congenital HIV infection, and consequently of deaths caused by AIDS, has dropped dramatically.

Although autopsies were rarely requested in cases of death caused by neoplasm, the frequencies of the types correlated with those typically seen in the general pediatric population in Brazil and in other countries.[19] The pediatric oncology team reported that the lower proportion of autopsies in these cases was related to the close relationship established between the team and the family of the patient and to the false perception that little or no valuable information is derived from autopsy in terminal cases. In addition, these patients are frequently sent home to die, another hindrance to postmortem examination. Neoplasms were responsible for 0.82% of all infant deaths in Brazil in the year 1979, corresponding to the ninth leading cause of death, and moved up to sixth place, at 2.74%, in 2002.[14]

In past decades, malnutrition was a major burden in Brazil, mainly around larger cities and in the less-devel-

Table 10. Diagnoses in the Hematologic/Immunologic, Neurologic, and Gastrointestinal Disorders Group: *International Classification of Diseases, 10th Revision* Categories III, VI, and XI

Group	Diagnosis	No. (%)
Hematologic diseases	Rh isoimmunization	21 (52.5)
	Primary immunodeficiencies	4 (10)
	ABO isoimmunication	3 (7.5)
	Chronic granulomatous disease of infancy	3 (7.5)
	Bone marrow aplasia	2 (5)
	Sickle cell anemia	2 (5)
	Pancytopenia	2 (5)
	Autoimmune diseases	2 (5)
	Fanconi anemia	1 (2.5)
	Total	**40 (100)**
Neurologic disorders	Convulsive syndromes	6 (21.4)
	Vascular disorders	4 (14.3)
	Neuromuscular disorders	4 (14.3)
	Degenerative disorders	1 (3.6)
	Acquired hydrocephalus	3 (10.7)
	Lymphocytic encephalitis	1 (3.6)
	Not defined	9 (32.1)
	Total	**28 (100)**
Gastrointestinal disorders	Extrahepatic biliary atresia	6 (24)
	Hepatitis	6 (24)
	Cirrhosis	3 (12)
	Others	2 (8)
	Unspecified bowel inflammations/infections	2 (8)
	Hirschsprung disease	2 (8)
	Short bowel syndrome	1 (4)
	Neonatal volvulus	1 (4)
	Protein-losing enteropathy	1 (4)
	Inguinal hernia	1 (4)
	Total	**25 (100)**

Table 11. Diagnoses in the Cardiovascular, Respiratory, Genitourinary, and Other Disorders Group: *International Classification of Diseases, 10th Revision* Categories IX, X, XIV, XIX, and XX

Group	Diagnosis	No. (%)
Cardiovascular disorders	Dilated cardiomyopathy	4 (33.3)
	Acute myocarditis	3 (25.0)
	Rheumatic heart disease	2 (16.7)
	Restrictive cardiomyopathy	1 (8.3)
	Kawasaki disease	1 (8.3)
	Budd-Chiari syndrome	1 (8.3)
	Total	**12 (100)**
Respiratory tract	Bronchospasm/asthma	5 (50)
	Chronic lung disease	3 (30)
	Diffuse pulmonary fibrosis	1 (10)
	Primary pulmonary hypertension	1 (10)
	Total	**10 (100)**
Genitourinary disorders	Glomerulopathies	3 (60)
	Acquired obstructive uropathy	1 (20)
	Acute renal failure	1 (20)
	Total	**5 (100)**
Other causes	Indeterminate	3 (33.3)
	Scorpion envenomation	2 (22.2)
	Type 1 diabetes mellitus	1 (11.1)
	Radiologic contrast anaphylaxis	1 (11.1)
	Foreign body in the esophagus	1 (11.1)
	Postoperative brain anoxia	1 (11.1)
	Total	**9 (100)**

oped northeastern states, representing the fourth leading cause of death in the first year of life, at 5.06%, in 1979, and falling to seventh place, at 2.37%, in 2002.[14] In this study, malnutrition accounted for 2.1% of pediatric deaths, was seen in the first year of life, and was predominately observed in females. We could find no reasonable explanation for the last finding.

All other causes of death were less frequent and jointly corresponded to less than 2% of the total. Among the 9 deaths falling under the rubric of other causes, 2 were related to scorpion sting, 3 were iatrogenic, and 3 were of undetermined cause.

Males predominated over females in all categories of the *ICD-10* except category IV (nutritional and metabolic diseases) and category XI (gastrointestinal, including hepatic, diseases). We could find no reasonable explanation for this result other than underrepresentation in the general population. It is known that, globally, there are more births and deaths among males,[20] and this is also seen in the general population of Brazil. In 2001, males composed 51.15% of the population, compared with 48.6% for females.[14] Indeterminate sex, a result of the intersex condition, was higher than that presented in the general population. This can be explained by the fact that we analyzed cases from a tertiary-care hospital to which complex cases are referred. This was also reflected in the high percentage of congenital anomalies. There was only 1 case of intersex, which was seen in a macerated fetus. However, because this information was not recorded, the true number of such cases is unknown.

In conclusion, the high autopsy rate at the hospital studied, together with the detailed examination protocol followed in pediatric cases allows us to make useful observations regarding the prevalence of conditions implicated in pediatric mortality. The high rates of mortality from perinatal conditions and congenital anomalies, both reflecting the need for a better prenatal care program, merit closer attention. It is clear that the early diagnosis of congenital anomalies should be followed by measures such as termination of pregnancy, if it was legalized (when medically feasible and when desired by the family). Another important observation is related to autopsies of oncologic cases. Although it is understood that emotional ties between the oncology team and the family are usually strong, the autopsy provides useful information by confirming suspected findings and verifying the diagnosis and effects of treatment, as well as furnishing new data that would not otherwise be disclosed.

Members of multidisciplinary teams involved in treating pediatric patients should actively solicit and encourage family consent for autopsy in all patient deaths. Doing so would help to achieve the primary goal of medical care, which is to provide the most accurate and complete diagnoses, and the most effective, least harmful treatment.

References

1. Burton JL. The autopsy in modern undergraduate medical education: a qualitative study of uses and curriculum considerations. *Med Educ.* 2003;37:1073–1081.
2. Gut AL, Ferreira AL, Montenegro MR. Autopsy: quality assurance in the ICU. *Intensive Care Med.* 1979;25:360–363.
3. Kajiwara JK, Zucoloto S, Manço AR, Muccillo G, Barbieri MA. Accuracy of clinical diagnoses in a teaching hospital: a review of 997 autopsies. *J Intern Med.* 1993;234:181–187.
4. World Health Organization. *International Classification of Diseases (ICD), 10th Revision.* Geneva, Switzerland: World Health Organization; 1989.
5. Opitz JM, Wilson GN. Causes and pathogenesis of birth defects. In: Gilbert-Barness E, ed. *Potter's Pathology of the Fetus and Infant.* St Louis, Mo: Mosby Year-Book Inc; 1997:44–46.
6. Brooks JP, Dempsey J. How can hospital autopsy rates be increased? *Arch Pathol Lab Med.* 1991;115:1107–1111.
7. Berthrong M. The autopsy as a vehicle for the lifetime education of pathologists. *Arch Pathol Lab Med.* 1984;108:506–509.
8. Hill RB, Anderson RE. The recent history of the autopsy. *Arch Pathol Lab Med.* 1996;120:702–712.
9. Kaufman SR. Autopsy. A crucial component of human clinical investigation. *Arch Pathol Lab Med.* 1996;120:767–770.
10. Grade MHC, Zucoloto S, Kajiwara JK, Fernandes MTP, Couto LGF, Garcia SB. Trends of accuracy of clinical diagnosis of the basic cause of death in a university hospital. *J Clin Pathol.* 2004;57:369–373.
11. Kumar P, Taxy J, Angst DB, Mangurten HH. Autopsies in children: are they still useful? *Arch Pediatr Adolesc Med.* 1998;152:558–563.
12. MacPherson TA, Valdés-Dapena M. The perinatal autopsy. In: Wigglesworth JS, Singer DB, eds. *Textbook of Fetal and Perinatal Pathology.* Boston, Mass: Blackwell Scientific Publications; 1991:93–122.
13. Valdés-Dapena M, Huff DS. *Perinatal Autopsy Manual.* Washington, DC: Armed Forces Institute of Pathology; 1983.
14. Ministry of Health, Brazil. *Vital Statistics—Mortality and Liveborn.* Available at: http://datasus.saude.gov.br. Accessed August 4, 2005.
15. Van Regemorter N, Dodion J, Druart C, et al. Congenital malformations in 10,000 consecutive births in a university hospital: need for genetic counseling and prenatal diagnosis. *J Pediatr.* 1984;104:386–390.
16. Galvao J. Access to antiretroviral drugs in Brazil. *Lancet.* 2002;360:1862–1865.
17. Levi GC, Vitoria MA. Fighting against AIDS: the Brazilian experience. *AIDS.* 2002;16:2373–2383.
18. Oliveira-Cruz V, Kowalski J, McPake B. Viewpoint: the Brazilian HIV/AIDS 'success story': can others do it? *Trop Med Int Health.* 2004;9:292–297.
19. Desandes E, Clavel J, Berger C, et al. Cancer incidence among children in France, 1990–1999. *Pediatr Blood Cancer.* 2004;43:749–757.
20. Bhaumik U, Aitken I, Kawachi I, Ringer S, Orav J, Lieberman E. Narrowing of sex differences in infant mortality in Massachusetts. *J Perinatol.* 2004;24:94–99.