



Do you know your ABCs? Airway, breathing, and colour-coding!

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Summary When most emergency medical caregivers are asked about the type of patients who truly inspire fear, more often than not, the answer is ‘‘children’’. Why is there this inverse relationship between the age of the patient and the caregiver’s level of anxiety? Perhaps the answer to this question is that while emergency personnel regularly provide medical and trauma care for adults, many of us see critically ill children or pediatric trauma patients only on a rare, if not very rare, basis.^{2–6} Recognising the effect of this anxiety has led to ongoing efforts to find ways to minimise the source of these stressors. This article will review the history, present status, and hopeful future of the Broselow tape – which was initially designed to assist in the quick and accurate estimation of weight in cases of pediatric trauma – with a specific focus on its applications for pediatric trauma care.

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The past: the origins of the tape

In the years before Broselow (BB), resuscitation courses emphasised the memorisation of various numbers. Vital signs, drug dosages, and countless other numbers representing essential bits of life-saving formula, were committed to memory if only for the day of the test. Unfortunately, when the

need to recall and actually use so many numbers was critically important, memory often failed, or even worse, mistakes were made.^{7–11}

The Broselow colour-coding tape was introduced in 1986. The idea was based upon the simple concept that there must be an easier way to arrive at some of these critical numbers, especially for those who only infrequently encounter sick children.^{1,3–6,13,14} After several research studies showed that length, even better than age, approximated weight, the Broselow tape was born.^{2,12,15–17} Once the tape was developed, colour-coded resuscitation packs and crash carts followed (**Photo 1**).¹⁸

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Photo 1 Colour-coded crash cart. (Photo: courtesy of Armstrong Medical.)

As revisions and improvements were made in resuscitation medications and equipment, updated versions of the original tape were made available. In the United States, as well as in Europe and Aus-

tralia, the tape (and the accompanying education as to its proper usage) has become an integral component of pediatric resuscitation.^{16,18–27}

The present: trauma and the tape

The Broselow tape was initially designed to assist in the quick and accurate estimation of weight in cases of pediatric trauma. In recent years, it has been also used to provide guidance for determining corresponding equipment sizes and medications.³⁵

A guiding principle in trauma care is that all patients must be treated as though they have a broken neck until proven differently. Implementing this principle poses some unique challenges in terms of initial cervical and spinal immobilisation of pediatric patients. As experienced EMS providers and trauma nurses alike will testify, many pediatric cervical collars simply do not fit pediatric patients. In addition, it is often difficult to determine the appropriate size for children because they span the age and size continuum. With these considerations in mind, Jerome Medical (Moorestown, NJ) has introduced pediatric cervical collars for EMS/ED use that fit children and follow the Broselow–Luten colour-coding system (Photo 2).

Although collars are an integral part of immobilisation, it is important to remember that young children have the 'big head, little body syndrome'; that is, they have a disproportionately large head compared to their small body. While cervical collars are used to provide significant limitation of cervical motion, there is also a need to avoid potential skin breakdown, even with short-term use. In addition, it is crucial to remember that if a child is placed



Photo 2 Colour-coded NecLoc Kids collars. (Photo: courtesy of Jerome Medical.)



Photo 3 Determination of a child's colour-code with the Airway PAD. (Photo: courtesy of Jerome Medical.)

supine on a stretcher or traditional spinal board without padding, the resulting position can lead to an undesired cervical flexion and potentially contribute to airway compromise.^{21,28–31} This need for proper padding and positioning led to the introduction of the Airway PAD for pediatric patients with medical and traumatic emergencies (Photo 3).

With the Airway PAD unfolded, its first use can be to determine the colour zone of the child. Once the colour zone has been established, the Airway PAD can be folded to the appropriate height and placed under the child's back to offset the preponderant occiput that gives them their big head.^{30–33} In addition, since the child's colour zone has been identi-

fied, the Broselow–Luten system can be used for the duration of the resuscitation to determine the proper size of additional equipment and dosages of medications (Photo 4).²⁴

The importance of patient safety and prevention of medication errors has led to the development and ongoing improvement of the Broselow tape and the development of an expanded colour-coding system. It now covers a wide spectrum of therapeutic needs, including radiology and the critical area of drug administration. Recently, radiologists have adapted this concept to the medical imaging area, with the introduction of colour-coded CT scans. As the child's colour has been determined on initial

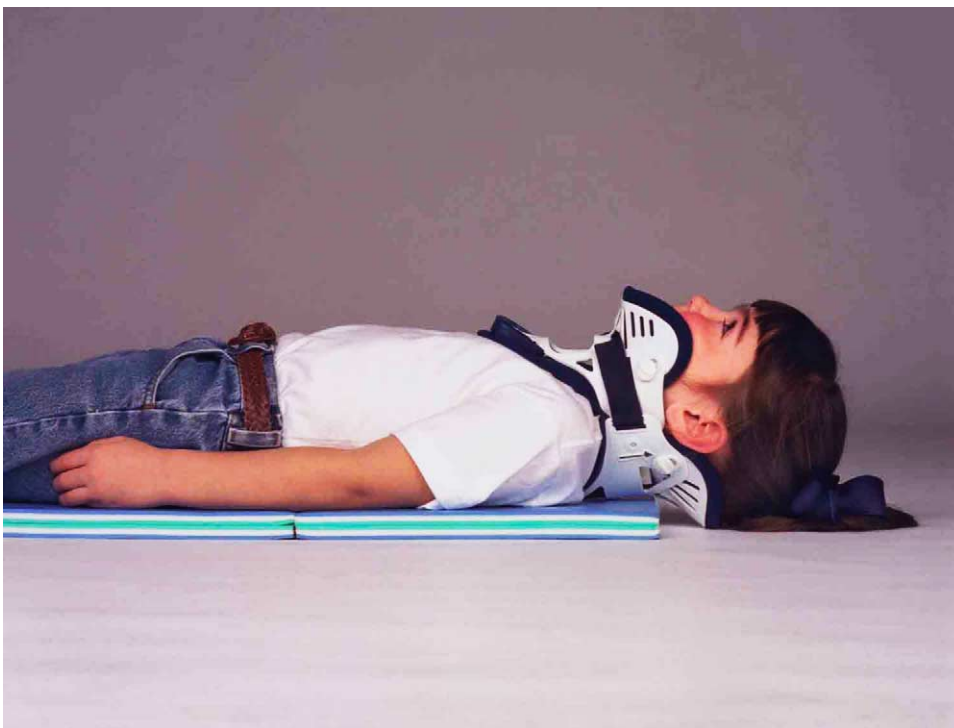


Photo 4 Use of the Airway PAD for pediatric trauma positioning. (Photo: courtesy of Jerome Medical.)



Photo 5 Colour-coded arm bands. (Photo: courtesy of James Broselow.)

admission by EMS or the ED, CT scans can now be adjusted by a well approximated body weight, allowing for the minimum appropriate amount of radiation exposure and contrast medium.³⁴

As we know, children come in all shapes, and more importantly, all sizes. Pediatric medications need to be calculated based upon the weight of the patient. The goal of this expanded portion of the Broselow–Luten system is to eliminate the undue reliance on memorisations and mathematics (M&M), which often confounds much of pediatric emergency care. The reliance on the old M&M system can lead to increased healthcare provider stress, unacceptable delays in treatment and, in the worst case scenarios, medication dosing errors.^{7–11}

In most cases of emergency resuscitation or stabilisation, the medications administered to children are the same as those for adults. The dosages, however, are dramatically different. Unlike adults, where we just give them an amp, when dealing with children, everything is weight-based and drug dosages are expressed as something per kilo. When calculations are needed, and time and increased stress are factors, even the simple placement of decimal points is crucial; a misplaced decimal point can result in a 10-fold error in medication administration.

The future: colour-coding kids

What's coming in the future for pediatric medical and trauma care? How about colour-coding kids? The idea is simple. On admission to the hospital, for whatever reason, every child from fast track to the critically ill or injured, will either be weighed and/or measured to determine their colour. If the child is not acutely ill and an accurate weight can be obtained, the colour-coding system can be used simply by finding the weight on a colour zone. However, if the child cannot be quickly and accurately weighed, the length-based method can be used to determine the approximate weight.

Once the colour zone of the child has been determined, a coloured dot can be placed on the chart. A corresponding colour coded and labeled wrist band can be placed on the patient. Thus, not only is every pediatric patient colour coded,

every pediatric chart is labeled and matched as well. If the child ever requires resuscitation, either on admission or later in the course of the hospital stay, caregivers can look at the chart or the child, note the colour zone, and grab the appropriate resuscitation bag and or equipment (Photo 5). In addition, ordering medications can also be done by colour. With pharmacy services incorporated into the colour-coding program, an order can be made, for example, for Rocephin (ceftriaxone), yellow, IVPB, q 12 hours, identifying the correct weight range of the patient and without concern for confusion between pounds and kilograms.

All common and many not so common medications, from Tylenol (acetaminophen) and antibiotics to biological warfare antidotes, are now being

EPINEPHRINE	
3 kg	0.3 mL
4 kg	0.4 mL
5 kg	0.5 mL
PINK	0.65 mL
RED	0.85 mL
PURPLE	1 mL
YELLOW	1.3 mL
WHITE	1.7 mL
BLUE	2.1 mL
ORANGE	2.7 mL
GREEN	3.3 mL
0.01 mg/mL (1:10,000)	

Photo 6 Colour-coded label for boxes of epinephrine. (Photo: courtesy of James Broselow.)

Patient Name: _____		Expiration Date: ____/____/____										
DOPAMINE											Maintenance Fluids 43 mLs/hr	
1600 mcg/mL												
mcg/kg/min	2 mcg	3 mcg	4 mcg	5 mcg	6 mcg	7 mcg	8 mcg	9 mcg	10 mcg	11 mcg		
mLs/hour	0.8 mL	1.2 mL	1.6 mL	2 mL	2.4 mL	2.8 mL	3.2 mL	3.5 mL	3.9 mL	4.3 mL		
mcg/kg/min	12 mcg	13 mcg	14 mcg	15 mcg	16 mcg	17 mcg	18 mcg	20 mcg	22 mcg	25 mcg		
mLs/hour	4.7 mL	5.1 mL	5.5 mL	5.9 mL	6.3 mL	6.7 mL	7.1 mL	7.9 mL	8.7 mL	9.8 mL		

Photo 7 Colour-coded dopamine infusion label. (Photo: courtesy of James Broselow.)

colour-coded; the colour can be used to access various information systems as well. The simplest example is a book, in print or in an electronic format for computers, with colour-coded pages. All doses are pre-calculated not only in milligrams (mg), but also in terms of the milliliters (ml) of a standard concentration and infusion rates where applicable. Syringes, resuscitation medica-

tion boxes, and i.v. infusion bags are having rainbow labels applied to them (see below), and i.v. infusion pumps are being integrated with colour-coded dosing and safeguards (Photos 6–8).

The precalculation of medication dosages has allowed the development of simplified therapeutic algorithms which address a wide variety of pediatric emergencies. Management of advanced life support

The screenshot shows a web-based interface for 'Color Coding Kids'. At the top, there is a navigation bar with color-coded tabs: Gray 3kg, Gray 4kg, Gray 5kg, Pink, Red, Purple (selected), Yellow, White, Blue, Orange, Green. The main content area is purple and contains the following information:

- Color Zone: **Purple**
- Height (cm): 75.3 - 84.75
- Weight (kg): 10 - 11
- Select Drug: **Diazepam IV Seizure**
- Concentration (mg/mL): 5
- Standard Dose (mg): 1.05
- Overwrite Standard Dose: 100% of Standard Dose (1.05 mg)

The 'Result' section is highlighted in a darker purple box and displays:

- Color: **Purple**
- Drug: **Diazepam IV Seizure**
- Dose: **0.21 mL (100% of Standard Dose)**

Photo 8 Computer colour-coding. (Photo: courtesy of James Broselow.)



Photo 9 Colour-coded Tylenol. (Photo: courtesy of James Broselow.)

resuscitation, anaphylaxis, rapid sequence intubation, seizures, burns, and many other situations will be simplified with an integrated colour-coded patient/medication system. With this approach, pediatric analgesia and sedation for procedures can be expedited as well. For home use, in addition to colour-coded car seats, a colour-coded wall chart can be paired with a corresponding colour-coded syringe to give effective home dosing of Tylenol (acetaminophen) or Motrin (ibuprofen). Guidelines designed for caregivers with limited mastery of the English language will be introduced in the near future (Photo 9).

As the colour-coding system is adopted by hospitals, can EMS providers be far behind? Many already use the system, and we can anticipate interesting radio transmissions in the future. Perhaps we will hear something like: ‘‘We’re three minutes out with a ‘Broselow Blues’ s/p a 10 meter fall . . . vitals are . . .’’. The simple addition of the colour designation can provide the receiving hospital or transport staff with some very valuable information. Not only will the facility be aware of an incoming pediatric trauma patient, but by knowing the child’s colour-code, they will be able to have appropriate medications prepared and equipment available prior to the child’s arrival.

Perhaps remembering our ABCs for pediatric patients will change in the very near future. Perhaps we will be considering ‘airway, breathing, colour-coding’.

Pediatric nursing is a challenging specialty and one that requires nurses to practice more skillfully than ever before. Increasing demands for technical skills, professional awareness, practice abilities, understanding medication orders, and knowing when to intervene to prevent medication errors are

requiring nurses to continually update their knowledge and skills. (7, p. 330)

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