

Section

4 Maintenance fluids and electrolytes

The primary focus of intravenous fluid replacement therapy is to provide for a child's maintenance and deficit fluid needs. Maintenance fluid needs are met by replacing fluids and electrolytes lost through normal body processes (for example, metabolism and respiration). Deficit fluid needs are met by replacing the fluids and electrolytes lost before therapy began. Additional fluids may be needed to replace abnormal losses that continue during therapy (for example, persistent vomiting, diarrhea, or nasogastric tube drainage).

This section shows how to calculate a patient's maintenance fluid needs. The sample problems allow you to practice your calculations.

Daily maintenance fluid needs

Daily maintenance fluids are those needed to replace:

- Insensible fluid losses from the skin and lungs.
- Urine and stool losses that result from normal metabolism.

There are many nomograms and other tables that help you determine maintenance fluid needs. Generally, these calculations are based on an estimate of a child's body surface area, body weight, or calories expended.

The most common method for calculating maintenance fluids is the Holiday-Segar method, which is based on the child's body weight. This method converts the caloric requirements of a child into free water requirements. It relies on the principle that one milliliter of water is spent for each calorie a child uses. Therefore, fluid needs can be determined directly from the calorie expenditure. Infants have higher caloric requirements per kilogram than older children. This method divides caloric (and therefore free water) needs into three categories based on body weight, as described in the table below.

Scale: Daily maintenance fluid needs	
Weight	Fluid needs per 24 hours
Newborn (0–72 hours)	60–100 ml/kg
0–10 kg (0–22 lb)	100 ml/kg
11–20 kg (24–44 lb)	1000 ml plus 50 ml/kg > 10 kg
> 20 kg (> 44 lb)	1500 ml plus 20 ml/kg > 20 kg

Example 1: An infant who weighs 5.5 kg (12 lb) requires 550 ml (100 ml x 5.5 kg) of fluid per day to meet maintenance needs.

Example 2: A 10 year old who weighs 30 kg (66 lb) requires 1700 ml [1500 ml + (20 ml/kg x 10 kg)] of fluid per day to meet maintenance needs.

Application: Calculating daily maintenance fluid needs

Instructions: Using the table provided, calculate the fluid maintenance requirement per 24-hour period for each child. Then determine the amount of fluid (in milliliters) each child needs per hour.

Scale: Daily maintenance fluid needs	
Weight	Fluid needs per 24 hours
Newborn (0–72 hours)	60–100 ml/kg
0–10 kg (0–22 lb)	100 ml/kg
11–20 kg (24–44 lb)	1000 ml plus 50 ml/kg > 10 kg
> 20 kg (> 44 lb)	1500 ml plus 20 ml/kg > 20 kg

- Megan, age 11 years

Kilogram weight = 32.7 kg (72 lb)

Fluid maintenance needed per 24 hours _____.

Fluid maintenance needed per hour _____.

- Andrew, age 2 years

Kilogram weight = 11.8 kg (26 lb)

Fluid maintenance needed per 24 hours _____.

Fluid maintenance needed per hour _____.

- Emily, age 4 weeks

Kilogram weight = 3.6 kg (8 lb)

Fluid maintenance needed per 24 hours _____.

Fluid maintenance needed per hour _____.

- David, age 7 years

Kilogram weight = 22 kg (48 lb)

Fluid maintenance needed per 24 hours _____.

Fluid maintenance needed per hour _____.

5. Sarah, age 15 months

Kilogram weight = 11 kg (24 lb)

Fluid maintenance needed per 24 hours _____.

Fluid maintenance needed per hour _____.

Application answers

All answers below are based on the Scale: Daily maintenance fluid needs table on page 31.

1. $1500 \text{ ml} + (20 \text{ ml/kg} \times 12.7 \text{ kg}) = 1754 \text{ ml per 24 hours.}$
 $1754 \text{ ml}/24 \text{ hours} = \mathbf{73 \text{ ml per hour.}}$
2. $1000 \text{ ml} + (50 \text{ ml/kg} \times 1.8 \text{ kg}) = 1090 \text{ ml per 24 hours.}$
 $1090 \text{ ml}/24 \text{ hours} = \mathbf{45 \text{ ml per hour.}}$
3. $100 \text{ ml/kg} = 100 \times 3.6 \text{ kg} = 360 \text{ ml per 24 hours.}$
 $360 \text{ ml}/24 \text{ hours} = \mathbf{15 \text{ ml per hour.}}$
4. $1500 \text{ ml} + (20 \text{ ml/kg} \times 2 \text{ kg}) = 1540 \text{ ml per 24 hours.}$
 $1540 \text{ ml}/24 \text{ hours} = \mathbf{64 \text{ ml per hour.}}$
5. $1000 \text{ ml} + (50 \text{ ml/kg} \times 1 \text{ kg}) = 1050 \text{ ml per 24 hours.}$
 $1050 \text{ ml}/24 \text{ hours} = \mathbf{44 \text{ ml per hour.}}$

The 4:2:1 rule

The 4:2:1 rule simplifies and speeds up calculations. IV fluid rates are written per hour rather than per day. Although you can divide the daily total by 24 to get the hourly rate, that can be difficult to do in your head (as it is for the authors of this book).

The 4:2:1 rule closely approximates the long route. Consider that $100 \text{ ml/kg/day} / 24 \text{ hours} = 4.2 \text{ ml/kg/hour}$ (close to 4), $50 \text{ ml/kg/day} / 24 \text{ hours} = 2.1 \text{ ml/kg/hour}$ (close to 2), and $20 \text{ ml/kg/day} / 24 \text{ hours} = 0.8 \text{ ml/kg/hour}$ (close to 1).