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Chapter 16

The Nutritional Status of Children with Suspected Abuse

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1. Introduction

Child abuse is the willful infliction of injury to a child. Estimated at 2.8 million children affected per year, over 2,000 die from maltreatment [1]. In 1998 alone, 900,000 cases were reported [2] and from 1986-1993 cases doubled in the United States. Up to 10% of children seen in the emergency room (ER) under the age of 6 had a non-accidental injury accounting for nearly 25% of all hospital admissions for head injury in infancy, producing significant morbidity [3, 4]. Abuse is not limited to poor or racial minorities [5]. Physical and sexual abuse during childhood/adolescence was reported by 22% on a questionnaire [6]. Abused children frequently have moderate to severe malnutrition [7] due to withholding of food which may lead to compromised nutritional state and failure to thrive (FTT) [8]. Twenty-nine percent of 42 children with severe trauma had under nutrition resulting in growth retardation [9].

Bonnier et al. reported that all 13 children with whiplash shaken infant syndrome had a weight <50th percentile and 9 had a weight <10th percentile. Average birth weight was at the 30th percentile, but body weight at admission for shaking was below the 10th percentile [10]. Poor physical growth/nutrition are seen in 25-35% of abused children [11]. The most common chronic illness of childhood is lead poisoning [11]. Siblings in foster care, physically abused or neglected children are at high risk of lead poisoning and incurring a developmental disability [12-14]. Lead poisoning is caused by ingesting contaminated paint from window sills, furniture, Mexican terra cotta pottery, imported tamarind candy, hot-running water through lead soldered pipes or anything covered in lead-based paint [12-14]. The interaction between nutrition and toxic hazards depends on the baseline nutritional status of the individual as well as total food intake, percent dietary fat, calcium, iron, zinc, vitamin D and phosphorus [15, 16]. Food restriction increased lead retention in animals fed lead containing diets [16, 17]. Yet, one study found a positive association between total caloric intake and blood lead levels [18]. Low calcium diets elevate lead tissue concentrations as calcium functions as a chelating agent reducing lead absorption [17, 19]. Lead competes with calcium in enzyme systems, alters calcium metabolism regulation, modifies the calcium second messenger system, impairs normal modulation of intracellular calcium homeostasis, modifies induction of calcium-regulating proteins and interferes with energy metabolism [19-22, 23]. Zinc status has been found to be approximately 20% lower in children with substantially elevated blood lead concentration. Children may have increased lead absorption following shorter fasting time than adults because of rapid gastric emptying [24]. As dietary zinc intake increases, tissue lead levels and toxicity decrease. Research suggests that higher dietary iron intake might be protective against high blood lead levels [24-26]. Another study found anemia in 13% of the 5,181 abused/neglected children screened; potentially due to lead interfering with heme synthetase.[27] When examining dietary iron intake and H/H levels, the degree of anemia from iron-deficient/lead-intoxicated rats was greater than either condition alone [16]. Lead ia a divalent cation which can deplete iron and zinc. In abused/neglected children, poor nutritional status and lead toxicity can result in severe neurological effects [16]. Increased lead levels, malnutrition and iron deficiency have negative effects on growth and development. Diets adequate in zinc, calcium, iron, vitamin D, phosphorus and protein can reduce high blood lead levels [22, 28]. Lead leakage from outdated non zinc-lined soldering seams in canned vegetables and fruits should be avoided (usually found in underdeveloped countries); accordingly, for homemade baby foods only fresh or frozen fruits and vegetables are recommended [29]. Calcium in evaporated or canned milk is rarely a problem as calcium chelates lead for excretion. Itoh and Suyama report another problem regarding calcium retention, high dietary sodium intake produces greater loss of calcium in urine as sodium and calcium compete for the same recovery mechanism in the kidney [30]. The purpose of this study was to determine the nutritional status of children with suspected abuse since it relates to health risk.

2. Methods

When the child was admitted to the ER with suspected abuse, a social worker was notified, who informed the investigator of the admission. The dietary department was contacted by nursing staff to record the child's dietary intake while a medical resident/staff was notified to perform laboratory levels as determined from the medical/social history. Medical records provided the following information: age, sex, race, type of injury, family size and family characteristics. Nutritional status was assessed using anthropometric measures, biochemical values and dietary intakes. Height and weight were plotted on the growth charts and head circumference, upper arm circumference and triceps skinfold measurements were performed according to the standard methods [31-34]. Biochemical values were obtained by established standard laboratory procedures. A calorie count one to three-day food record was obtained for each child and calculated by the dietitian for calories, protein, zinc, vitamin A, calcium, magnesium, phosphorus, iron, thiamin, riboflavin, niacin, vitamin C and vitamin D from standard data; below two-thirds of the standard being deficient [35]. Due to confidentiality and legal issues with these families, only hospital dietary intakes could be obtained A t-test was performed from anthropometric, biochemical, and dietary values against the standard and further compared PA against SA children. The research proposal was accepted by the Children's Hospital Medical Center's Institutional Review Board. Fingerprick lead screening

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was performed on 14 of the 28 children, as determined by medical staff from the medical/social history, and thus are listed as an outgrowth of the study.

3. Results/Discussions

Twenty-eight children suspected victims of child abuse, aged 1.5 months to 8.75 years [10 Caucasians, 17 African American, 1 bi-racial child; 14 male, 14 female) were admitted to ER. Type of injury, number of cases, and size of family are shown in Table 1. Many of the families received financial assistance, which is not atypical (Table 1). Anthropometric results showed the majority of subjects (61%) below the 50^{th} percentile; 32% above the 75^{th} percentile for height-for-age and 64% below the 50^{th} percentile for weight-for-age (Table 2). The majority had TSF values of 8-9 mm; below the standard of 10.6 mm. Weight was significantly below the mean for PA children (p=0.05) and PA significantly below the mean of SA children (p=0.019). TSF for PA children were significantly below national government standards (p=0.01). All SA children were in upper percentiles of height-for-age and weight-for-age, while the majority of PA children were below the 50^{th} percentile for weight-for-age. Biochemical results (Table 2) revealed the average hemoglobin was 11.6 gm%; significantly below the average of 12.7 gm% (p=0.0005) and. the average hematocrit was 35.5%; significantly below the standard of 37.1% (p=0.025) although dietary iron was adequate. Of 14 children, 36% had lead levels above normal and 28% were borderline indicating that lead levels may be high in some children with suspected abuse. SA children (p=0.005) and PA children (0.025) had significantly higher lead levels with PA children having more variability within the group. Hematocrits of SA children were slightly higher. PA subjects show that weight (p=0.05) and TSF (p=0.01) were significantly below standards (Table 2). Although diets offered to the hospitalized children were nutritionally adequate, diets consumed by children with suspected abuse were significantly lower than standard data in vitamin D and zinc (p=0.0005). When comparing PA and SA children, height (p=0.033) and weight (p=0.019) were significantly different and lower in PA children. A history of PA was more often found in males, with SA occurring more often in females [36, 37]. The incidence of abuse is not limited to racial minorities [38]; many children with suspected PA were Caucasian. The decreased weight of PA children found in this study is consistent with other findings that underweight and poor physical growth accompany child abuse [11, 39-42]. Low TSF values are consistent with findings and further indicate poor nutritional status. Leung et al. suggested FTT in child abuse may be due to withholding of food or the child not eating (appetite loss) associated with abuse/neglect. Twenty-five of 50 abused children had hemoglobin concentrations of less than 10gm% [38], while 25% fell below 10 gm% in this study. Bithoney et al. stated that every FTT child is malnourished [13]. Thirty-six percent [5 of 14 children) had elevated blood lead levels with 28% borderline, while Flaherty found 64.7% of abused and neglected children had elevated levels [14]. Behavioral manifestations of elevated lead may be more noticeable than effects on intelligence (elevated tempers and mental retardation) [43]. Zinc and vitamin D, which enhances calcium absorption, were low; thus, nutrient chelators were not available to reduce lead absorption [44]. Reduced weight and triceps values often accompany abuse, possibly indicating inadequate availability of food. Due to confidentiality of being classified with suspected abuse, home visits were not available as is typical in other reports on dysfunctional families. PA children have a higher rate of malnutrition, reduced growth, low iron status and elevated blood levels. Each is interrelated increasing the effects of the other. Leung et al [8] claim that if children are suffering from malnutrition, it is essential to begin early intervention because of unknown prognosis. Adequate energy needs should be addressed immediately, followed by treatment of iron deficiency anemia and elevated lead levels [13]. Furthermore, early intervention is essential as children may develop significant long-term cognitive and developmental delay.

Age Range:		1.5 months to 8.75 years	
Age		**Number of Subjects**	
0-3 years		10	
1-3 years		8	
4-6 years		8	
Over age 6		2	
Total:		28	
Type of Abuse		**Number of Subjects**	
1. Sexual		7	
2. Bruises/lacerations		8	
Subdural hematomas/facial trauma		6	
3. Dehydration/severe neglect		1	
4. Burns		3	
5. Fractures		3	
Total:		28	
Cross-Tabulation for Type of Abuse with Socioeconomic Variables:			
		Sexually Abused (SA)	**Physically Abused (PA)**
Race	Caucasian	1 (14.3%)	10 (47.6%)
	Non-Caucasian	6 (85.7%)	11 (53.4%)
Parents	One	4 (57.1%)	15 (71.4%)
	Two	3 (42.9%)	6 (28.6 %)
Receiving Government Aid	Yes	3 (42.9%)	13 (61.9%)
	No	4 (57.1%)	8 (38.1%)

Table 1. Summary of Characteristics of Children with Suspected Abuse

Factor	Mean	Standard Values	Standard Deviation	*p
All Subjects:				
Height (cm)	84.6	86.1	24.0	NS
Weight (kg)	12.4	16.6	8.4	NS
Head Circumference (cm)	46.6	46.6	5.3	NS

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Triceps (mm)	9.2	10.6	4.7	0.10
Hemoglobin (g/dL)	11.6	12.7	1.0	0.0005*
Hematocrit (%)	35.5	37.1	4.0	0.025*
Vitamin D (I.U.)	247.7	400.0	69.7	0.0005*
Calcium (mg)	761.6	671.0	264.1	0.10+
Protein (g)	48.8	21.7	24.87	0.005*+
Magnesium (mg)	122.4	141.4	58.0	0.10+
Zinc (mg)	5.8	7.9	2.8	0.0005*
Physically Abused:				
Height (cm)	79.1	79.0	21.3	NS
Weight (kg)	10.3	12.2	5.9	0.05*
Head Circumference (cm)	45.7	45.5	5.9	ND
Triceps (mm)	8.5	10.4	2.9	0.01*
Hemoglobin (g/dL)	11.6	12.5	1.1	0.001*
Hematocrit (%)	35.4	36.8	4.3	0.05*
Vitamin D (I.U.)	254.7	400.0	76.8	0.0005*
Calcium (mg)	699.0	628.6	269.8	NS+
Protein (g)	42.0	18.6	25.1	0.0005*+
Magnesium (mg)	102.7	119.5	53.8	0.10+
Zinc (mg)	5.3	7.3	2.8	0.0005*

	Mean		
All Subjects	**Sexually Abused (SA)**	**Physically Abused (PA)**	***p**
Height (cm)	101.1	79.1	0.0033*
Weight (kg)	18.7	10.3	0.019*
Head Circumference (cm)	49.6	45.7	0.09
Triceps (mm)	11.4	8.5	0.10
Hemoglobin (g/dL)	11.6	11.6	NS
Hematocrit (%)	35.7	35.4	NS
Vitamin D (% DRI)	55.1	65.2	0.185
Calcium (% DRI)	112.8	112.5	NS+
Protein (%DRI)	299.4	230.0	NS+
Magnesium (% DRI)	79.9	85.0	NS+
Zinc (% DRI)	74.4	82.5	NS
Lead Screen (14 subjects) (% std) high 5(36%) borderline 4(28%) SA p=0.005* PAp=0.025*			

*Statistically significant p<0.05 by "t" test

+Nutrient intake and dietary iron adequate

Table 2. Nutritional Status Evaluation of Children with Suspected Abuse

4. Conclusion

Research indicates that abused children may be at nutritional risk upon hospital admission. PA children are especially vulnerable; therefore, awareness of the child's nutritional status by the health care team should be increased. Interdisciplinary cooperation involving physicians, social workers, nurses, and dietitians are needed to provide the best health care for these children. Dietitians should be responsible for employing various nutritional assessment techniques and teamwork with other disciplines. Further studies concerning dietary patterns in the home environment and nutritional knowledge of the caretaker/parent(s) should be conducted to prevent reoccurrence.

5. Applications

Dietitians/nutritionists should be included as members of a child abuse team. Child abuse/neglect training materials for medical/health professionals should incorporate nutritional status and provide nutrition education to caretakers/parents through Parents Anonymous Groups and similar therapeutic sessions. Nutritional as well as other environmental toxins, such as lead and mercury, also should be discussed with the families. Cooking sessions with culturally diverse nutrition education materials, nutrition counseling, and teamwork may need to be conducted by dietitians with families who have minimal cooking and/or nutritional skills using some of the available resources [45-51].

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