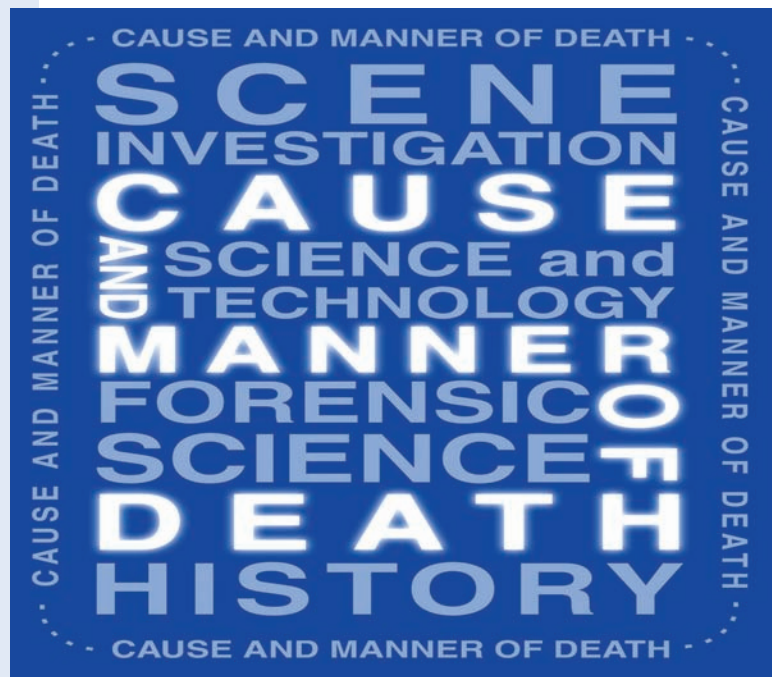


chapter 2



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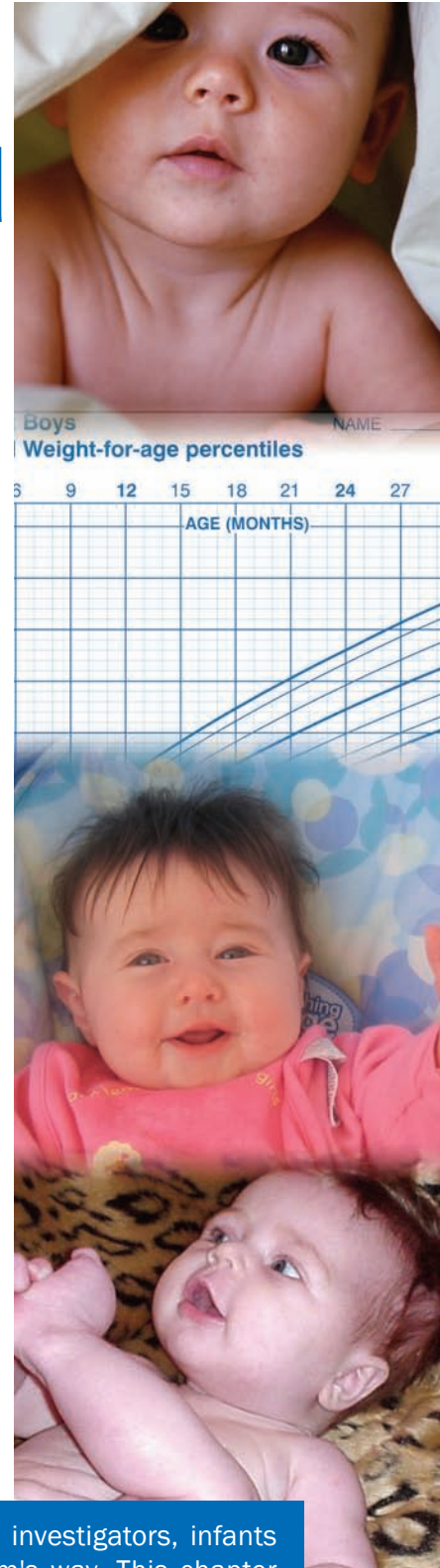
Infant Growth and Development

Birth to One Year of Age

Unit 3: Infant Growth

Unit 4: Infant Developmental Milestones

Unit 5: Infant Feeding, Diet, and Risks



Unlike most decedents encountered by death investigators, infants have limited ability to put themselves in harm's way. This chapter covers basic human growth and development, and dietary issues as applicable to infants from birth to one year of age, and information and technologies that can assist the investigator in evaluating the plausibility of witness accounts and observations as they pertain to infant abilities and purported actions prior to death.

OVERVIEW

One of the most difficult tasks the infant death investigator has to perform is sorting the numerous details each case produces. Often, these details are part of a witness account of infant activity prior to the incident that preceded the death. Investigators must understand normal infant abilities—based on age—and be able to correlate these with those activities reported by witnesses. This chapter details normal, and abnormal infant growth and development. The student will also be introduced to the most common growth charts and developmental screening tests used in the United States.

SUPPORT MATERIALS

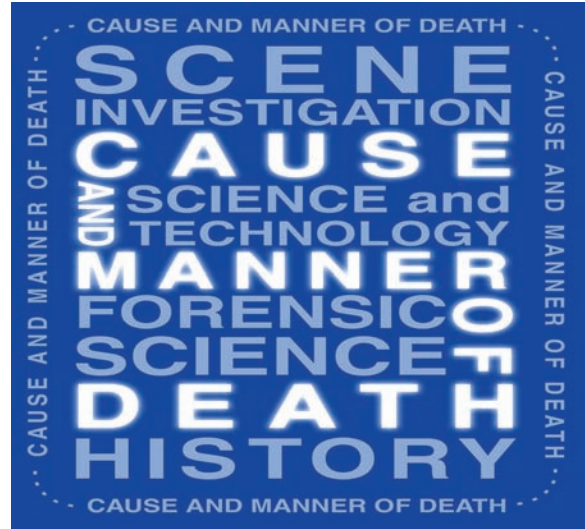
In addition to the SUIDI Reporting Form or jurisdictionally approved equivalent, the following support materials are suggested:

1. Denver Developmental Screening Test-II (DDST-II). Denver Developmental Materials, Inc., P.O. Box 371075, Denver, CO 80237-5075, (303) 355-4729 or 1 (800) 419-4729.
2. CDC Growth Charts: United States. Advance Data No. 314, Vital and Health Statistics of the Centers for Disease Control and Prevention. National Center for Health Statistics; 2000. Available at <http://www.cdc.gov/growthcharts>.
3. Pediatric Nutrition Handbook. 4th ed. Elk Grove Village, Ill: American Academy of Pediatrics; 1998; 168–169.
4. Dietz WH, Stem L. American Academy of Pediatrics Guide to Your Child's Nutrition: Making Peace at the Table and Building Healthy Eating Habits for Life. New York, NY: Random House; 1999.
5. Block RW, Krebs NF, Committee on Child Abuse and Neglect, Committee on Nutrition. Failure to thrive as a manifestation of child neglect. *Pediatrics*. 2005;116:1234–1237.
6. Zenil JA Jr. Failure to thrive: A general pediatrician's perspective. *Pediatr Rev*. 1997;18:371–378.
7. Growth Charts Training. Washinton, DC: US Dept of Health and Human Services, Health Resources and Services Administration, Maternal and Child Health Bureau; 2000. Available at <http://depts.washington.edu/growth/index.htm>.
8. Mitchell EA, Thach BT, Thompson JM, Williams S. Changing infants' sleep position increases risk of sudden infant death syndrome. *Arch Pediatric Adolesc Med*. 1999;153:1136–1141.

CHAPTER OBJECTIVES

By the end of this chapter, students will be able to:

1. Identify normal versus abnormal infant growth.
2. Describe infant growth charts.
3. Describe developmental screening tools.
4. Apply infant developmental milestones.
5. Apply basic feeding and dietary concepts.
6. Describe dietary concerns.



3

Infant Growth

unit

INTRODUCTION

Infants (children aged 0 to 12 months) have a wide range of birth weights. However, there is a normal range of weights and lengths for age, such that most one-month-old male infants born at term (born at or after the end of the 37th week of pregnancy) should weigh between 7 pounds, 3 ounces and 12 pounds. It is important for the infant death scene investigator to recognize when an infant's weight and length are below what is expected for his or her age. Infants whose weight is less than the 5th percentile for age may have an underlying disease or condition that may have contributed to their death. Alternatively, if no underlying cause can be found for the infant's growth failure, the infant may have an environmental or psychosocial cause for his or her growth failure that may also have placed him or her at risk for death.

NORMAL INFANT GROWTH

Infancy, the period of time from birth to a child's first birthday, is a time of tremendous physical growth. It is common for infants to lose weight (less than 8% to 10% of birth weight) during their first week of life. However, by two weeks of age, an infant's weight should be back to their birth weight. Typically, an infant will weigh twice their birth weight by 4 months of age and three times their birth weight by 12 months of age. Length will often increase by 50% by 12 months of age. Infants tend to grow in spurts, so it may be common to see a significant increase in length followed by a slower growth period when weight catches up and vice versa. Growth rates may differ between breastfed and formula-fed infants. Infants that are breastfed only (no infant formula) often gain more weight more rapidly in the first three months of life than formula-fed infants. However, by 6 to 12 months of age, breastfed infants often weigh less than formula-fed infants.

The following tables list the normal growth (weight and length) by age in months for the 5th to 95th percentile of the population. For example, a female infant who is 13 pounds at two months of age is at the 95th percentile for weight for her given age. Or in other words, she is heavier than 95 out of 100 two-month-old female infants. On rare occasions, an infant's growth may fall outside of this range, but they still have normal growth overall. So it is important to monitor overall trends in growth over time and to assess weight-for-length. Weights are listed in both pounds and kilograms, and length is listed in both inches and centimeters. Length is measured with the infant lying down from the top of the head to the bottom of the heel of the foot. In contrast, height is measured in children older than 12 months with the child standing upright.

INFANT GROWTH CONCERNS

Documenting and tracking an infant's weight, length, and head circumference over time is important for assessing nutritional status. The growth of a term infant typically follows the same percentile rank, such that if the infant is at the 25th percentile for age at four months the infant should be at or near the 25th percentile at six months. If there is a decrease in the expected rate of growth based on the infant's previously defined growth curve, or if the infant's weight is consistently below the 5th percentile for age or decreases to below the 5th percentile, the infant should be evaluated for failure to thrive.

Some infants' growth is always outside of the normal range. There are a number of health conditions that affect the timing and rate or speed of growth. For example, infants with Down syndrome, very low birth weight (weight of less than 3 pounds, 5 ounces or 1,500 grams), or who were born preterm (born before the end of the 37th week of pregnancy) often have a different growth pattern than healthy term infants with normal birth weight (weight of 5 pounds, 8 ounces or more, or greater than or equal to 2,500 grams). There are special growth charts that may be used for infants affected by these conditions. The age of the infant needs to be adjusted by his or her gestational age when using the CDC growth charts and other specialized growth charts, such that a five month old born two months early should be monitored as a three-month-old infant.

FAILURE TO THRIVE

Failure to thrive (FTT) is a sign of unexplained weight loss or poor weight gain in an infant or child. FTT is most often defined as a weight-for-age or a weight-for-length that is below the 5th percentile on more than one occasion or a decrease in the expected rate of growth based on the infant's previously defined growth curve. (Some nutrition experts believe that when weight-for-age is used to detect FTT, other indices such as weight-for-length should also be examined.) Typically, an infant loses weight first, before their length or head circumference are affected. This means that an infant with FTT may be growing appropriately in terms of their length and head circumference.

A term infant's growth typically follows the same percentile rank on the growth chart. A decline in the expected rate of growth can be identified when an infant's weight decreases across two or more major percentiles regardless of whether their weight drops below the 5th percentile. Major percentiles include: 95th, 90th, 75th, 50th, 25th, 10th, and 5th. For example, if an infant's weight is at the 75th percentile for age at two months and then it declines to the 25th by the infant's four-month clinic visit, the infant may have FTT. In addition, a decrease in the expected rate of growth can occur when an infant's rate of daily weight gain is less than expected for age. Infants are expected to gain between 26 to 31 grams per day at 0 to 3 months, 17 to 18 g/day at 3 to 6 months, 12 to 13 g/day at 6 to 9 months, and 9 g/day at 9 to 12 months of age.

FTT is often described as organic or non-organic. However, an infant may have both an organic and non-organic reason for their FTT. Organic FTT refers to growth failure that is due to an acute or chronic disorder known to interfere with normal nutrient intake, absorption, metabolism, or excretion. Non-organic FTT refers to growth failure due to environmental neglect (e.g., lack of food) or other psychosocial factors.

CAUSES OF FAILURE TO THRIVE

Undernutrition is the immediate underlying cause of FTT. Alternatively, the infant may have adequate caloric intake for age but their body either cannot digest or use the food effectively or they need more calories than they are able to eat. The healthcare provider needs to find out why the infant is undernourished in order to have any effect on the infant's growth. The following is a list of causes of FTT.

- Inadequate nutrient intake.
 - o Not enough foods given to the infant to eat.
 - Intentional withholding of food by caregiver.
 - No food available in the home.
 - o Poor quality food given to the infant to eat.
 - Too much juice or empty calorie "junk" foods.
 - Dilution of infant formula.
 - o Infant with lack of appetite.
 - Chronic infection (e.g., HIV/AIDS).
 - Chronic anemia.
 - o Feeding difficulties.
 - Poor suck due to medical condition involving brain, nerves, or muscles (e.g., cleft palate, cerebral palsy [CP]).
 - Shortness of breath due to heart and/or lung disease.
 - Skull and/or facial malformation (e.g., cleft lip and palate).
 - Vomiting and/or reflux (e.g., food allergies).
- Food not getting absorbed in the infant's gut.
 - o Chronic disease (e.g., cystic fibrosis, liver disease).
 - o Intestinal problems (e.g., short gut syndrome).
- Increased need for food (increased metabolism).
 - o Hyperthyroidism.
 - o Chronic infection or disease (e.g., cancer, heart or lung disease).
- Poor use of food.
 - o Genetic condition (e.g., Down syndrome).
 - o Metabolic disease (e.g., medium chain acyl-CoA dehydrogenase deficiency [MCAD]).

Normal Range for Age (5th–95th Percentile): Female				
Age	Weight		Length	
	lbs	kg	in	cm
Birth	5.7-9.2	2.6-4.2	18-21.1	45.7-53.5
1 month	7-11.2	3.2-5.1	19.5-22.75	49.5-57.8
2 months	8.5-13	3.8-5.9	20.75-23.8	52.7-60.5
3 months	9.5-15	4.4-6.8	21.75-24.8	55.2-63
4 months	11-16.3	5-7.4	22.5-25.75	57.2-65.4
5 months	12-17.8	5.5-8.1	23.4-26.6	59.4-67.5
6 months	13-19	5.9-8.6	24-27.2	61-69
7 months	14-20.2	6.4-9.2	24.6-28	62.5-71.1
8 months	14.7-21.4	6.7-9.7	25.2-28.7	64-72.9
9 months	15.5-22.5	7-10.2	25.75-29.25	65.4-74.3
10 months	16.3-23.3	7.4-10.6	26.25-29.75	66.75-75.6
11 months	17-24.2	7.7-11	26.75-30.3	67.9-77
12 months	17.6-25	8-11.4	27.2-30.9	69-78.5

Figures taken from the NCHS/CDC Growth Charts: United States at <http://www.cdc.gov/growthcharts>. For example: 5 out of 100 (5%) one-month-old female infants in the United States weigh 8.5 pounds or less, and 5% weigh 13 pounds or more.

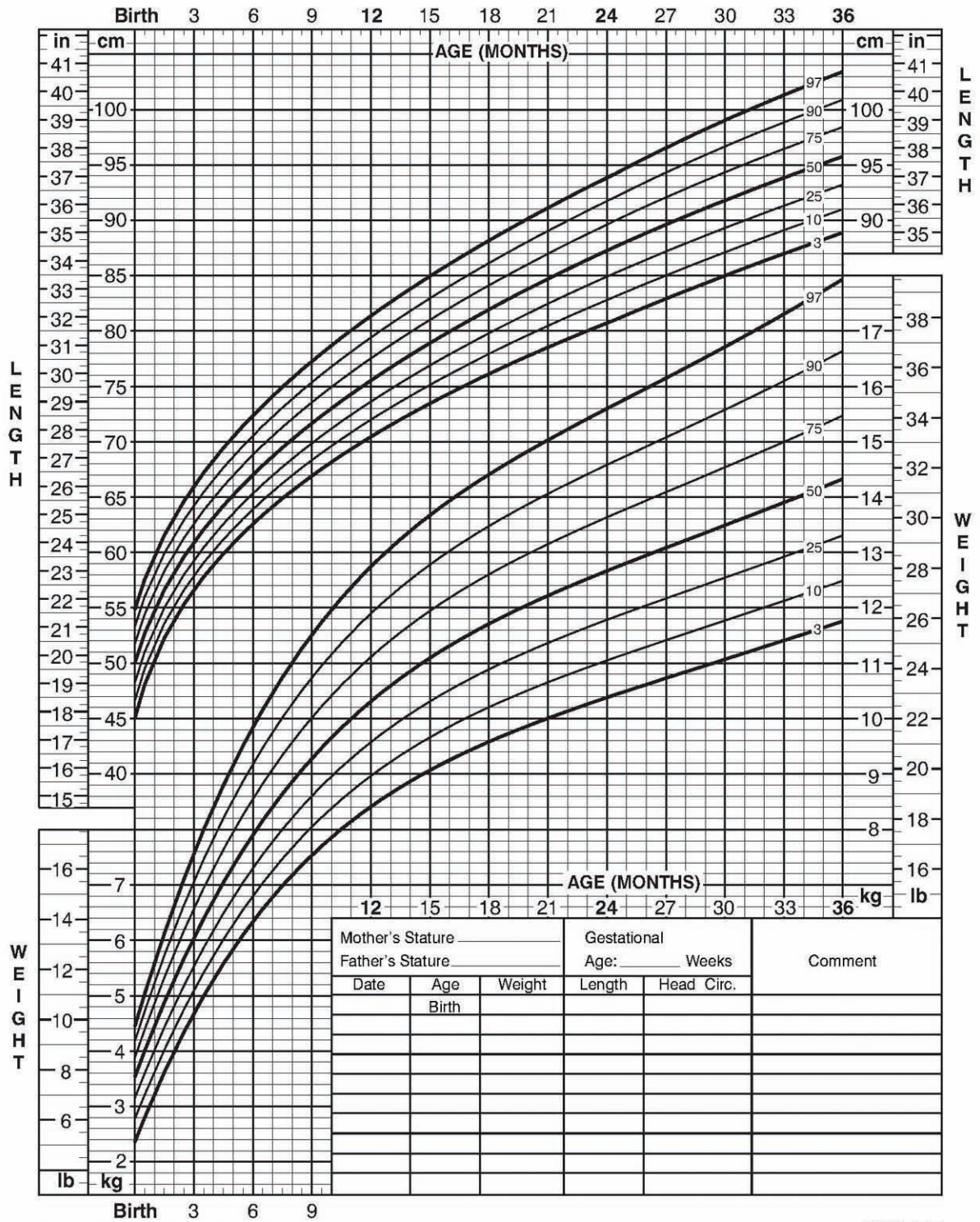
Normal Range for Age (5th–95th Percentile): Male				
Age	Weight		Length	
	lbs	kg	in	cm
Birth	5.5-9.7	2.5-4.4	18-21.3	45.7-54
1 month	7.3-12	3.3-5.5	19.9-23.1	50.5-58.5
2 months	9-14.1	4.1-6.4	21.3-24.5	54-62.2
3 months	10.5-16	4.8-7.3	22.4-25.6	57-65
4 months	12-18	5.5-8.2	23.4-26.6	59.4-67.6
5 months	13.2-19.5	6-8.9	24.1-27.5	61.2-69.9
6 months	14.3-21	6.5-9.5	24.8-28.2	63-71.6
7 months	15.2-22.5	6.9-10.2	25.4-28.8	64.5-73.2
8 months	16.3-23.5	7.4-10.7	26-29.5	66-74.9
9 months	17-24.6	7.7-11.2	26.5-30.1	67.3-76.5
10 months	17.8-25.5	8.1-11.6	27-30.7	68.6-78
11 months	18.5-26.4	8.4-12	27.5-31.2	69.9-79.3
12 months	19-27.5	8.6-12.5	28-31.7	71.1-80.5

Figures taken from the NCHS/CDC Growth Charts: United States at <http://www.cdc.gov/growthcharts>. For example: 5 out of 100 (5%) male infants in the United States have a birth weight of 5.5 pounds or less, and 5% have a birth weight of 9.7 pounds or more.

Birth to 36 months: Boys
Length-for-age and Weight-for-age percentiles

NAME _____

RECORD # _____



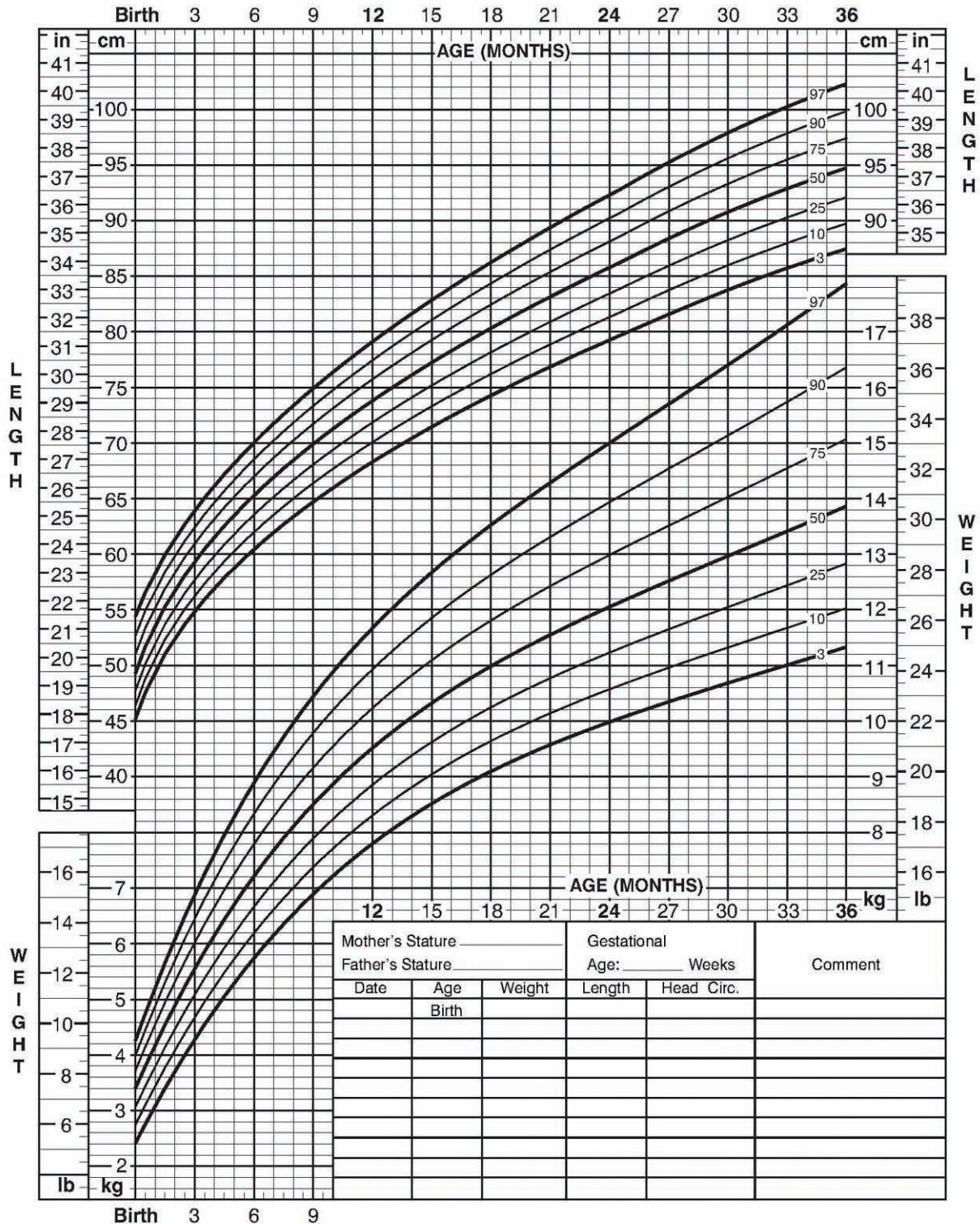
Published May 30, 2000 (modified 4/20/01).
 SOURCE: Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000).
<http://www.cdc.gov/growthcharts>



Birth to 36 months: Girls
Length-for-age and Weight-for-age percentiles

NAME _____

RECORD # _____



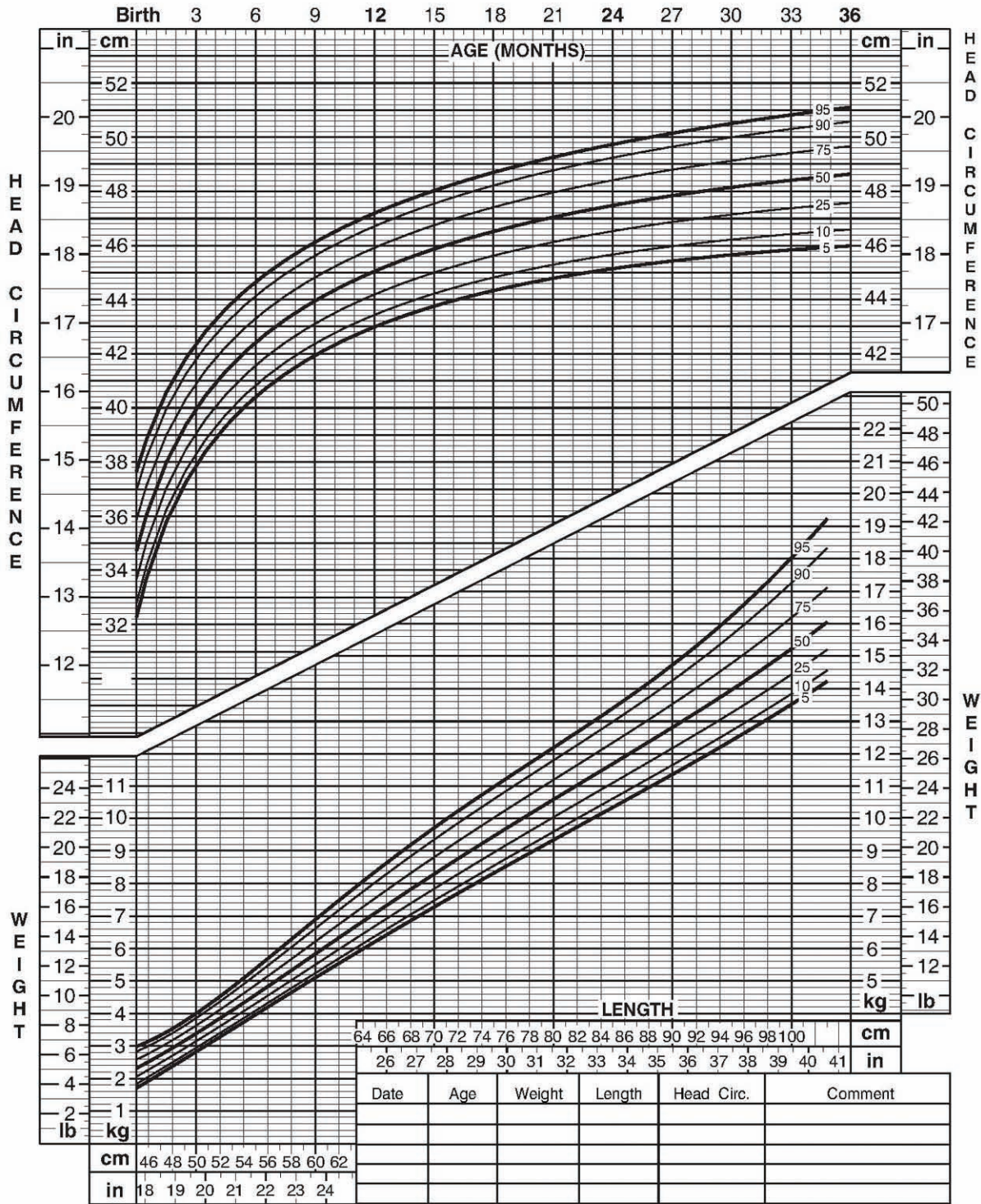
Published May 30, 2000 (modified 4/20/01).
 SOURCE: Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000).
<http://www.cdc.gov/growthcharts>



Birth to 36 months: Girls
Head circumference-for-age and
Weight-for-length percentiles

NAME _____

RECORD # _____



Published May 30, 2000 (modified 10/16/00).
 SOURCE: Developed by the National Center for Health Statistics in collaboration with
 the National Center for Chronic Disease Prevention and Health Promotion (2000).
<http://www.cdc.gov/growthcharts>



INFANT GROWTH CHARTS

Understanding the basics of growth monitoring (i.e., documenting and tracking an infant's weight, length, and head circumference over time) is important for infant death investigators because these skills enable them to assess an infant's nutritional status. Applying these skills will enable investigators to ask appropriate questions to determine whether the infant's growth and development are within the expected normal range for age. It will also help investigators assess the accuracy of the information provided by the parents or caregivers concerning the circumstances surrounding the infant's death. Investigators' knowledge of normal growth and development will enable them to identify potentially dangerous environmental situations for an infant of a given age.

STANDARD INFANT GROWTH CHARTS USED IN THE UNITED STATES

In the United States, many healthcare professionals use the 2000 CDC Growth Charts. These charts were created using information from a large national survey that has been collecting information about Americans since the 1960s. There are different growth charts for boys and girls and for children 0 to 36 months of age versus those who are 2 to 20 years old. To document and track an infant's growth, the 0- to 36-month-old growth charts should be used. These include weight-for-age, length-for-age, weight-for-length, and head circumference-for-age growth charts.

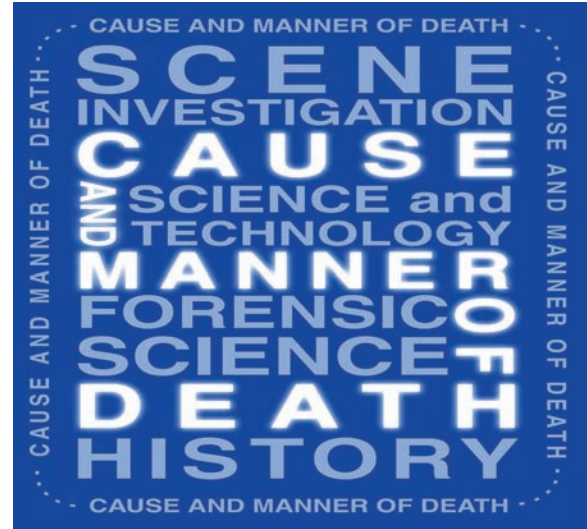
Weight-for-age growth charts help identify infants who are underweight or overweight for their age. Weight-for-length charts are useful in identifying failure to thrive. An infant whose weight-for-length is less than the 5th percentile is considered underweight. Length-for-age growth charts identify infants who are short or tall for their age. An infant whose length is less than the 5th percentile for the infant's age is considered to have short stature. Head circumference-for-age less than the 5th percentile or greater than the 95th percentile may be an indicator of developmental problems.

Infant growth, assessed by using a growth chart, is described using percentiles. Percentiles tell us what percentage of the reference population the infant's weight or length would be less than, be equal to, or exceed. For example, an infant whose weight is at the 5th percentile for age weighs the same or more than 5% of all infants of the same age and weighs less than 95% of all infants of the same age. An infant that is at the 50th percentile length-for-age would be considered of average length (i.e., 50% of infants the same age would be taller, 50% would be shorter).

HOW TO USE THE GROWTH CHARTS

After obtaining the infant's weight and age in months, locate the weight (in either pounds or kilograms) on the left side of the chart and the infant's age at the bottom of the chart. Draw a horizontal line or use a straight edge to trace the line from the infant's weight across the chart until you are directly over the infant's age. Draw or trace a vertical line straight up from the infant's age at the bottom of the chart to their weight, and pinpoint the spot on the chart where the two lines meet. This spot tells you what percentile the infant's weight falls within.

Often, the infant's weight will not fall exactly on one of the percentile lines but rather in between two percentiles. For example, a nine-month-old girl that weighs 17 pounds would fall between the 10th and 25th percentile. Now try to plot this infant's growth on the chart yourself. Did you find the same answer? Use the same method for the length-for-age, head circumference-for-age, and weight-for-length growth charts, except when plotting weight-for-length—the length is at the bottom, instead of the infant's age. The following website offers more information about growth charts: <http://www.cdc.gov/nccdphp/dnpa/growthcharts/training/modules>.



4 — Infant Developmental Milestones

unit

INTRODUCTION

An infant will accomplish many developmental milestones before his or her first birthday. A developmental milestone is a set of functional skills or age-specific tasks that most children can do within a certain age range. The actual age when a normally developing infant achieves a given milestone can vary quite a bit. For example, infants can walk well alone between 11 and 14¾ months. If an infant was born preterm, the infant will reach various milestones based on the infants' due date, not the infant's birthday. A five-month-old infant born two months early would be expected to have the same developmental skills as a 3-month-old who was born at term.

Motor development happens in a predictable pattern such that control and use of an infant's body parts generally proceeds from head to foot. For instance, infants develop head control before they learn to sit. Infants generally have good trunk (torso) control and use their arms and hands before they can walk. Motor development skills are attained within a predictable age range so that a parent, healthcare provider, or investigator can estimate what motor skills an infant might have at a given age. For example, at birth an infant is unable to hold his or her head steady when held upright. Newborns spend most of their time sleeping on their backs with their fists clenched and their legs flexed. By six months of age most infants can sit without assistance, and by one year, most children are standing alone for a few seconds without hanging onto anything.

Developmental milestones are traditionally divided into five skill areas: (1) gross motor, (2) fine motor, (3) social, (4) language, and (5) cognitive. For the purposes of this training, we will not review cognitive development of the infant. We will cover gross motor, fine motor, social, and language skills.

GROSS MOTOR SKILLS

Gross motor skills can be defined as the ability to move and control large muscles in the body or groups of muscles (e.g., muscles in the arms, legs, or torso). Examples of gross motor skills are sitting, crawling, standing, and walking.

FINE MOTOR SKILLS

Fine motor skills can be defined as the movement and control of the small muscles of the body (e.g., muscles in the hands, fingers, neck, and head) that act in an organized manner to accomplish more difficult and delicate tasks, especially those requiring eye-hand coordination. Examples of fine motor skills include reaching, grasping, and manipulating objects with one's hands.

SOCIAL SKILLS

Social skills can be defined as an infant's ability to interact with his or her environment and the individuals who care for him or her.

LANGUAGE SKILLS

Language skills can be defined as the ability to understand language and to vocalize, babble, and ultimately say words. Language abilities depend on an infant's ability to hear. All infants in the United States should have a hearing screening done at birth.

UNACCUSTOMED PRONE (ON THE STOMACH) SLEEP

The supine (on the back) sleeping position is associated with the lowest risk of SIDS. An infant is at increased risk when placed on their stomach (prone) or side to sleep. Unaccustomed prone sleep position occurs when an infant who is typically placed to sleep on their back is placed on their stomach to sleep. Unaccustomed prone sleep places infants at a higher risk for SIDS. Studies have found that non-parental caregivers (e.g., grandparents, babysitters, child care providers) may be more likely to place an infant in an unaccustomed prone sleep position. Part of the risk may be because infants who typically sleep on their back develop upper body strength later than infants who typically sleep on their stomach. If these infants are placed on their stomach and they get into a suffocating or low-oxygen situation, they cannot lift or move their heads to get out of that situation.

It is important for an infant's development to have supervised "tummy time." Tummy time is playtime with the infant while he or she is positioned on their stomach. Tummy time promotes normal infant development by giving the infant an opportunity to learn to lift and turn his or her head and strengthen his or her neck, arm, and shoulder muscles. This will help ensure that the infant will reach their developmental milestones at the expected time.

DEVELOPMENTAL SCREENING TOOLS

The Denver Developmental Screening Test II (DDST-II) tests a child's development of gross and fine motor, language (including understanding and verbal skills), and social skills from birth to six years. It is used by healthcare providers to monitor a child's development and to identify children who have developmental delay or disabilities. It is important that infant death scene investigators have a general knowledge of infant development so that they are able to evaluate the accuracy of the circumstances surrounding the death of the infant and are able to assess safety concerns related in the witness account of when the infant was last seen alive. For example, if a two-month-old infant was last seen alive sitting alone on the sofa and later found unresponsive with their face down on the sofa, the investigator would know that infants do not sit without support until 5 ¼ to 6 ¾ months. Sitting on a soft surface like a sofa would be a potentially dangerous situation for a two-month-old infant who has poor head control and cannot sit unassisted. Knowledge of normal infant development will also allow investigators to ask more informed questions about an infant's abilities and skills and identify items in the infant's environment that need to be examined more carefully.

MONITORING PROCESS

An infant's development is monitored at well-child clinic visits. Healthcare providers typically ask the parent/caregiver if he or she has any concerns about the infant's development. They also ask specific questions about the infant's development. For example, "Is your infant talking?" Healthcare providers also interact with the infant to evaluate what gross and fine motor, language, and social skills the infant has acquired. For example, the healthcare provider may place a six month old in a sitting position to see if the infant is able to sit unassisted. If developmental delays are suspected based on the healthcare provider's history (including findings from the DDST-II) and physical examination, follow-up is planned for further testing.

APPLYING THE DDST-II

The DDST-II is the most commonly used test to monitor development in the United States. The average age and age ranges at which skills are acquired in each area of development are the basis of the DDST-II. It is a one-page chart with the child's age in months along the bottom and top. The DDST-II has 124 test skills divided into four categories: gross motor, language, fine motor, and social skills. The skills categories are listed at the left side of the DDST-II. Each skill is represented by a rectangle that spans the ages at which 25%, 50%, 75%, and 90% of the sample population of children were able to do the skill.

The DDST-II is used by first finding the infant's age (in months) at the bottom of the chart. If the infant was born preterm, the age must be adjusted by subtracting the number of weeks he or she was born early from his or her age. Then a straight vertical line is drawn from the bottom to the corresponding age at the top of the chart. This line will cut through all the skills that the infant has accomplished or is working toward. Remember that there is an age range at which these skills are acquired. The skills to the left of the line represent skills that he or she has already accomplished, and skills to the right of the line represent skills that he or she will acquire in the future. The healthcare provider then asks the parent or caregiver whether the infant has mastered the skills that are appropriate for the infant's age. The healthcare provider works with the infant to evaluate the infant's gross and fine motor skills and some social skills. The DDST-II is placed in the child's chart next to the infant growth chart and ideally is used throughout the child's first six years.

Type of Motor Skill	Age at which Some (25%) and Most (90%) Infants Can Do Skill	
	25% of infants	90% of infants
Gross Motor Skill		
Lifts head and chin slightly (and briefly) when lying on stomach on a flat surface		Birth
Lifts head (45 degrees) off surface when lying on stomach	1 month	2 ³ / ₄ months
Lifts head (90 degrees) off surface when lying on stomach	1 ¹ / ₂ months	3 ¹ / ₂ months
Holds head up steady without support when held upright in standing position	1 ¹ / ₂ months	3 ³ / ₄ months
Bears some weight on legs when held upright in standing position	1 ³ / ₄ months	4 ¹ / ₄ months
Rolls over from lying on stomach to back first, then from back to stomach	2 months	5 ¹ / ₂ months
Raises chest and supports self on outstretched arms when lying prone on stomach	2 ¹ / ₂ months	4 ¹ / ₂ months
Keeps head level with body when pulled to sitting position when lying on back	2 ³ / ₄ months	6 months
Sits without support on hard, flat surface	5 ¹ / ₄ months	6 ³ / ₄ months
Stands holding onto low chair or table	6 ¹ / ₂ months	8 ¹ / ₂ months
Crawls or moves using hands and arms to move across the floor	7 months	9 months
Gets into sitting position from lying, crawling, or standing position	7 ¹ / ₂ months	9 ³ / ₄ months
Pulls to standing position from sitting	7 ³ / ₄ months	9 ³ / ₄ months
Stands for ten seconds or more without hanging onto anything	10 ¹ / ₂ months	13 ¹ / ₄ months
While standing, stoops and picks up an object	11 months	14 ¹ / ₂ months
Walks alone well	11 months	14 ³ / ₄ months

Type of Motor Skill	Age at which Some (25%) and Most (90%) Infants Can Do Skill	
	25% of infants	90% of infants
<i>Fine Motor Skill</i>	25% of infants	90% of infants
Keeps hands in fist (closed tightly)	Birth	2 months
Eyes or eyes and head follow object moved in an arc about 8 inches above face to midline (straight ahead)	Birth	1 ¼ months
Eyes or eyes and head follow object moved in an arc about 8 inches above face to past midline (straight ahead)	¾ month	2 ¾ months
Brings both hands together while lying on back	2 months	4 months
Eyes or eyes and head follow object moved in an arc about eight inches above face 180 degrees	2 ¼ months	4 ½ months
Grasps (holds onto) rattle placed in hand for few seconds	2 ½ months	3 ¾ months
Reaches for an object	4 ½ months	5 ½ months
Passes object from one hand to the other	5 months	7 ¾ months
Picks up object using a raking grasp	5 ¾ months	7 ¼ months
Picks up two objects, one in each hand	5 ¾ months	9 months
Bangs together objects held in hand	6 ¾ months	10 ¾ months
Uses thumb and finger to pick up object	7 months	10 months
Puts object in cup	9 ¾ months	13 ¾ months

INFANT DEVELOPMENTAL MILESTONES BY MONTH

The infant death investigator may need to know the basics of infant development (e.g., when an infant can sit upright without support) during death scene interviews when witnesses recount events involving an infant's movements and actions. The investigator must be aware of typical infant abilities and correlate those abilities in light of witness accounts during interviews. For example, the investigator is told that the two-month-old infant crawled to the corner of the bed where they were later found face down, wedged between the mattress and the bed. An investigator with a general knowledge of infant development would know that infants typically do not crawl until seven to nine months of age. The investigator would then know to ask more questions concerning the infant's skills and would ask to examine the mattress and bed. This knowledge may prove invaluable to the investigator who is attempting to determine the circumstances surrounding the infant's death.

ONE-MONTH DEVELOPMENTAL MILESTONES



Fig. 2.1: One-month-old infant.

One-month-old infants vary in their level of development. However, when born at term, most (90% or 9 out of 10) one-month-old infants should be able to do the following:

- Lifts head and chin slightly (and briefly) when lying on stomach on a flat surface.
- Keeps hands in fist (closed tightly).
- Eyes or eyes and head follow object moved in an arch about six inches above face to midline (straight ahead).
- Smiles in response to another person's smile or being talked to.
- Responds to a bell by startling, crying, or becoming quiet.
- Vocalizes in other ways than crying (e.g., "eh", "ah".)

TWO-MONTH DEVELOPMENT MILESTONES

Two-month-old infants vary in their level of development. However, when born at term the following are skills that most (90% or 9 out of 10) two-month-old infants should be able to do:

- Lifts head (45 degrees) off surface when lying on stomach.
- No longer clenches fist tightly all of the time.
- Eyes or eyes and head follow object moved in an arc about six inches above face past midline (straight ahead).
- Recognizes parents.
- Smiles spontaneously before being talked to, smiled at, or touched.
- Makes vowel "cooing" sounds (e.g., "ooh," "aah," "ooo").

THREE-MONTH DEVELOPMENT MILESTONES



Fig. 2.2: Three-month-old infant.

Three-month-old infants vary in their level of development. However, when born at term the following are skills that most (90% or 9 out of 10) three-month-old infants should be able to do:

- Lifts head 90 degrees off surface when lying on stomach.
- Holds head upright and steady without support when held in sitting position.
- Holds hand open at rest.
- Grasps (holds onto) rattle placed in hand for few seconds.
- Laughs out loud.

FOUR- TO FIVE-MONTH DEVELOPMENT MILESTONES



Fig. 2.3: Four- to five-month-old infant.

Four- to five-month-old infants vary in their level of development. However, when born at term, most (90% or 9 out of 10) four- to five-month-old infants should be able to do the following:

- Raises chest and supports self on outstretched arms when on stomach.
- Rolls over from stomach to back and then from back to stomach.
- Bears some weight on legs when held upright in the standing position.
- Brings both hands together when lying on back.
- Reaches for objects placed in front of him or her.
- Eyes or eyes and head follow object moved in an arc about eight inches above face 180 degrees.

- Works to get toy by reaching or stretching arm or body toward object.
- Turns toward rattling sound.
- Pays attention to (discovers) their own hands.

SIX-MONTH DEVELOPMENT MILESTONES



Fig. 2.4: Six-month-old infants.

Six-month-old infants vary in their level of development. However, when born at term, most (90% or 9 out of 10 infants) six-month-old infants should be able to do the following:

- Put feet in mouth when lying on back.
- Sit upright without support (without props) on hard surface.
- Keep head level with body when pulled to sitting position when lying on back.
- Begin to feed self.
- Turn to voice.

SEVEN- TO EIGHT-MONTH DEVELOPMENT MILESTONES



Fig. 2.5: Seven- to eight-month-old infant.

Seven- to eight-month-old infants vary in their level of development. However, when born at term, most (90% or 9 out of 10) seven- to eight-month-old infants should be able to do the following:

- Stands holding on to a low table or chair for support.
- Picks up object using raking grasp.
- Passes object from one hand to the other.
- Imitates sounds and speech.
- Says “ba,” “da,” “ga,” “ma,” or similar vowel-consonant combinations.
- Makes razz sound (wet, razzing sound with bubbles coming out mouth).

NINE-MONTH DEVELOPMENT MILESTONES

Nine-month-old infants vary in their level of development. However, when born at term, most (90% or 9 out of 10) nine-month-old infants should be able to do the following:

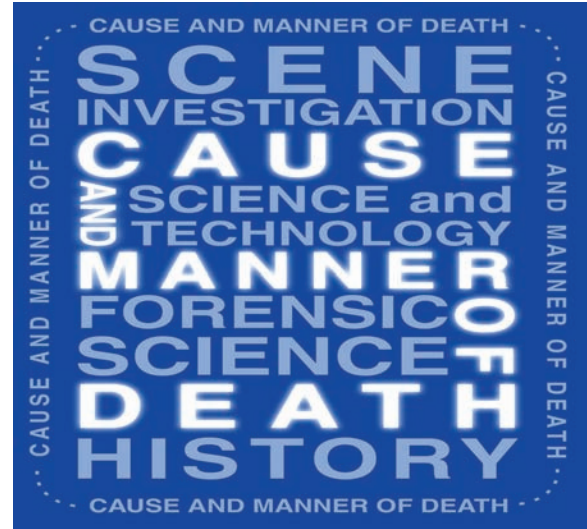
- Gets into sitting position from lying, crawling, or standing position.
- Pulls self to a standing position from sitting position.
- Crawls or moves across floor using both legs and arms.
- Holds bottle and feeds self using fingers.
- Picks up two objects and holds one in each hand at the same time.
- Says dada/mama indiscriminately (not specific).

TEN- TO 12-MONTH DEVELOPMENT MILESTONES

Fig. 2.6: Ten- to 12-month-old infant.

Ten- to 12-month-old infants vary in their level of development. However, when born at term, most (90% or 9 out of 10) 10- to 12-month-old infants should be able to do the following:

- Stands without hanging onto anything for two seconds.
- Begins to walk (walks well by 14 $\frac{3}{4}$ months).
- Bangs two blocks held in hands together.
- Uses thumb and finger to pick up small objects (pincer grasp).
- Plays patty-cake (clap hands).
- Indicates what they want.
- Combines syllables (e.g., “dadada,” “gagaga”).
- Jabbers or uses unintelligible conversation to self using inflection and pauses.



5

Infant Feeding, Diet, and Risks

unit

INTRODUCTION

What an infant is able to eat varies by his or her age and developmental skill level. For example, newborn infants do not eat solid food. Instead, they are breastfed or bottle-fed infant formula. Developmentally, newborns are not meant to eat solids. If you try to put solid food in a young infant's (typically less than four months of age) mouth, his or her tongue will reflexively push it out. It is important for an investigator to know what a typical infant's diet consists of at various ages so that he or she can evaluate the circumstances surrounding the death. The investigator should be aware of foods that are a choking risk for infants so that he or she can ask the caregiver about these foods in an interview. Investigators will benefit from knowing about food allergies, cultural remedies, and food-borne illnesses, such as infant botulism, because these conditions may contribute to the infant's death.

TYPICAL FEEDING PERIODS IN THE UNITED STATES

Nursing Period

The nursing period is defined as the period of time when an infant is given only breast milk and/or infant formula to eat. This period typically lasts for the first four to six months of life. According to the American Academy of Pediatrics (AAP), “adequate intake of human milk or a commercial infant formula meets all of the known nutritional requirements of infants for the first six months of life, with the possible exception of vitamin D in dark-skinned or sun-deprived breastfed infants.” (Pediatric Nutrition Handbook, 2005).

Physically and developmentally, infants are not ready to eat solid foods until they are four to six months old. Before this time, infants' digestive systems are still maturing. Infants lose the tongue-thrust reflex (when their tongue is touched, they will react by pushing their tongue outward or forward) by about four to six months. Most infants also learn how to hold their head steady while in the sitting position and develop the coordination needed to chew and swallow solid foods by 3 ³/₄ months. Most infants (90%) can sit unsupported on a hard surface by 6 ³/₄ months. By five to six months, infants can show a desire for food by opening their mouth and leaning forward. They can also show their parents/caregivers their disinterest in food by turning their head away or leaning back.

Transitional Period

The transitional period is defined as the period of time when soft, pureed foods and cereals are introduced into the infant's diet. Controversy still exists about the optimal timing of the introduction of solid foods. However, until infants lose the tongue-thrust reflex and are able to swallow nonliquid foods, it will be difficult to feed them by spoon. After four to six months, most infants' coordination has advanced sufficiently that they can swallow pureed solids.

In the United States, solid foods usually are introduced into an infant's diet between four and six months of age. Recommended first solids include vitamin-fortified infant cereals and pureed vegetables and fruit (e.g., baby foods). Food items should be introduced one at a time so that the parents/caregivers can watch for signs and symptoms of food allergies.

By 8 to 10 months, infants can begin to eat finely chopped foods (i.e., finger foods) because the likelihood of choking is decreased (Pediatric Nutrition Handbook, 2005). Teething biscuits can also be offered at this age. Foods that can break off and cause choking should be avoided.

Modified Adult Period

The modified adult period is defined as the period of time when most of an infant's nutrients come from table foods. This period generally begins after 10 months. Children may be taken off infant formula and given whole cow's milk after their first birthday.

DIETARY RISK FACTORS

Choking Risks

Children less than four years old are at greatest risk for choking on food, which can lead to death by asphyxiation (i.e., obstructive suffocation). Foods that are round, hard, and difficult to dissolve in saliva are most likely to cause problems. Infants and toddlers should not be given nuts, seeds, hard candies, round candies, grapes, raw carrots, popcorn, or hot dogs. These food items are easy to choke on. Choking also can occur if too much food is stuffed in an infant's mouth, if a child runs while eating, or if the child eats while unsupervised. Medications that are used to numb the gums and ease teething pain can increase a child's risk of choking. Children who receive medications should be observed carefully while eating. Children who have facial or oral abnormalities such as cleft lip or palate, esophageal anomalies, history of brain damage, or cerebral palsy are at increased risk of swallowing problems and choking.

Food Allergies.

A food allergy is an exaggerated immune response triggered by food. Reactions to foods may vary from mild to fatal. Food allergies can produce a variety of signs and symptoms, including scratchy throat, stomach pain, diarrhea, vomiting, shortness of breath, wheezing, difficulty swallowing, hives, angioedema (swelling of the eyelids, face, lips, and tongue), or anaphylaxis (a severe whole-body allergic reaction that can result in low blood pressure and death). Most reactions happen soon after contact with the food. While first-time exposure to the food may only produce a mild reaction, repeated exposures may lead to more serious reactions. Once the infant has had a previous reaction to food, even a very limited exposure to a very small amount of the food can trigger a severe reaction. It is important to ask the parent or caregiver if the deceased infant had any known food allergies. Common food allergies include dairy products (e.g., cow's milk), eggs, peanuts, nuts and seeds, wheat, soy, corn, shellfish, and fish. Also, the investigator should ask if anyone in the immediate family (especially siblings of the deceased infant) has a history of food allergies since they occur more frequently in infants with a positive family history.

Cultural Remedies

A cultural remedy can be defined as a non-regulated, non-prescription medicine, supplement, or treatment that may have been purchased or made by the caregiver. Many cultural remedies contain herbs and are technically considered food products under the U.S. Dietary Supplements Health and Education Act of 1994. Unlike prescription medicines and over-the-counter products (e.g., Tylenol), herbal products don't have to be tested to prove that they work well and are safe before they are sold. Because of this, herbal products may contain contaminants (e.g., benzodiazapines) that could make the infant sick or lead to his or her death. It is important for the investigator to ask the caregiver if the deceased infant was ever given cultural remedies in the past and if he or she was given one in the 24 hours prior to death. If so, the remaining sample should be collected for testing.

Food-Borne Illnesses

Food, and waterborne illnesses may be caused by a variety of bacteria, viruses, parasites, or toxins and can affect infants, children, and adults. Illness is often caused by consuming contaminated foods or beverages and could result from the ingestion of a microorganism (this is often referred to as an infection) or from the ingestion of a toxin that was produced by a microorganism (often called an intoxication). A few examples of organisms that may cause foodborne illness in infants include Salmonella and Clostridium botulinum.

Salmonella

A bottle-fed infant may be at high risk for severe infections with Salmonella or other bacteria that can grow in a bottle of warm formula if it is left at room temperature for many hours. Particular care is needed to be sure that the baby's bottle is cleaned and disinfected and that leftover milk formula or juice is not held in the bottle for many hours.

C. botulinum

Botulism is a rare but serious illness that is caused by a bacteria called Clostridium botulinum. There are three main kinds of botulism: food-borne botulism, wound botulism, and infant botulism. Infant botulism is caused by consuming the spores of the C. botulinum bacteria, which then grow in the intestines and release toxin. All forms of botulism can be fatal and are considered medical emergencies. Of the approximately 110 cases of botulism that are reported on average each year in the United States, 72% of these are infant botulism. Infants with botulism appear lethargic, feed poorly, are constipated, and have a weak cry and poor muscle tone. These are all symptoms of the muscle paralysis

caused by the bacterial toxin. If untreated, these symptoms may progress to cause paralysis of the arms, legs, trunk, and respiratory muscles. The risk factors for infant botulism are poorly described, but possible sources of spores include foods and dust. Honey should not be fed to infants less than one year of age because it has been identified as a botulism source.

Summary

DISCUSSION QUESTIONS

1. You are interviewing the parents of a six-week-old infant and they tell you that the infant was sleeping alone in her crib near the top and in the middle of the mattress. They tell you that the baby rolled over and was found face down on a small pillow on the side of the crib. When the infant was found by Dad, she was unresponsive. What is unlikely about this scenario? What further questions should you ask?
2. The mother of the infant tells you she knew that her four month old was last alive when she checked on him in his crib. She said that the infant was sitting up in bed unsupported playing with his baby rattle. When she checked on him an hour later, she found him lying down face up and not breathing. What is unlikely about this scenario? What additional information do you need?
3. What are the three infant feeding periods, and when are infants typically introduced to solid foods?
4. What types of solid foods are associated with choking? Describe the types of food and give examples.
5. What are the common causes of food allergies? List the main categories of food.

SAMPLE QUESTIONS

1. Which statement is false about normal growth?
 - A. An infant's weight may drop below the 5th percentile for age when the infant starts weaning.
 - B. An infant's length often increases by 50% from birth to one year.
 - C. An infant's weight often doubles by four months and triples by one year.
 - D. A newborn loses weight in the first week of life.
2. Which of the following infants may be underweight?
 - A. Has weight-for-length greater than 95%.
 - B. Has weight-for-length less than 5%.
 - C. Has length-for-age less than 25%.
 - D. Has a weight at 50% for age.
3. Which infant's growth is abnormal and should raise concern?
 - A. A newborn who has lost weight in the first week of life.
 - B. An infant whose birth weight was 6 pounds is 12 pounds at four months of age.
 - C. An infant whose birth weight was 8 pounds is 24 pounds by 12 months of age.
 - D. A female term infant who is 8 pounds at two months or weighs less than 5% for age.
4. What infant does not need evaluation for failure to thrive?
 - A. An infant whose weight is consistently below the 5% for age.
 - B. An infant whose weight drops to below the 5% for age.
 - C. An infant whose growth has declined or stopped.
 - D. An infant whose weight is consistently at the 5% for age.

5. Developmental milestones include
 - A. Gross and fine motor skills.
 - B. Gross and fine motor, social, and language skills.
 - C. Gross motor, social, language, and cognitive skills and abilities.
 - D. Gross and fine motor, social, language, and cognitive skills.

6. Gross motor skills can be defined as
 - A. The ability to move and control large muscles in the body or groups of muscles.
 - B. The ability to move and control small muscles in the hands, fingers, neck, and head.
 - C. The ability to interact with the environment and caregivers.
 - D. Involuntary movements or reflexes that an infant is born with.

7. At what age can most infants (90%) sit?
 - A. Two months.
 - B. Six months.
 - C. Four months.
 - D. Three months.

8. At what age can most infants (90%) roll over both ways?
 - A. Five months.
 - B. Two months.
 - C. One month.
 - D. Three months.

9. What types of growth charts are available for U.S. term infants?
 - A. Weight-for-age, weight-for-length, and head circumference-for-age.
 - B. Weight-for-age, length-for-age, and weight-for-length.
 - C. Weight-for-age, length-for-age, weight-for-length, and head circumference-for-age.
 - D. Weight-for-age.

10. What infant may have a different growth pattern compared to the majority of U.S. infants?
 - A. An infant who just had a cold but is typically healthy.
 - B. An infant born at the 28th week of pregnancy.
 - C. An infant whose birth weight was 6 pounds.
 - D. An infant who was born at the 40th week of pregnancy.