Pediatric Nutrition Assessment Tools

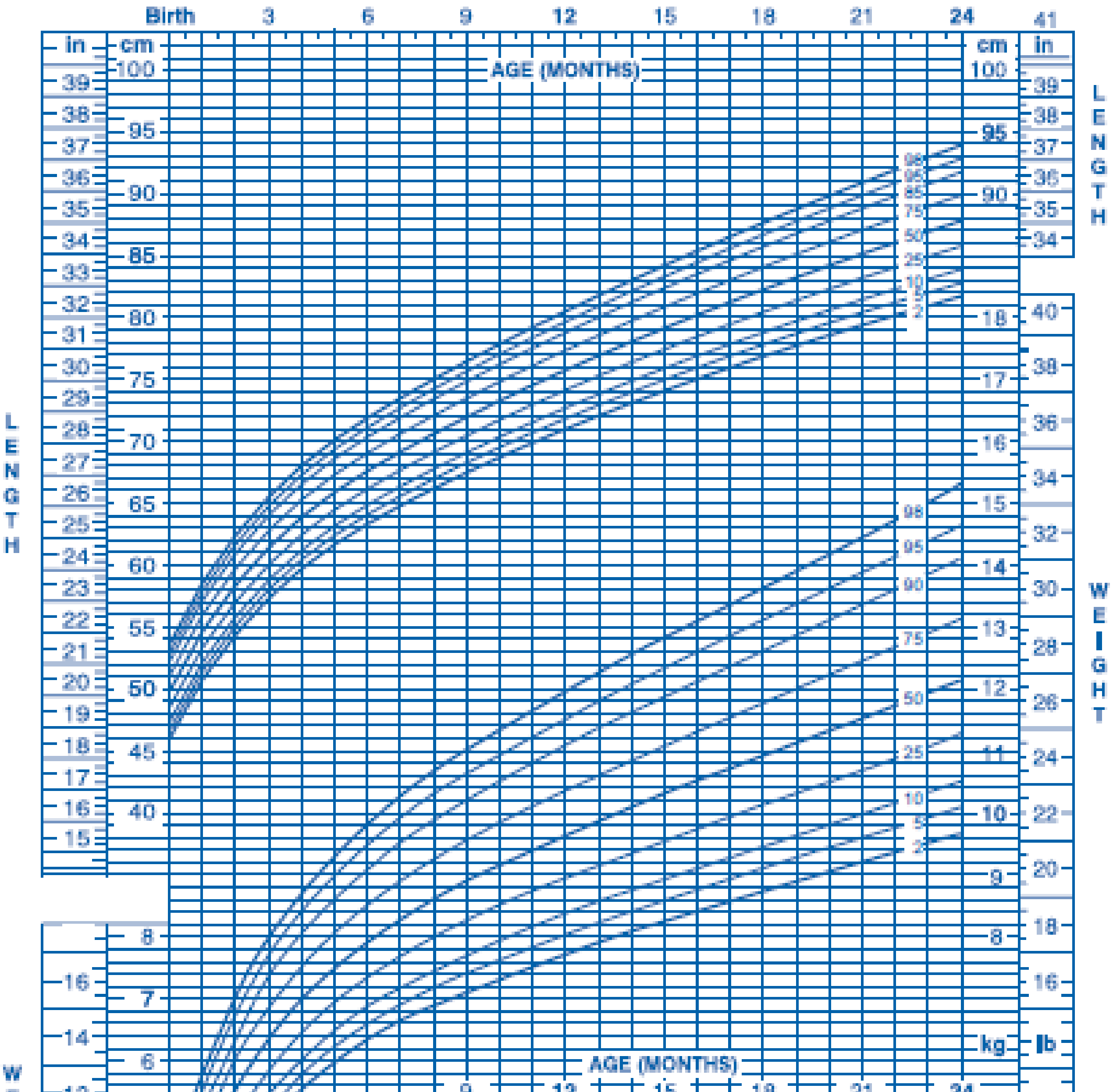
Clinical Nutrition Week 2016
Austin, TX

Children's Mercy

Birth to 24 months: Boys
Length-for-age and Weight-for-age percentiles

NAME ______________________

RECORD # ______________



Mother's Stature ______________ Gestational

Father's Stature ______________ Age: ________ Weeks

Comment

Date	Age	Weight	Length	Head Circ.
	Birth			

Published by the Centers for Disease Control and Prevention, November 1, 2009
SOURCE: WHO Child Growth Standards (http://www.who.int/childgrowth/en)

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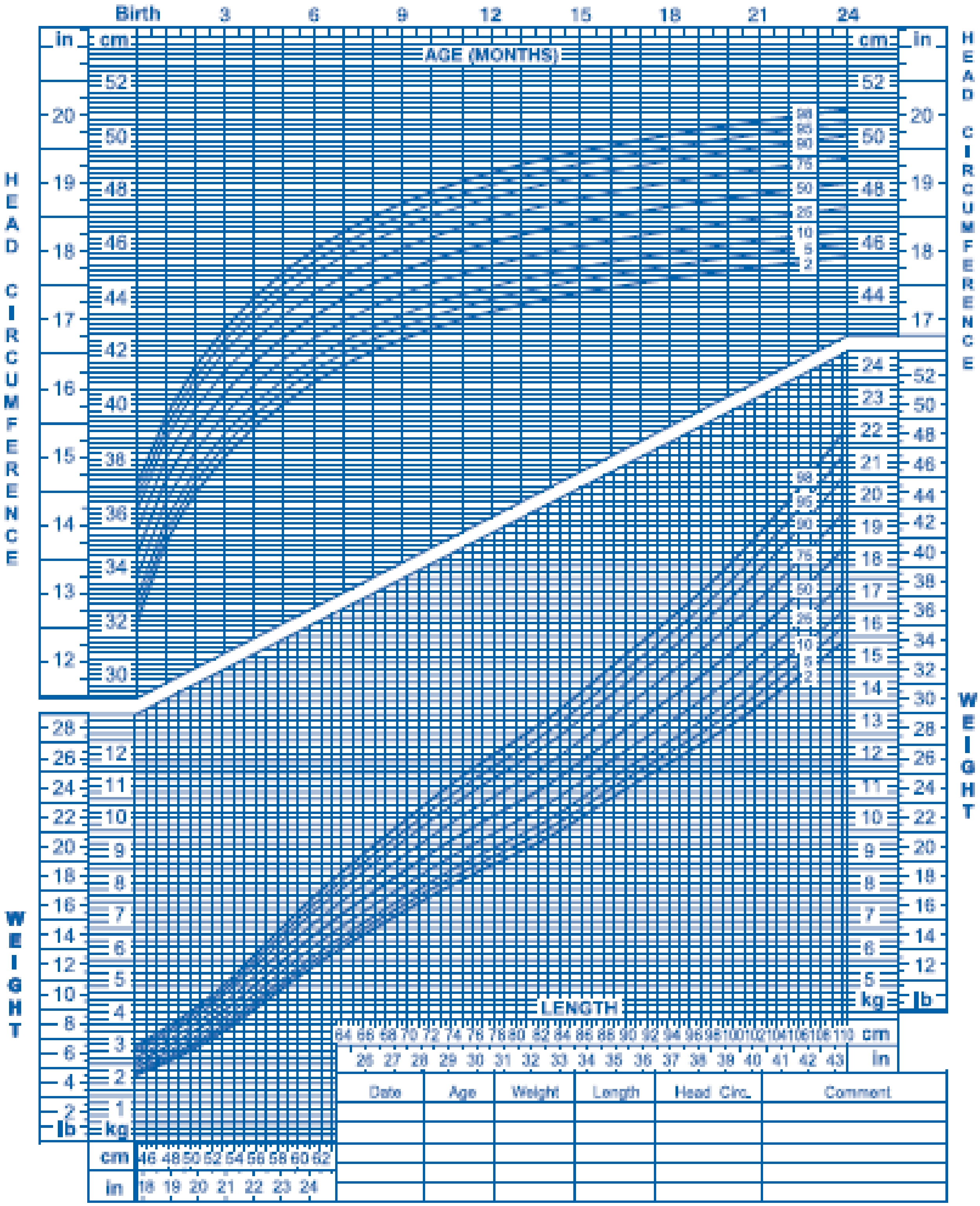

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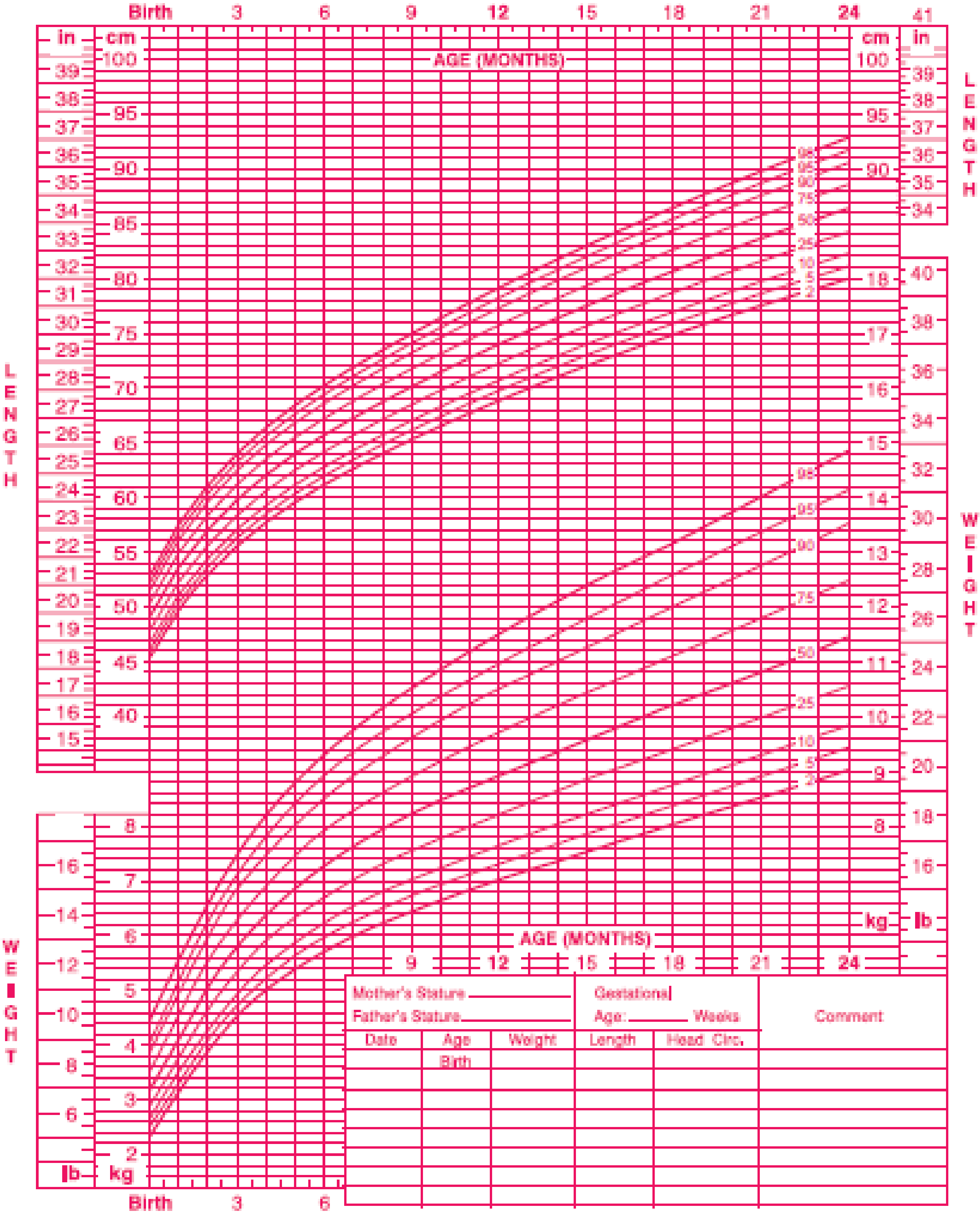

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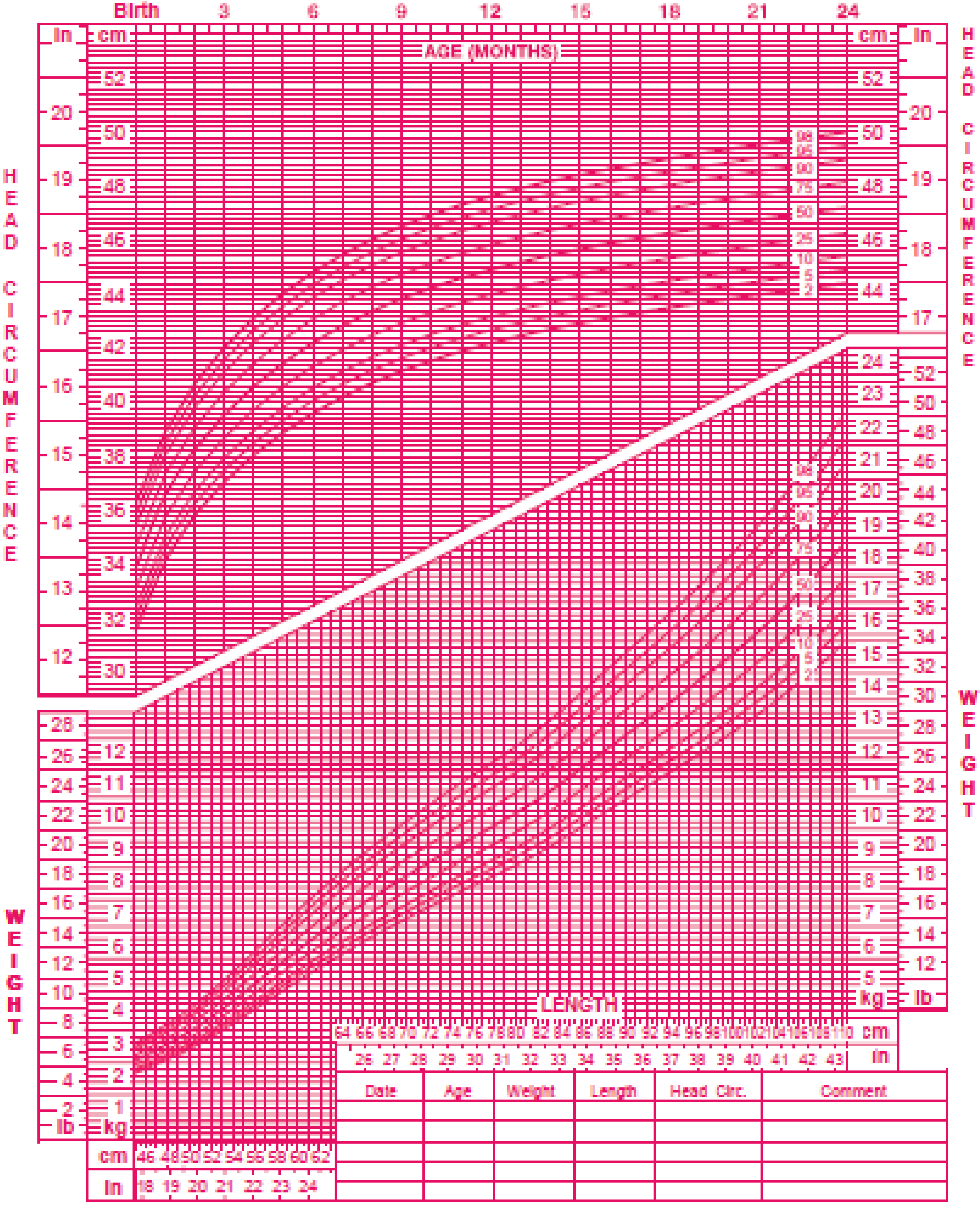

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2 to 20 years: Boys
Stature-for-age and Weight-for-age percentiles

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Mother's Stature ______________ Father's Stature ______________

Date	Age	Weight	Stature	BMI*

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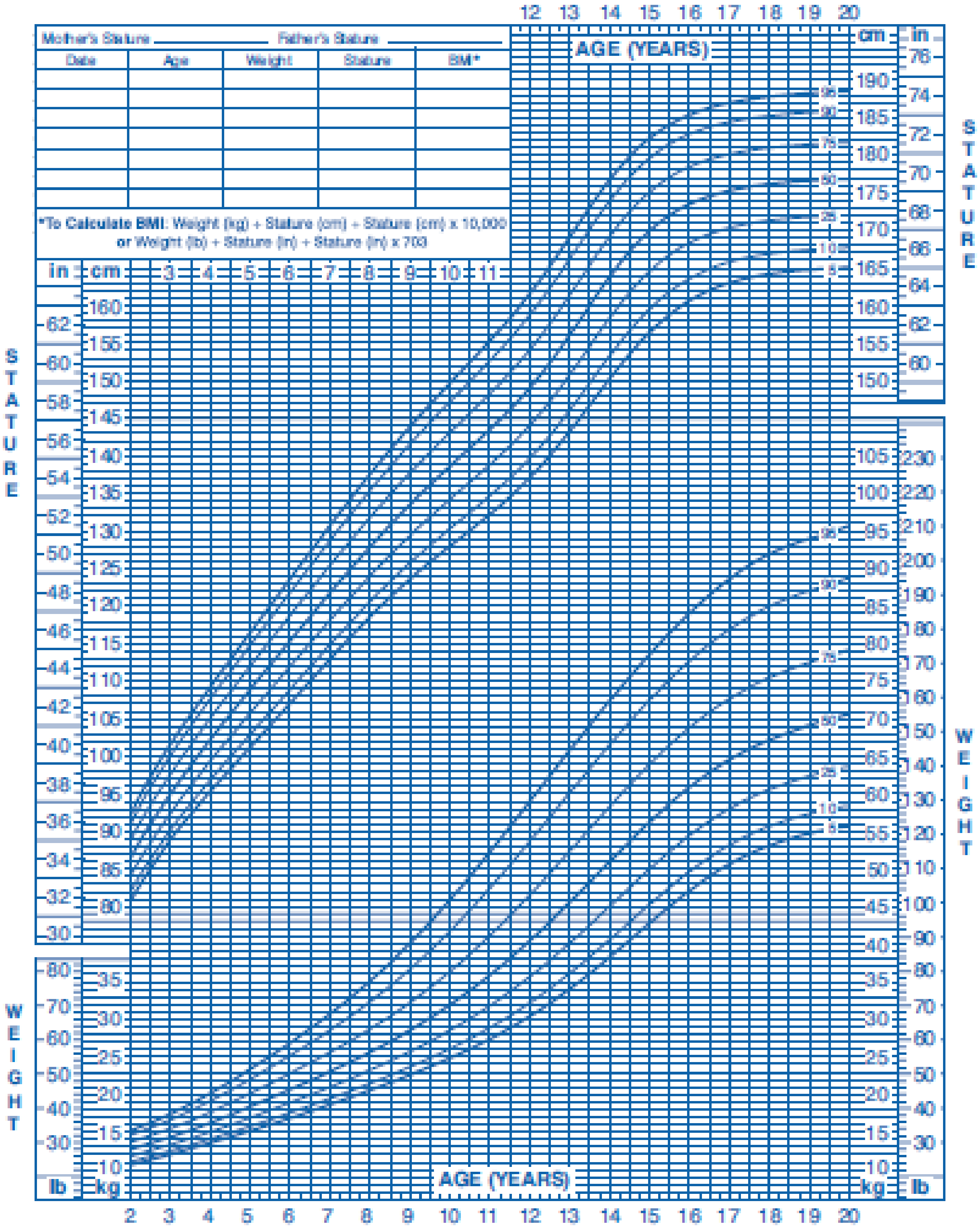

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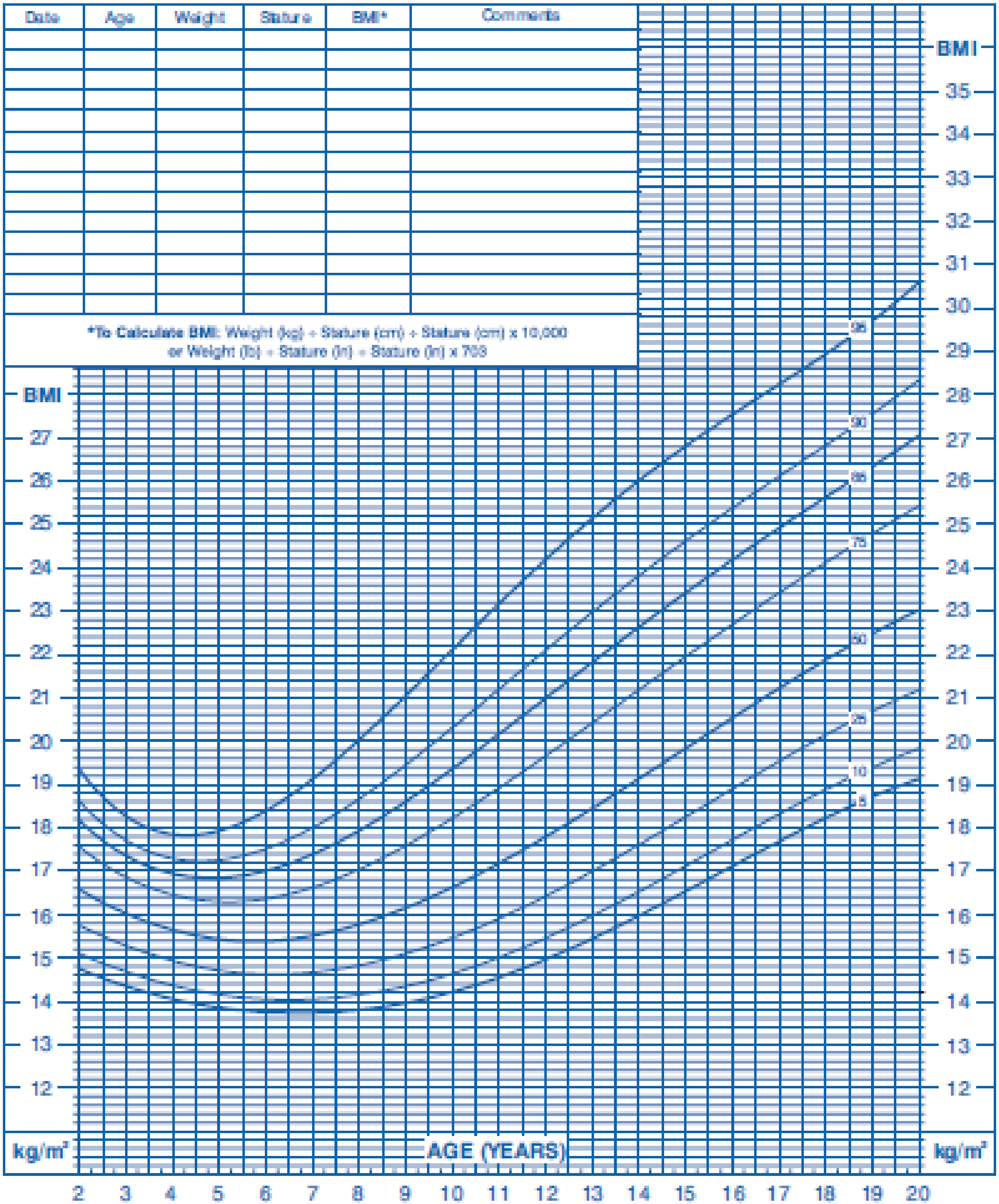

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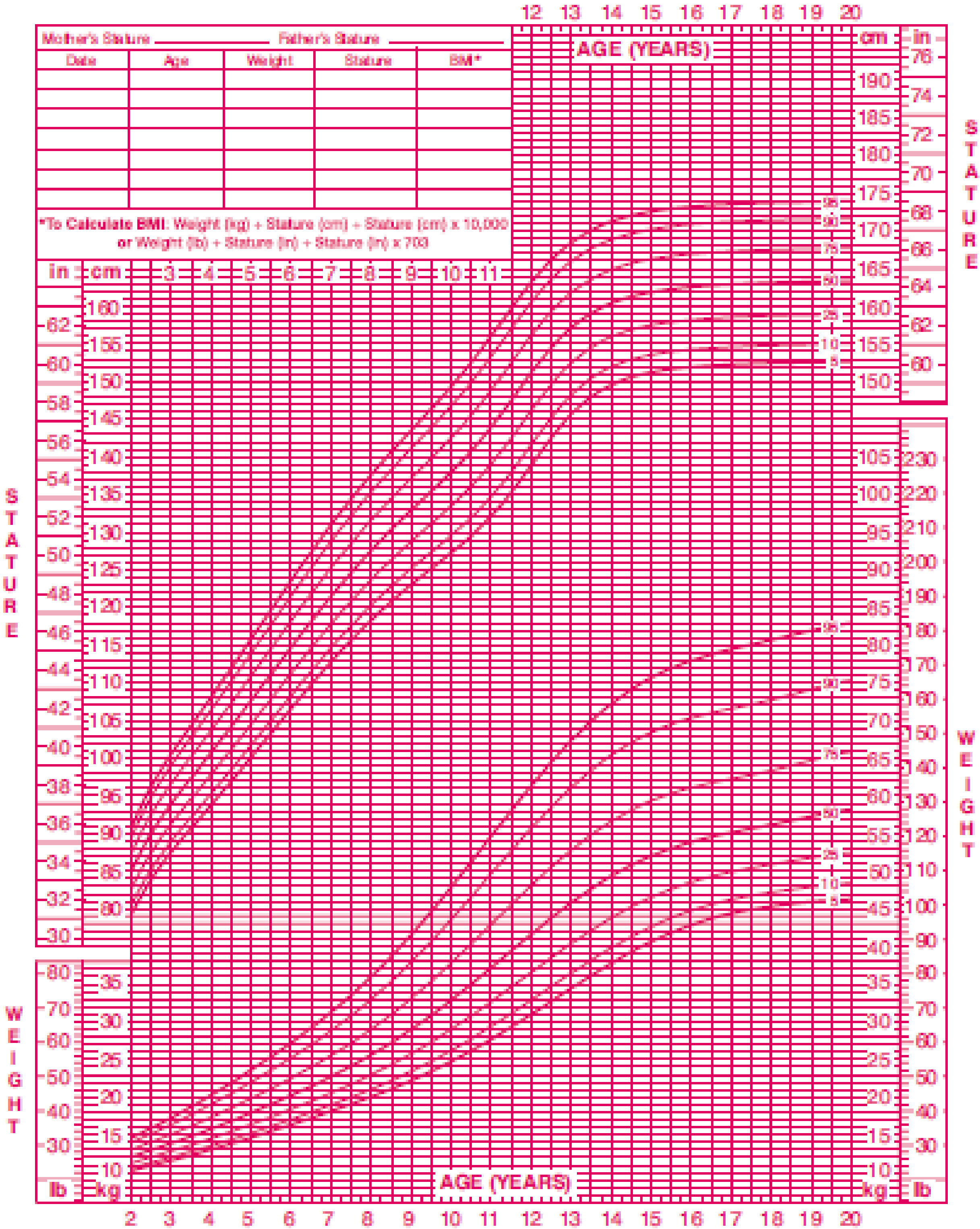

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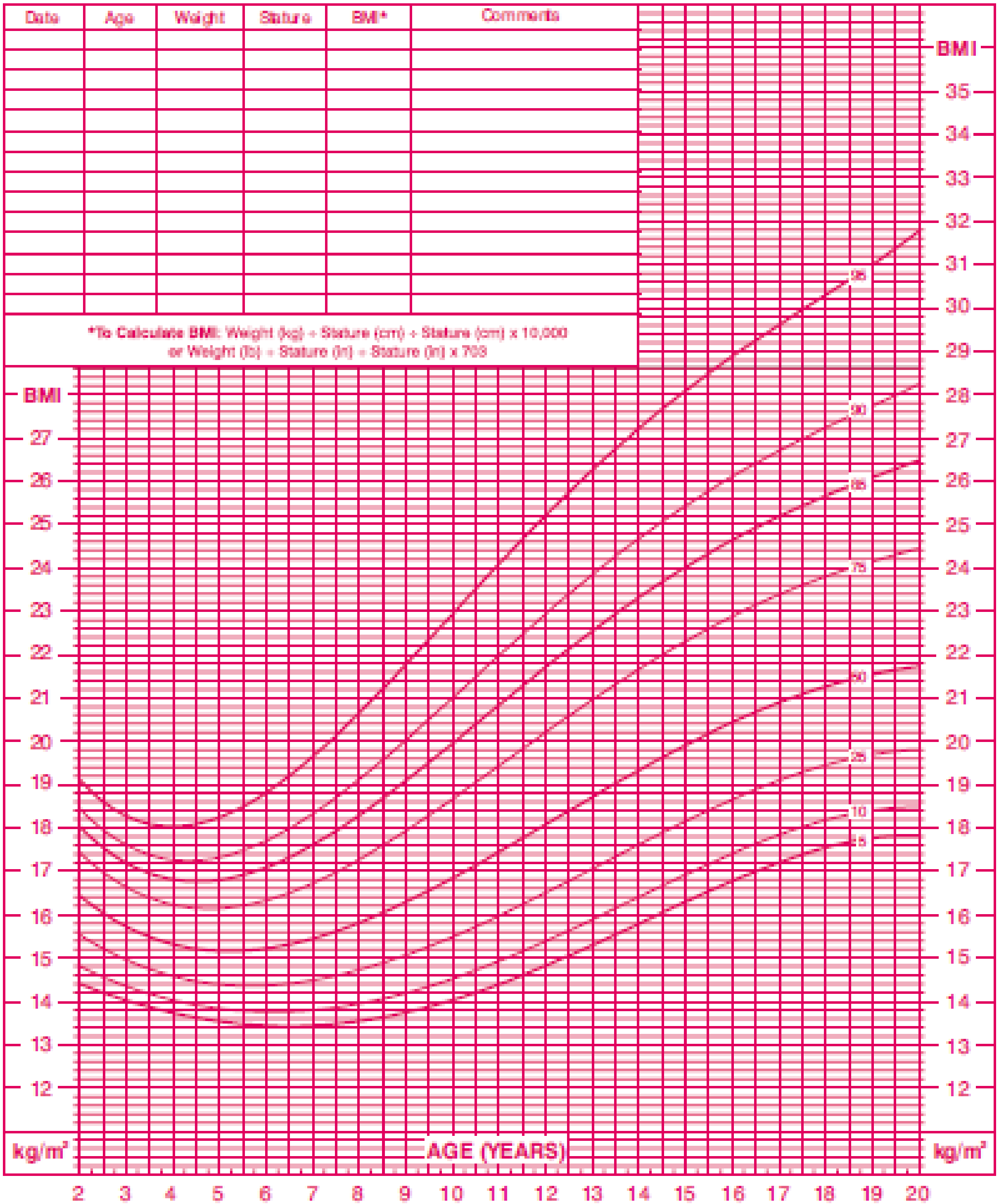

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Malnutrition Indicators using Z Scores

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Primary indicators	Mild malnutrition	Moderate malnutrition	Severe malnutrition
Weight for height *z*score	−1 to −1.9 *z* score	−2 to −2.9 *z* score	−3 or greater *z* score
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Weight loss (2 to 20 y of age)	5% usual body weight	7.5% usual body weight	10% usual body weight
Deceleration in weight for length/height *z* score	Decline of 1 *z* score	Decline of 2 *z* score	Decline of 3 *z* score
Inadequate nutrient intake	51% to 75% estimated energy/protein need	26% to 50% estimated energy/protein need	≤25% estimated energy/protein need

aFrom Guo et al.[84]

bWorld Health Organization data for patients younger than 2 y old.[85]

Food and Nutrient Intake
(Diet History)

Energy Needs Equations

DRI (2005)

	Age (years)	§Reference Weight (kg)	§Reference Height (cm)	BMR (kcals/kg/day) Schofield***	DRI – Energy *Based on EER with PAL = **Sedentary***		DRI - Protein	
					kcals/day	kcals/kg/day	(g/day)	(g/kg/day)
Infants	0 – 2 mo	N/A	N/A	- -	- -	- -	- -	1.52*
	2 – 3 mo	6	62	54	**609**	102	9.1	1.52*
	4 - 6 mo	6	62	54	**490**	82	9.1	1.52*
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Boys	3 y/o	12	86	57	**1020**	85	13	1.08**
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Girls	9 – 11	37	144	32	**1567**	42	34	0.92**
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	14 – 16	54	163	26	**1760**	33	46	0.85**
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§*Reference weights and heights taken from: Dietary Reference Intakes: The essential guide to nutrient requirements divided into smaller groupings. Based on NCHS/CDC 2000 Growth Charts. Institute of Medicine. 2006.*

* Adequate Intake

** RDA

*** Estimates based on Schofield equations for calculating basal metabolic rate in children.

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RDA (1989)

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0-6 months	108
7-12 months	98
1 to 3 years	102
4 to 6 years	90
7 to 10 years	70

Catch-up Growth: (IBW in kg /Actual Weight) x Kcal per kg

ESTIMATED ENERGY NEEDS FOR ADOLECENTS BASED ON HEIGHT

	Kcal/cm	
Age	Males	Females
11 to 14 years	16	14
15 to 18 years	17	13
19 to 22 years	16	13

WHO Equation:

Sex	Age (yrs)	REE Equation
Male	0-3	(60.9 x wt in kg) -54
	3-10	(22.7 x wt in kg) + 495
	10-18	(17.5 x wt in kg) + 651
Female	0-3	(61 x wt in kg) -51
	3-10	(22.5 x wt in kg) + 499
	10-18	(12.2 x wt in kg) + 746

World Health Organization (WHO) 1965

Injury or Illness Factors to WHO:

- **Surgery 1.05-1.5**
- **Sepsis 1.2-1.6**
- **Closed Head Injury 1.3**
- **Trauma 1.1-1.8**

(Information taken from Pediatric Nutrition Care Manual, Academy of dietetics and Nutrition)

Calculation of IBW

Calculated at the 50th percentile weight for length using WHO Growth Chart

Calculated at the 50th percentile BMI x Height in meters^2 using CDC Growth Chart

Growth Expectations

*Birth - 24 Months Based on WHO Growth Charts;
2 - 20 Years Based on CDC Growth Charts

	Males	Males	Females	Females
Age	Grams/day	cm/month	Grams/day	cm/month
* 0-1 Month	36	4.5	30	4.5
*1-2 Months	35	4	30	3.5
*2-3 Months	27	3	27	3
*3-4 Months	23	2.5	20	2
*4-5 Months	17	2	17	2
*5-6 Months	13	1.5	13	2
*6-9 Months	11	1.5	10	1.3
*9-12 Months	8	1.3	8	1.3
*12-18 Months	7	1.1	7	1.1
*18-24 Months	7	1	7	0.8
2-6 Years	6	0.6	5.5	0.4
6-7 Years	5.5	0.5	5.5	0.5
7-8 Years	7	0.5	8	0.5
8-9 Years	8	0.5	9.5	0.5
9-10 Years	9.5	0.5	11	0.4
10-11 Years	11	0.5	11	0.5
11-12 Years	12	0.5	12	0.6
12-13 Years	14	0.6	12	0.5
13-14 Years	15	0.7	9.5	0.3
14-15 Years	15	0.5	7	0.2
15-16 Years	12	0.3	5.5	0.1
16-17 Years	9.5	0.2	3	0-0.1
17-18 Years	7	0.1	4	0
18-19 Years	3	0-0.1	3	0
19-20 Years	7	0-0.1	3	0

Fluid Guidelines

Weight	Fluid Calculation
1-10 kg	100 mL/kg
11-20 kg	1000mL +50 mL/kg for each kg >10 kg
>20 kg	1500 mL + 20mL/kg for each kg > 20kg

Examples:

8 kg	100 ml x 8 kg = 800 ml
15 kg	1000 mL + 50mL x 5kg = 1250 mL
30 kg	1500 mL + 20mL x 10 = 1700 mL

*Maximum fluid intake: 200 ml/kg/d

(Holiday-Segar method) Holiday, M. and Segar, W. Pediatrics, 19: 823-832, 1957

Nutrition Pearls

Protein needs for the critically ill

Age	Protein Recommendations
0-2 years	2-3 g/kg/day
2-13 years	1.5-2 g/kg/day
13-18 years	1.5 g/kg/day

- Indirect calorimetry is the most precise method estimate energy needs in hospitalized patients.
- Use the WHO equation to estimate energy needs of overweight or obese children. Use a child/adolescent's actual body weight for calculations.
- Z score of 2.5 or above indicates obesity
- Hand grip strength

CDC[a] Growth Charts	WHO[b] Growth Charts
STAT GrowthCharts (compatible with iPod Touch, iPhone, iPad [Apple Inc])	STAT GrowthCharts WHO (compatible with iPod Touch, iPhone, iPad [Apple Inc])
Epi Info NutStat: (available for download) http://www.cdc.gov/growthcharts/computer_programs.htm	WHO *z* score charts: http://www.who.int/childgrowth/standards/chart_catalogue/en/index.htm
CDC website: *z* score data files available as tables: http://www.cdc.gov/growthcharts/zscore.htm	WHO Multicentre Growth Study website: http://www.who.int/childgrowth/software/en/ All four macros (SAS, S-plus, SSPS, and STATA) calculate the indicators of the attained growth standards
PediTools Home: www.peditools.org Clinical tools for pediatric providers; growth charts, calculators, etc; mobile compatible	PediTools Home: www.peditools.org Clinical tools for pediatric providers; growth charts, calculators, etc; mobile compatible

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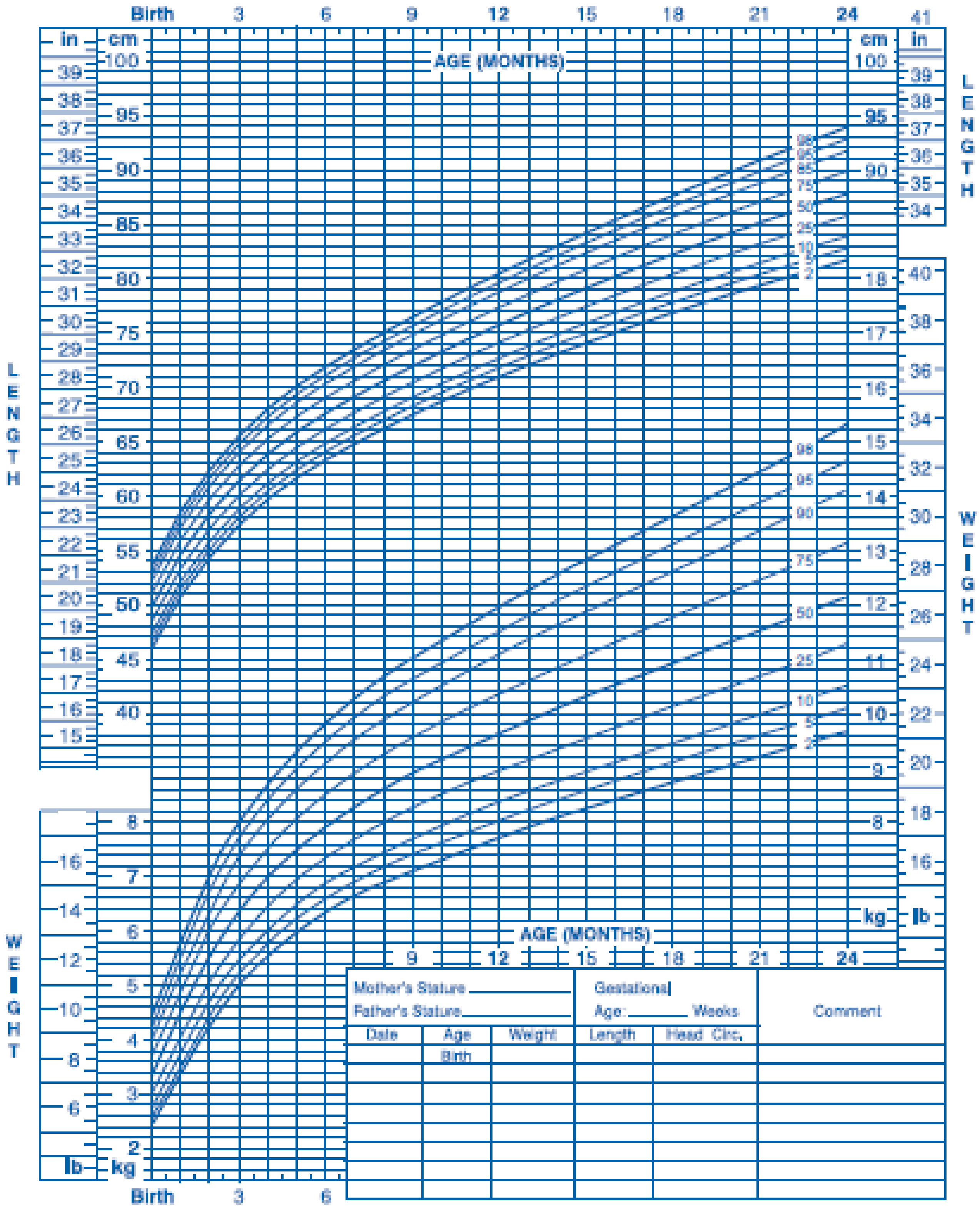

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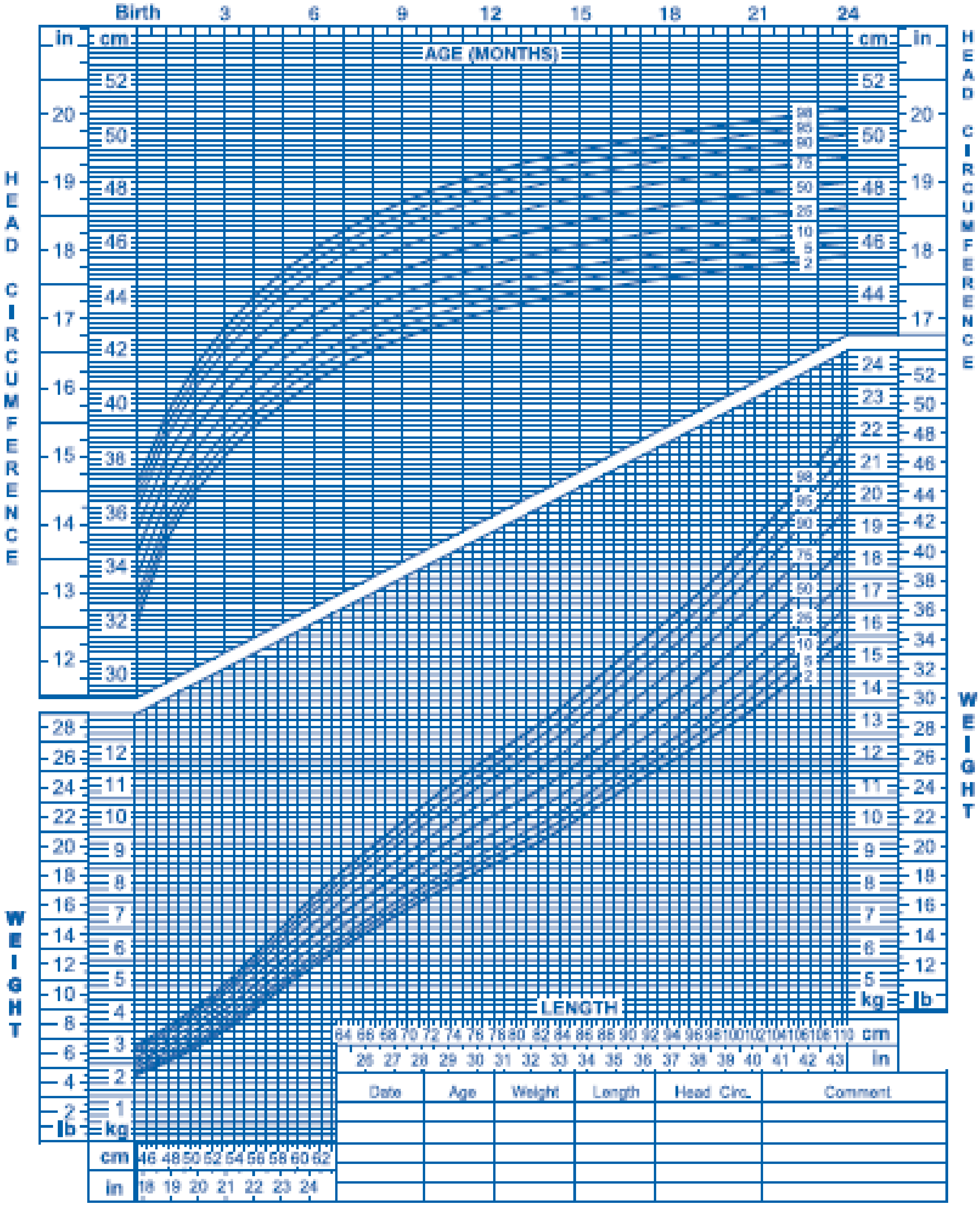

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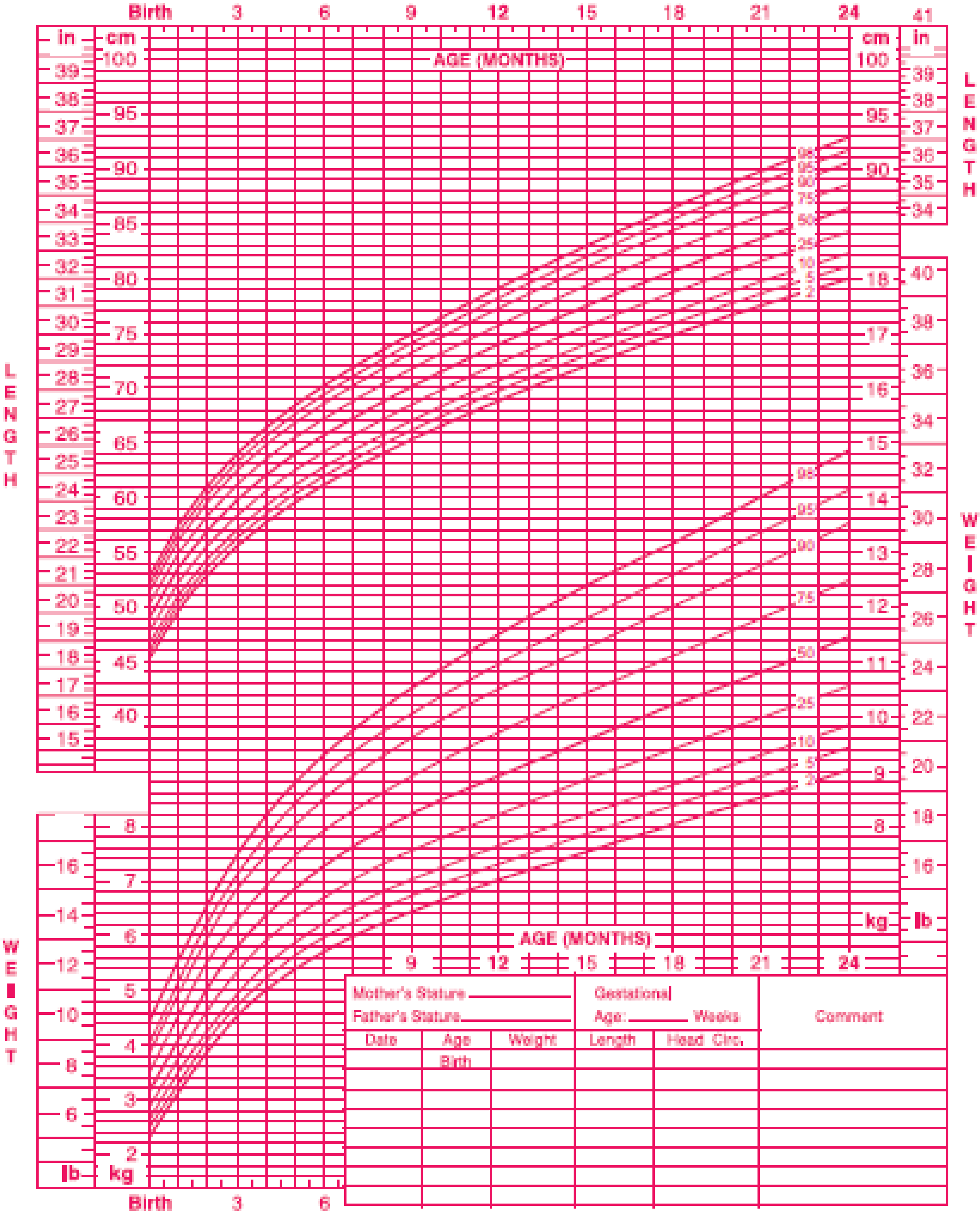

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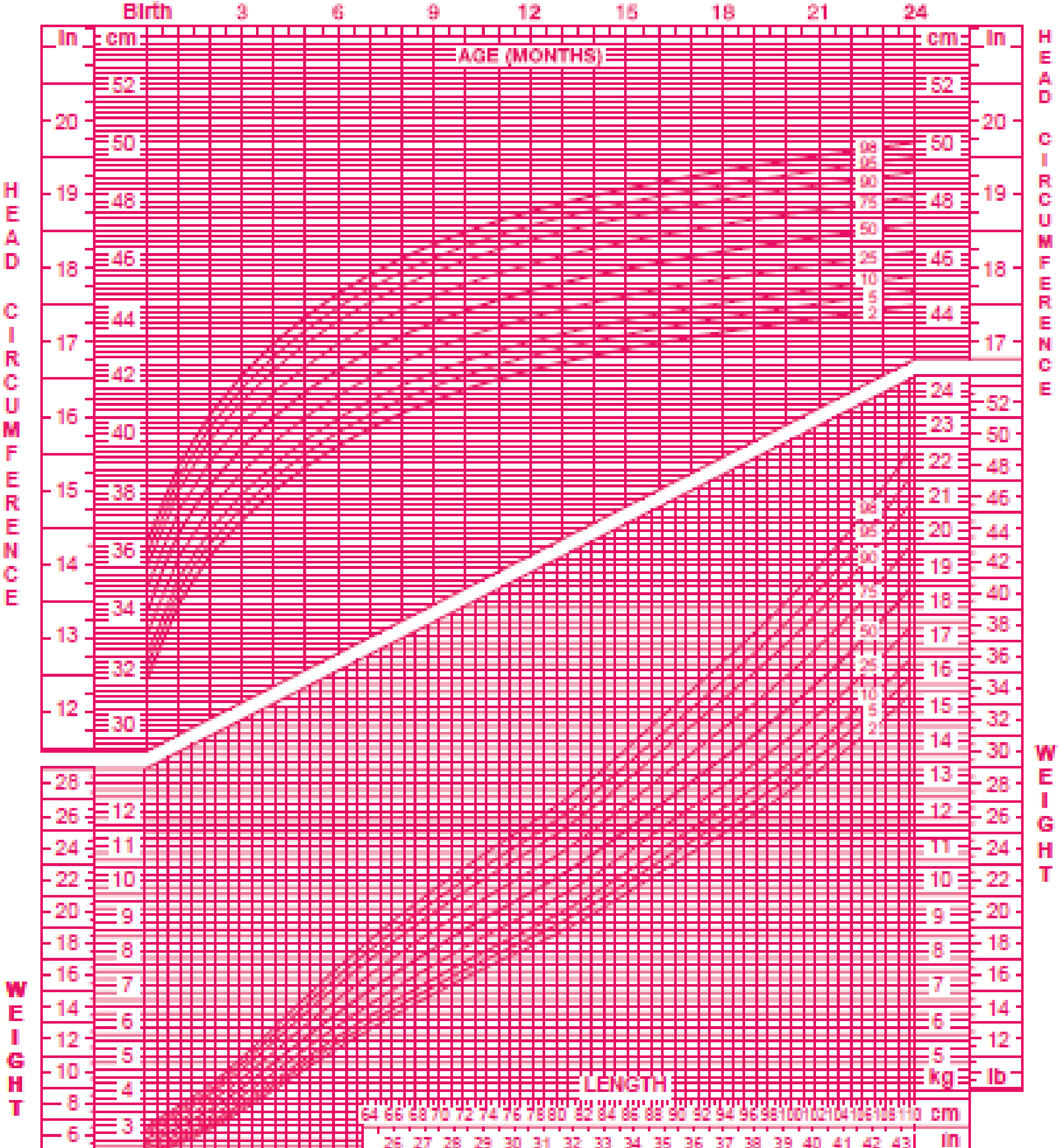

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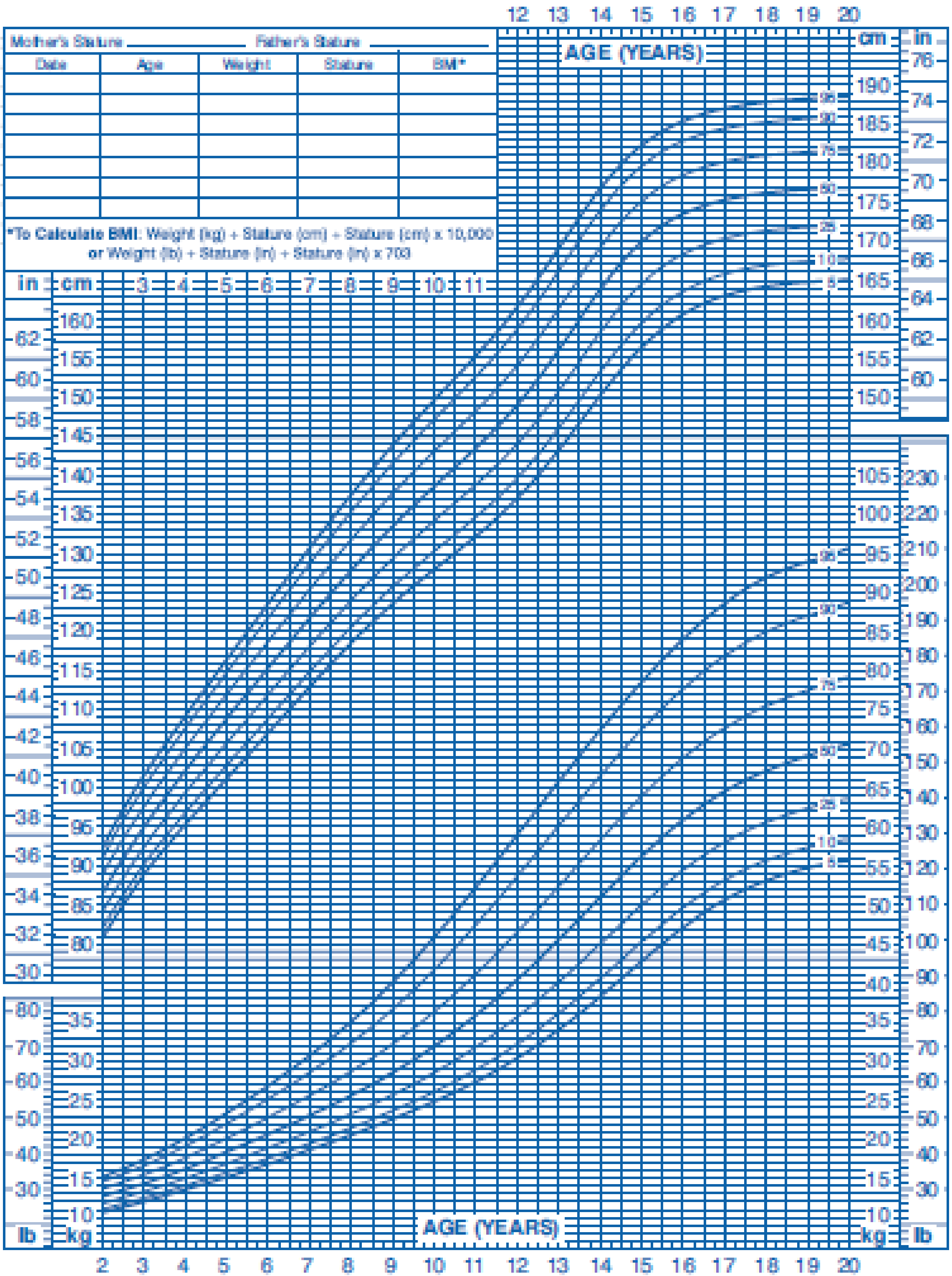

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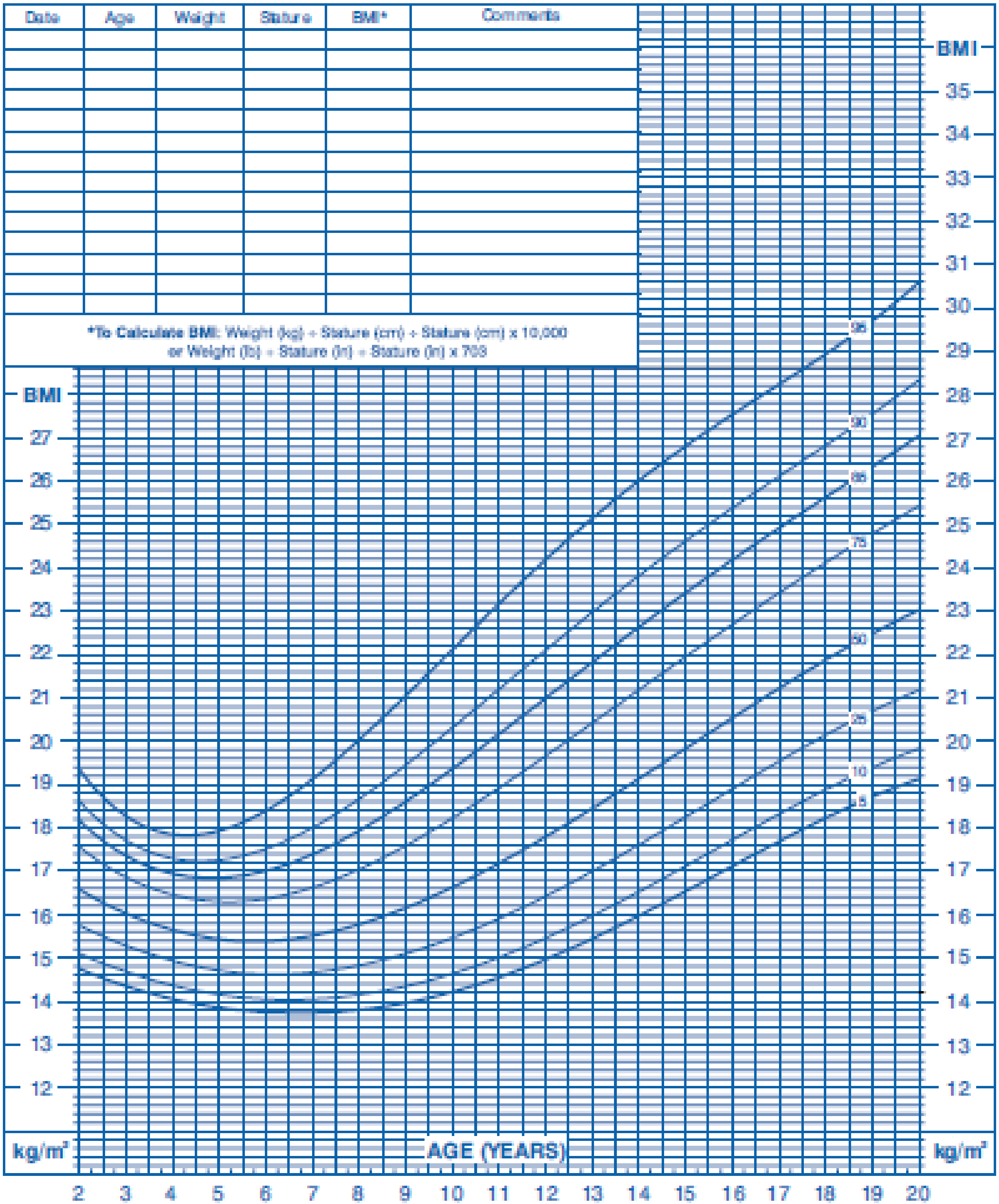

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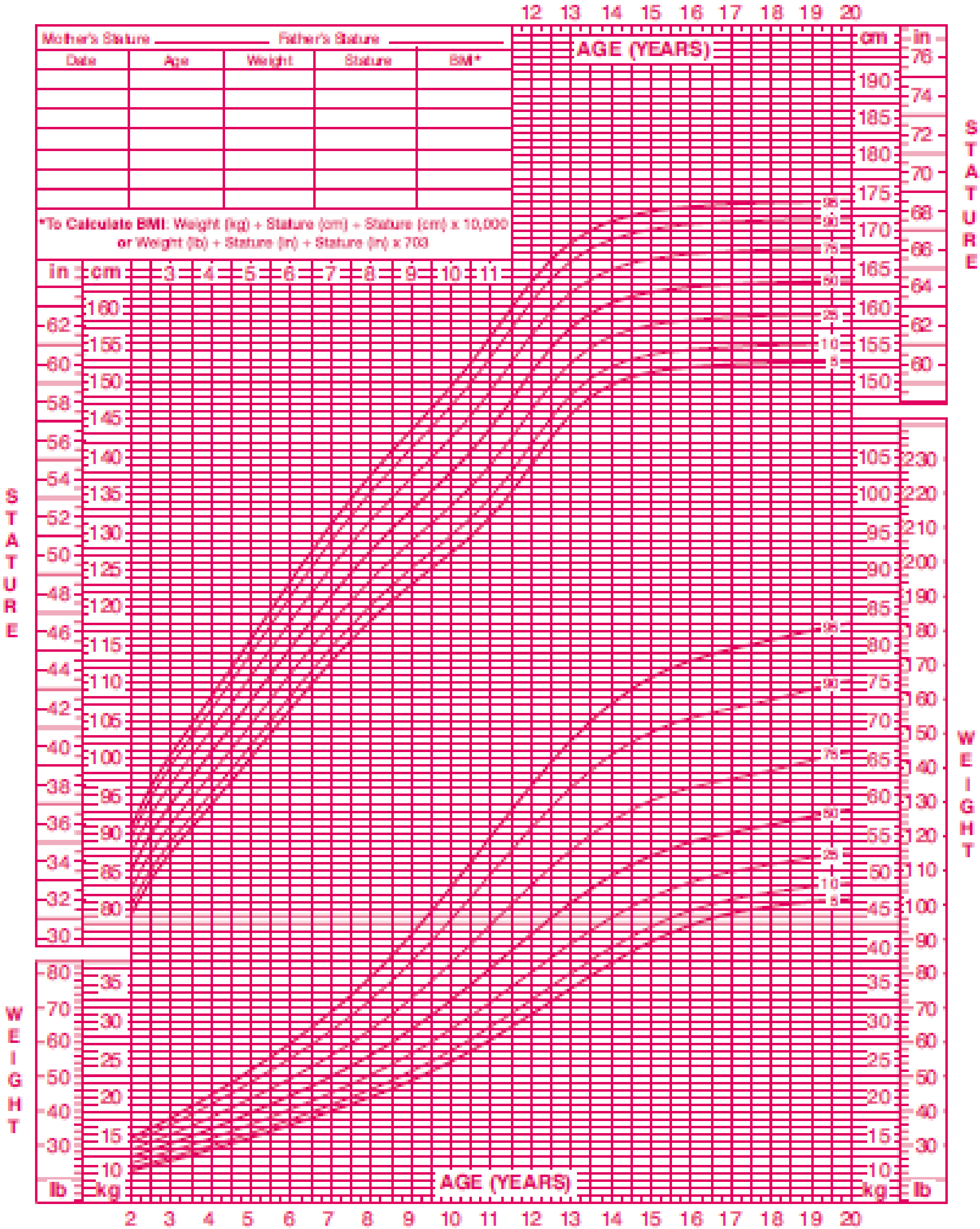

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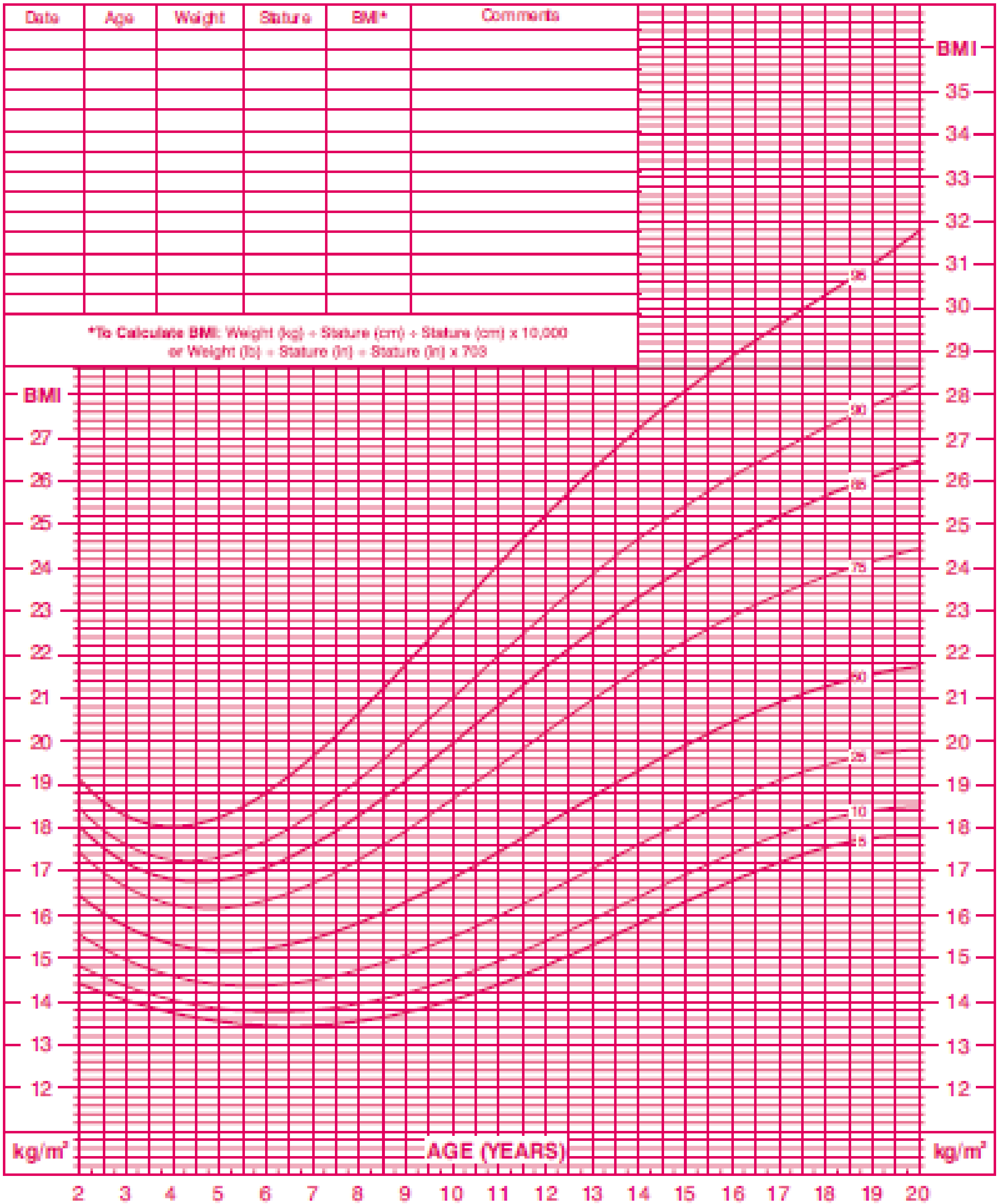

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Catch-up Growth: (IBW in kg /Actual Weight) x Kcal per kg

ESTIMATED ENERGY NEEDS FOR ADOLECENTS BASED ON HEIGHT

	Kcal/cm	
Age	Males	Females
11 to 14 years	16	14
15 to 18 years	17	13
19 to 22 years	16	13

WHO Equation:

Sex	Age (yrs)	REE Equation
Male	0-3	(60.9 x wt in kg) -54
	3-10	(22.7 x wt in kg) + 495
	10-18	(17.5 x wt in kg) + 651
Female	0-3	(61 x wt in kg) -51
	3-10	(22.5 x wt in kg) + 499
	10-18	(12.2 x wt in kg) + 746

World Health Organization (WHO) 1965

Injury or Illness Factors to WHO:

- **Surgery 1.05-1.5**
- **Sepsis 1.2-1.6**
- **Closed Head Injury 1.3**
- **Trauma 1.1-1.8**

(Information taken from Pediatric Nutrition Care Manual, Academy of dietetics and Nutrition)

Calculation of IBW

Calculated at the 50th percentile weight for length using WHO Growth Chart

Calculated at the 50th percentile BMI x Height in meters^2 using CDC Growth Chart

Growth Expectations

*Birth - 24 Months Based on WHO Growth Charts;
2 - 20 Years Based on CDC Growth Charts

	Males	Males	Females	Females
Age	Grams/day	cm/month	Grams/day	cm/month
* 0-1 Month	36	4.5	30	4.5
*1-2 Months	35	4	30	3.5
*2-3 Months	27	3	27	3
*3-4 Months	23	2.5	20	2
*4-5 Months	17	2	17	2
*5-6 Months	13	1.5	13	2
*6-9 Months	11	1.5	10	1.3
*9-12 Months	8	1.3	8	1.3
*12-18 Months	7	1.1	7	1.1
*18-24 Months	7	1	7	0.8
2-6 Years	6	0.6	5.5	0.4
6-7 Years	5.5	0.5	5.5	0.5
7-8 Years	7	0.5	8	0.5
8-9 Years	8	0.5	9.5	0.5
9-10 Years	9.5	0.5	11	0.4
10-11 Years	11	0.5	11	0.5
11-12 Years	12	0.5	12	0.6
12-13 Years	14	0.6	12	0.5
13-14 Years	15	0.7	9.5	0.3
14-15 Years	15	0.5	7	0.2
15-16 Years	12	0.3	5.5	0.1
16-17 Years	9.5	0.2	3	0-0.1
17-18 Years	7	0.1	4	0
18-19 Years	3	0-0.1	3	0
19-20 Years	7	0-0.1	3	0

Fluid Guidelines

Weight	Fluid Calculation
1-10 kg	100 mL/kg
11-20 kg	1000mL +50 mL/kg for each kg >10 kg
>20 kg	1500 mL + 20mL/kg for each kg > 20kg

Examples:

8 kg	100 ml x 8 kg = 800 ml
15 kg	1000 mL + 50mL x 5kg = 1250 mL
30 kg	1500 mL + 20mL x 10 = 1700 mL

*Maximum fluid intake: 200 ml/kg/d

(Holiday-Segar method) Holiday, M. and Segar, W. Pediatrics, 19: 823-832, 1957

Nutrition Pearls

Protein needs for the critically ill

Age	Protein Recommendations
0-2 years	2-3 g/kg/day
2-13 years	1.5-2 g/kg/day
13-18 years	1.5 g/kg/day

- Indirect calorimetry is the most precise method estimate energy needs in hospitalized patients.
- Use the WHO equation to estimate energy needs of overweight or obese children. Use a child/adolescent's actual body weight for calculations.
- Z score of 2.5 or above indicates obesity
- Hand grip strength

CDC[a] Growth Charts	WHO[b] Growth Charts
STAT GrowthCharts (compatible with iPod Touch, iPhone, iPad [Apple Inc])	STAT GrowthCharts WHO (compatible with iPod Touch, iPhone, iPad [Apple Inc])
Epi Info NutStat: (available for download) http://www.cdc.gov/growthcharts/computer_programs.htm	WHO *z* score charts: http://www.who.int/childgrowth/standards/chart_catalogue/en/index.htm
CDC website: *z* score data files available as tables: http://www.cdc.gov/growthcharts/zscore.htm	WHO Multicentre Growth Study website: http://www.who.int/childgrowth/software/en/ All four macros (SAS, S-plus, SSPS, and STATA) calculate the indicators of the attained growth standards
PediTools Home: www.peditools.org Clinical tools for pediatric providers; growth charts, calculators, etc; mobile compatible	PediTools Home: www.peditools.org Clinical tools for pediatric providers; growth charts, calculators, etc; mobile compatible

[a]CDC=Centers for Disease Control and Prevention.

[b]WHO=World Health Organization.

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TITLE: Basic Pediatric Skills Lab

SUMMARY: Understanding, writing or managing pediatric TPN orders is a difficult task for all members of the health care team. A simple approach to this process will be presented.

OBJECTIVES:
1. Demonstrate the differences between pediatric and adult nutritional requirements
2. Discuss appropriate markers for monitoring nutritional adequacy in pediatrics
3. Demonstrate a simplified method for quick assessment of nutritional needs

REFERENCES:
1. Mehta N, Compher C, ASPEN Board of Directors. ASPEN Clinical Guidelines: Nutrition Support of the Critically Ill Child. JPEN 2009; 33(3):260-276

2. ASPEN Board of Directors. Clinical Guidelines for the Use of Parenteral and Enteral Nutrition in Adult and Pediatric Patients, 2009. JPEN 2009; 33(3):255-259.

3. Shulman R, Phillips S. Parenteral Nutrition in Infants and Children. J Ped Gastro Nutr 2003; 36:587-607

Pediatric Parenteral Nutrition

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Introduction

Children are at much greater risk than adults for protein-energy malnutrition. This is partly due to their decreased fat and protein stores. These limited endogenous resources, coupled with their increased metabolic demands for growth and development, make them particularly vulnerable to nutritional inadequacy.

This is particularly true for the premature or sick term newborn. The tremendous advances in neonatal care over the past two decades have allowed the survival of increasingly smaller and sicker babies. Along with this has been a change in our expectations, nicely characterized by Ekhard Ziegler - "We are no longer content to provide **some** nutrition within a **few days** and to **gradually** increase nutrient intake over several **weeks**".

Part of this plan for earlier provision of optimal nutrition is the use of total parenteral nutrition (TPN). It is particularly valuable for those patients who are unable to take calories by the enteral route.

General Guidelines

The goal of TPN is to provide adequate nutrition and to individualize for:
- resting energy requirements
- adequate growth and development
- specific disease processes (trauma, sepsis, burns, etc.)
- prevent/treat both macro- and micro-nutrient deficiencies/excesses
- avoid complications
- improve patient outcomes
- (it is NOT to be used for correcting electrolyte abnormalities)

The TPN formulation will depend on several factors - the patient's clinical status, nutritional status, age and size and developmental state (pre- or post-pubertal). Before ordering TPN, you must know the patient's weight, fluid status and the baseline lab values.

In general, it is more difficult to order TPN for a child than an adult or even a neonate because of the large variations in weights among children. This in turn leads to significant differences in fluid and caloric requirements and substrate goals (CHO, lipid, protein).

Indications

When the nutritional needs of the patient cannot be met solely by the enteral route, parenteral nutrition is indicated. Parenteral nutrition can be used to provide **all** nutrients IV (total - TPN) or in combination with **some** enteral feedings (partial - PPN).

The common diagnoses related to a non- or poorly-functioning GI tract include:
- functional immaturity of the GI tract
- surgical GI disorders
- short bowel syndrome
- malabsorption
- intractable diarrhea of infancy
- necrotizing enterocolitis
- pharmacologic paralysis

Not all patients with the above conditions will require TPN. Additional criteria to consider for the use of TPN are that the patient is already malnourished and/or will need to remain NPO for an extended period of time - 1-3 days for newborns and infants and 3-5 days for previously well-nourished pediatric patients.

Indications (cont)

- Sick newborn
  - Neonates (start within 24-48 hrs of birth)
- GI non functioning
- If EN not possible, PN should be started within
  - 1-3 days in infants
  - 4-5 days in older children
- GI fistula
- Acute pancreatitis
- Short bowel syndrome
- Malnutrition with >10% to 15 % weight loss
- Nutritional needs not met; patient refuses food

Contraindications to PN

- Anticipated duration of therapy <3 days unless severe malnutrition present
- Functional GI tract when enteral nutrition can safely meet needs
- Inability to obtain venous access
- Refusal by patient or family of enteral tube placement
- Prognosis doesn't warrant aggressive nutrition support (controversial)

Initiation

Once you have decided the enteral vs parenteral and peripheral vs central questions you are ready to order the TPN. You should follow an orderly sequence of calculating TPN components when doing this:

- establish fluid goals
- establish caloric goals
- calculate protein, CHO and lipid concentrations
- determine electrolyte requirements
- determine vitamin/mineral requirements
- consider other additives

After the final calculations, you should order appropriate initial laboratory assessment and ongoing monitoring parameters. Finally, consult the pediatric dietitian for help and guidance (or just call TPN Steve).

Initiation (cont)

Begin by establishing a total fluid goal for the patient:
- evaluate current fluid balance by physical exam, I/O and labs
- calculate maintenance fluid requirements using standard guidelines
- take into account any fluid restrictions (cardiac/renal disease, BPD)

Next determine how much of total daily fluid can be given as TPN. Take into account **ALL** fluids given - medications, piggybacks, IV drips and any enteral feeds. Subtract these from the total daily fluid amount and the remainder is what can be given as TPN. Pharmacy will automatically adjust the actual total TPN fluid amount for the IV tubing and residual volume while keeping the macro- and micro-nutrients as ordered.

If the patient is dehydrated this should be addressed with isotonic fluids. **Do NOT** try to correct for fluid deficits with TPN. Fluid errors are the most common mistakes made when ordering TPN and can be inadvertently perpetuated. **Be careful and recalculate fluids daily**!!

Initiation (cont)

A minimum amount of protein **must** be supplied to all patients to avoid a catabolic state. If an insufficient amount is given, even excessive non-protein calories will not prevent the catabolism of lean protein stores. However, excessive amino acid (AA) administration can lead to azotemia, hyperammonemia, metabolic acidosis or cholestasis.

Protein requirements are substantially higher (per weight) for infants and children compared to adults. The enzyme systems of neonates and infants are poorly developed and cannot appropriately metabolize standard adult AA solutions. Solutions designed for infants are formulated to account for the impaired conversion of methionine to cysteine and subsequently to taurine. Use of these AA solutions results in greater weight gain, improved nitrogen balance and serum AA patterns similar to those of breast-fed infants. The AA solutions used in older children are the same products as those used in adults.

For the majority of patients, recommended guidelines for protein requirements should be followed. Ideally 24-32 non-protein calories (NPC) per gram of AA allows for efficient utilization. BUN and acid-base balance must be monitored to assess tolerance for protein administration.

Fluid Requirements

<10 kg	100 mL/kg
10-20 kg	50 mL/kg + 500 mL
>20 kg	20 mL/kg + 100 mL

This will give the total volume needed in a day

4-2-1 method

This will give the rate of the infusion in mL/hr

Calculate Calorie Requirements

SAME PROCEDURE AS FLUID CALC.

0-10 kg	100 kcal/kg
10-20 kg	50 kcal/kg + 1000 kcal
20 kg	20 kcal/kg + 1500 kcal

4-2-1 Method then multiply x 24 hrs to obtain calorie needs

Calculate Components

PROTEIN
- 10 - 15 % of the total calories

CAROBOHYDRATE
- 55 - 60 % of the total calories

FAT
- 30 % of the total calories

Parenteral Amino Acids (AA)

Neonatal AA (Trophamine 10%)	Pediatric AA (Travasol 10%)
▪ AA attempt to mimic breastmilk ▪ Cysteine added to lower pH = more Ca and Phos to TPN ▪ More fluid-restricted than pediatric standard AA solution ▪ Used for primarily in the NICU or CTICU	Used for >5kg Contains Phos 0.1 mmol/gram AA

ASPEN (2010)

Parenteral AA Guidelines

Age	Initiate	Advance	Maximum
<1yr	1-2g/kg/day	1g/kg/day	4g/kg/day
1-10yr	1-2g/kg/day	1g/kg/day	1.5-3g/kg/day
>10yr (adolescents)	1g/kg/day	1g/kg/day	0.8-2.5g/kg/day

*****Goal AA correspond to ASPEN protein guidelines for critical illness**
*****4kcal/gm**

NATIONWIDE CHILDREN'S

Carbohydrates (Dextrose)

Total amount should not exceed daily amount the body can utilize
Don't exceed body's max. oxidative rate
Infants require more CHO than adults and older children due to increased energy needs
Initial concentration: 10-12.5% exception: neonates (can't tolerate large dextrose load due to decreased insulin production)
neonates endogenous glucose production is 4-8 mg/kg/min
If max. oxidative rate exceeded
-fatty liver
-insulin resistance
-hyperglycemia

NATIONWIDE CHILDREN'S

GIR/Dextrose Guidelines

Age	Initiate	Advance	Maximum
<1yr	~6-9mg/kg/min	1-2mg/kg/min	Goal: 10-12mg/kg/min Max: 14-15mg/kg/min
1-10yr	1-2mg/kg/min >IVF GIR	1-2mg/kg/min	Max: 8-10mg/kg/min
>10yr (adolescents)	1-2mg/kg/min >IVF GIR	1-2mg/kg/min	Max: 5-6mg/kg/min

ASPEN (2010)

NATIONWIDE CHILDREN'S

Lipid Emulsion

Three different concentrations available:
10% 1.1 kcal/mL
20% 2 kcal/mL
30% 3 kcal/mL

10% not used routinely anymore due to the high concentration of phospholipids which are not cleared well resulting in elevate triglyceride levels

NATIONWIDE CHILDREN'S

Lipid Emulsion

Contains 50% long chain fats

Predominately soy based (omega-6)

Need to provide at least 8-10% of the calories from the lipid emulsion in order to prevent the development of an essential fatty acid deficiency (this will provide 4-5% of the calories as essential fatty acids

NATIONWIDE CHILDREN'S

Essential Fatty Acid Deficiency

- Can occur within "days to weeks" although clinical S/S may not been detected for months
- Triene:tetaene ratio ≥ 0.4
- Prevented by providing 0.5g/kg/day of lipid (2-4% of total kcal)
- Symptoms of EFAD:
  - Alopecia, scaly dermatitis, increased capillary fragility, poor wound healing, increased platelet aggregation, increased susceptibility to infection, fatty liver, and growth retardation in infants and children

Marcason (2007), ASPEN (2010)

NATIONWIDE CHILDREN'S

E.F.A. Deficiency

Omegaven

- Fish oil based lipid emulsion (omega 3)
- Comes as a 10% concentration
- Contains no essential fatty acids
- Not approved for use in the U.S. and therefore not available for general use
- Restricted to investigational use

NATIONWIDE CHILDREN'S

Electrolyte Needs

- Sodium
  - Preterm 2-3 mEq/kg
  - Infants 2-4 mEq/kg
  - VLBW infants require twice or more as much due to poor renal tubular function
    - ~6-8 mEq/kg
  - Children 2-3 mEq/kg
  - Adolescents 1-3 mEq/kg

NATIONWIDE CHILDREN'S

Electrolyte Needs

- Potassium
  - Preterm 2-3 mEq/kg
  - Infants 2-4 meq/kg
  - Children 2-3 mEq/kg
  - Adolescents 1-2 meq/kg

NATIONWIDE CHILDREN'S

Electrolyte Needs

- Magnesium
  - <2 kg 0.25-0.6 mEq/kg
  - >2 kg 0.25-0.5 mEq/kg
  - Infants 0.25-0.5 mEq/kg
  - Children 0.25-0.5 mEq/kg
  - Adolescents 0.25-0.5 mEq/kg

NATIONWIDE CHILDREN'S

Electrolyte Needs

Calcium
- <2 kg 3-4.5 mEq/kg
- >2 kg 2-3 mEq/kg
- Infants 1-2 mEq/kg
- Children 0.5-1mEq/kg
- Adolescents 0.25-0.5 mEq/kg

NATIONWIDE CHILDREN'S

Electrolyte Needs

Phosphorus
- <2 kg 1-3 mMol/kg
- >2 kg 1-2 mMol/kg
- Infants 1-2 mMol/kg
- Children 0.5-1mMol/kg
- Adolescents 0.25-0.5 mMol/kg

NATIONWIDE CHILDREN'S

Limits on Calcium:Phosphorus

Relative amounts of both

Protein concentration

pH (L-cysteine plays major role here)

Temperature

Magnesium content

2:1 ratio

NATIONWIDE CHILDREN'S

Additional

Extra zinc needed for:
- Growth
- Wound healing
- Diarrhea

Carnitine
- Neonates are deficient
- Responsible for transporting long chain fats inside of the mitochondria

NATIONWIDE CHILDREN'S

L-cysteine

There are a number of intravenous drugs currently on a national shortage list including L-cysteine

Generally speaking, if a neonate is receiving at least 3 gm/kg of protein there is no need to supplement

High risk infants can receive a reduced dose of 20 mg/kg of protein (40 mg/g is standard)

NATIONWIDE CHILDREN'S

Lab Testing

Basic metabolic panel

Prealbumin

CRP

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CRP

CRP is an acute phase protein used primarily in the I.D. world

In nutrition, used as a marker of stress which indicates a catabolic state

Providing "calculated" calories or increasing the caloric intake due to stress will result in overfeeding, especially in the surgical neonate

Albumin and prealbumin will be depressed when a patient is in a stressed state and is not a reliable indicator of nutritional status

As the CRP begins to fall the albumin and prealbumin will begin to rise

Adverse Reactions to TPN-PNALD

Causes of PN Associated Liver Disease

1. Preemie
2. Sepsis
3. SBS
4. Bacterial Overgrowth
5. Decreased/absent enteral intake
6. Calorie intake
7. Dextrose intake
8. AA source and intake
9. IVFE

Treatment/Preventions of PN associated Liver Disease

1. Carnitine
2. Cycling PN
3. IVFE intake
4. GIR
5. Antibiotics
6. Urso
7. Trace elements

Medications and PN

1. Insulin
2. Albumin
3. PPI
4. H2
5. Octreotide

Cycling PN

1. Calculate 24 hr PN volume
2. Divide the 24 hr volume by the hours goal MINUS 0.5
3. Round off the rate
4. Multiply new rate by the hours MINUS 1
5. Subtract the number from step 4 from your 24 hr volume

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Cycled PN Example

1. Total volume = 1500 mL
2. Desired cycle = 12 hrs
3. 1500 mL / 11.5 hrs = 130.4
4. 130 x 11 hrs = 1430 mL
5. 1500 mL – 1430 mL = 70 ml
6. Cycled PN = 130 mL/hr x 11 hrs, 70 mL/hr x 1 hr

NATIONWIDE CHILDREN'S

Special Circumstances

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PICU-associated malnutrition

Metabolic stress response

Estimations of energy requirement

Prescription and Delivery

Preexisting deficiency/reduced somatic stores

Mehta and Duggan (2009), Hulst et al. (2006), Rogers et al. (2003)

NATIONWIDE CHILDREN'S

Nutrition Goals for the PICU

1. Minimize protein catabolism
2. Meet energy requirement

Mehta and Duggan (2009)

NATIONWIDE CHILDREN'S

Energy Expenditure

Pediatric patients may not exhibit significant hypermetabolism post-injury

Decreased physical activity, decreased insensible losses, and transient absence of growth during the acute illness may reduce energy expenditure

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Metabolic Alterations in Critical Illness

Lipid Utilization in Acute Illness:

Stress Hormones (Catecholamines/Cortisol) ↑ Lipolysis: "FFA (major fuel in acute illness)"

a. Oxidation via TCA cycle

b. Lipogenesis

c. Ketogenesis (Glucagon inhibited during critical illness)

d.PDH Inhibition (prevents Glucose TCA Oxidation and increases FFA TCA Oxidation)

NATIONWIDE CHILDREN'S

Metabolic Alterations in Critical Illness

Protein Metabolism in Acute Illness

Catabolism (Skeletal Muscle)

a. Gluconeogenesis (Alanine)

b. Acute Phase Proteins (Liver Synthesis)

"Negative Nitrogen Balance"

NATIONWIDE CHILDREN'S

Stress Liver synthetic Changes

Anabolic :	Stress/Acute Phase:
Albumin, antithrombin,	Fibrinogen
protein C	Ferritin,
High Density Lipoproteins	alpha-1antitrypsinogen
	anitiproteases

Altered Cellular Metabolism

Diminished Mitochondrial Energy Production:

I. Dysfunctional Respiration: Downregulation of genes coding for electron transport chain

II. Dysfunctional Glycolytic pathway:

Down regulation of gene for PFK (rate limiting enzyme)

NATIONWIDE CHILDREN'S

Energy Provision

Increased risk of overfeeding with sedation or intubation

- impaired liver function by inducing steatosis/cholestasis
- increased risk of infection
- hyperglycemia
- prolonged mechanical ventilation (↑production of C02)
- increased LOS

Shown to provide no benefit to the maintenance of lean body mass

NATIONWIDE CHILDREN'S

Energy Requirements

Standard equations to predict energy needs unreliable

Indirect calorimetry is the gold standard to accurately predict REE

Unable to use IC for all PICU patients

NATIONWIDE CHILDREN'S

Suggested Candidates for Indirect Calorimetry (IC)

- Underweight (BMI < 5th percentile for age) or overweight (BMI > 95th percentile for age) *(EN or PN support)
- Failure to wean, or need to escalate respiratory support*
- Need for muscle relaxants or mechanical ventilation for > 7 days

Mehta et al. (2009)

NATIONWIDE CHILDREN'S

Suggested Candidates for IC

- Neurologic trauma*
- Children with thermal injury*
- Children suspected to be severely hypermetabolic or hypometabolic
- Any patient with ICU LOS > 4 weeks

Mehta et al. (2009)

NATIONWIDE CHILDREN'S

Limitations of IC

Air leaks around ET tubes

Chest tubes

FiO2 >60%

Receiving dialysis

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DRI vs. REE

Age	DRI (kcal/kg)	REE (kcal/kg)
0-3 mon	102	54
4-6 mon	82	54
7-12 mon	80	51
13-35 mon	82	56
3 y	85	57
4 y	70	47
5-6 y	65	47
7-8 y	60	47

Kcal Requirements: Intubated Child <12m

May require >REE

activity not a significant percent of kcal

Kcal used predominantly for growth

Consensus is to provide >REE for infants 0-12 months despite intubation or sedation

(75-80% of the DRI for age)

0-3 months ~80 kcal/kg

4-12 months ~65 kcal/kg

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Kcal Requirements: Intubated Child >12m

Kcal goal = REE

WHO, Schofield or White equation

3 yo ~60 kcal/kg

4-8 yo ~50 kcal/kg

Activity and injury factors not routinely used with the exception of the burn patient

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Kcal Requirement for the Extubated Child

Kcal goal = DRIs for age/gender
- Catch up growth may be necessary
  - (DRI x IBW) ÷ actual wt (kg)
  - BMI for age >85th%tile use IBW
    - IBW: BMI for age @50th%tile
      - (BMI @50th%tile x actual wt) ÷ actual BMI

NATIONWIDE CHILDREN'S
When your child needs a hospital, everything matters.

Adjustments for Other Special Populations

1. SBS
   1. Delete manganese and reduce copper intake
   2. Extra zinc
   3. Carnitine
   4. Use of Trophamine® (or Aminosyn PF®) w/o cysteine
2. Hepatic
   1. No special amino acid products (ie, Hepatamine® are required but protein intake probably needs to be reduced in hyperammonemia
   2. Would most like benefit from the Trophamine® or Aminosyn PF® due to the increased amount of BCAA.
3. Renal
   1. CRRT usually requires more protein due to loss through the circuit
   2. Depending status of dialysis may have to hold trace elements, vitamins and selenium

NATIONWIDE CHILDREN'S
When your child needs a hospital, everything matters.

Pediatric Basic Skills Lab CNW 2016
Feeding and Nutrition in Children with Neurodevelopmental Challenges

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Feeding problems and poor nutrition are very common in children with neurodevelopmental problems. These children are often unable to consume adequate calories, transition to age-appropriate foods, swallow with ease or grow according to standards for typical children.

This session will provide an opportunity to explore the importance of nutrition and its assessment and monitoring in children with neurodevelopmental challenges using appropriate anthropometric assessments and growth charts.

What is known about the nutritional status of children with neurodevelopmental challenges?

- In children with neurodevelopmental challenges, good nutrition:
    - Impacts overall developmental progress and has neuro-rehabilitation implications
    - Health and longevity
    - Community participation
    - Bone health
- Poor nutrition is remedial a good nutritional care plan is important in the rehabilitation toolkit

What are the causes of poor nutritional status in children with neurodevelopmental challenges?

- Nutritional factors
    - Inadequate intake
    - Poor utilization of nutrients
    - Increased losses
    - Energy expenditure
- Non-nutritional factors
    - Endocrine
    - Neurological factors
    - Bone health

If nutrition is important, how do we ensure we are assessing & monitoring it correctly?

- History and physical
- Anthropometry
    - Weight
    - Height or Length or Segmental measures
    - Head Circumference
    - Triceps skin fold
- Growth Chart
- Weight gain velocity
- Body composition
- Interpreting the measurements

How do we formulate an appropriate treatment plan?

- Estimating energy requirements
- Maximize oral nutrition
    - Manipulation of nutritional intake
    - Provide appropriate texture, viscosity of food

---

[1] *I have no commercial relationships relevant to the topic presented*

- Careful, well-paced feeding
  - Position well
  - Ensure the teeth are in good shape
- Enteral nutrition
  - Feeding enough but not too much
  - Exact nutritional requirements not clear so frequent follow up required until the weight gain trajectories are reached

Conclusion

- Good nutrition is an important part of neuro-rehabilitation, growth and development
- The earlier we give good nutrition, the better the outcome
- Assessment of nutritional status is not straightforward. Regular monitoring is important
- Parental support and engagement in nutritional care leads to better outcomes.

Questions

1. **Which of the follow measurement are important in deciding on appropriate growth in children with neurodevelopmental challenges?**
   a. Weight
   b. Triceps Skin Fold
   c. Body Mass Index or Weight for Height
   d. a, b, c
   e. a and b
2. **True or False**
   Segmental measurements for children with neurodevelopmental challenges are validated measures of length and height**.**
3. **Energy expenditure in children with neurodevelopmental challenges is:**
   a. Similar to age matched peers
   b. Can be estimated by simple clinical measures
   c. Determined by the degree of motor impairment
   d. a, c
   e. a, b, c
4. **Gastrostomy feeding**
   a. Decreases the occurrence of aspiration pneumonia
   b. Is associated with weight gain
   c. Is associated with overweight status and bone fragility
   d. All of the above
   e. “b” and “c”

ANSWERS: 1:E, 2: True, 3: D, 4: E

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Guide to Writing Parenteral Nutrition Orders in Children

0. Indication for Parenteral Nutrition

1. Estimation of Calorie Needs

- Seashore Equation [55-2 (Age)] Wt. + 20%
- Harris-Benedict Equations

2. Estimation of Fluid Needs

- 100 cc/kg for 1st 10 kg; 50 cc/kg for 2nd 10 kg; 20 cc/kg for > 20 kg

3. Correction of Calorie/Fluid Needs

4. Calculation of Fat

- ~30 % of total kilocalories or 1.5 to3.0 g/kg per day

5. Calculation of Protein

- 1 - 2 g/kg per day
- Goal of 24-48 non-protein kilocalories/g of protein
- Amino acid concentration

To determine the maximum amount of protein (g/kg/day) in a patient who is not losing protein, divide the total calories by 28 and the patient's weight.

6. Calculation of Carbohydrate

Example of PN Calculations in a Pediatric Patient

35 kg, 10 year old boy in an ICU with 2° C fever receiving an IV of D5 at 10 cc/hr S/P abdominal surgery.

0. Patient NPO due to bowel surgery; not expected to eat for 7 days.

1. Calculated Energy Requirements:

[55 - 2 (10)] X 35 = 1225 kilocalories
+ 20 % = 245 kilocalories
+ 26 % (2° C fever) = 318 kilocalories
Total = 1788 kilocalories

2. Calculation of Fluid Requirements:

100 cc/kg X 10 kg + 50 cc/kg X 10 kg + 20 cc/kg X 15 kg =

1800 cc

3. Correction of Calorie/Fluid needs

D5 at 10 cc/hr provides 240 cc and 41 kilocalories.

Corrected Energy Requirements = 1747 kilocalories
Corrected Fluid Requirments = 1560 cc.

4. Calculation of Fat

30 % of 1788 Calories = 536 kilocalories
1.5 g/kg per day X 35 kg X 10 kilocalories/g = 525 kilocalories

1747 kilocalories - 525 kilocalories = 1222 kilocalories
1560 cc - 262 cc = 1298 cc

5. Calculation of Protein

1788 kilocalories/(28 X 35) = 1.8 g/Kg per day maximum

1.8 g of protein/Kg X 35 Kg = 63 g or 63 g X 4 kcal/g = 252 kilocalories

63 g in 13 dl = A4.8

1222 kilocalories - 252 kilocalories = 970 kilocalories

6. Calculation of Carbohydrate

(970 kilocalories/13 dl) X (1 g/3.4 kilocalories) = D21.9

Order:

1.3 L of D22 with 1.8 g of amino acids/Kg per day and 1.5 g of 20% IL/Kg per day

⇒ 1790 kilocalories and 1802 cc per day

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- Neonatal/Infant Parenteral Nutrition Writing
- "I have no commercial relationships to disclose"

Presentation Overview/Summary

- Often times the practicing clinician, especially those new to the area of nutrition support lack knowledge and skills to safely identify the need, components and ability to prescribe or deliver parenteral nutrition to the neonatal/infant patient. This portion of the Pediatric Skills lab will provide targeted education on writing parenteral nutrition orders for the neonatal/infant patient using case specific scenarios.

Learning Objectives

Upon completion of this session, the learner will be able to:

1. Determine the indications for neonatal/infant parenteral nutrition
2. Discuss the macronutrients and micronutrients used in parenteral nutrition
3. Write a parenteral nutrition order using a patient specific case scenario

Learning Assessment Questions

1. Which of the following is **<u>NOT</u>** an indication for neonatal/infant parenteral nutrition?
   a) Very low birth-weigh infants who cannot adequately feed enterally
   b) Infants with intolerance to cow's milk-based formulas
   c) Premature infants with severe respiratory distress syndrome
   d) Infants with congenital defects altering the gastrointestinal tract (i.e., gastroschisis, meconium ileus, intestinal atresia)

2. Which of the following leads to an increased risk of calcium-phosphate precipitation?
   a) Lower pH of the parenteral nutrition solution
   b) Lower temperatures
   c) Use of calcium gluconate
   d) Extended time since preparation of the parenteral nutrition solution

3. Which of the following trace elements should be removed from the parenteral nutrition solution in neonates/infants with parenteral nutrition-associated liver disease (PNALD)?
   a) Chromium
   b) Selenium
   c) Manganese
   d) Zinc

Learning Assessment Answers:

1. Answer = B; Rationale: Alternative enteral formulas are available for infants with intolerance to cow's milk based formulas such as amino acid based enteral formulas and the patient does not require parenteral nutrition
2. Answer = D; Rationale: Solubility decreases with time after mixing as more calcium dissociates
3. Answer = C; Rationale: Serum manganese is elevated in patients with cholestatic jaundice and levels are directly correlated to the severity of cholestasis. Excessive intakes of parenteral manganese may induce PNALD and neurotoxicity.

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