Preventing Mixups With Color-Tinted Intravenous Tubing

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**PROBLEM:** Color has often been used effectively to capture attention or differentiate items, but its use in health care as a strategy for patient safety has frequently fallen short of achieving its intended results. The overuse of color-coding; an overreliance on color to identify items, rather than enhance or differentiate them; a lack of standard colors to ensure meaning; the use of too many colors to be distinguishable and memorable; and assigning a single color to multiple items that are different, but within the same general category, have exhausted many of the potentially positive attributes of using color to improve patient safety.

For example, the Institute for Safe Medication Practices (ISMP) suggests that armband colors used to communicate patient status may differ among hospitals. Despite efforts to standardize these colors within each state, staff members who have changed jobs or who work at several hospitals have misinterpreted the meaning of the color schemes used for patient armbands at different hospitals.

Several years ago, an ISMP newsletter addressed the potential for serious mixups among various drugs within a class with the use of syringes that are color-coded according to anesthesia classes established by ASTM International (formerly, the American Society for Testing and Materials). Color-coding the label and the package of whole classes of medications has also led to mixups among different ophthalmic agents or their strengths within the same class. Mixups have also occurred because there is too little difference between the colors in the color scheme.

The ISMP also published alerts about Smiths Medical ambulatory infusion pumps with color-coded screens. For these devices, the user decides which colors are associated with which types of infusions, for example, intravenous (IV) patient-controlled analgesia (PCA), epidural PCA, or subcutaneous PCA. This was another setup for mistakes because the definitions of the colors were inconsistent.

In another case, the ISMP described an oral liquid medication that was administered intravenously. This occurred because the purple connector for enteral use at this hospital was the same shade of purple used with C. R. Bard's peripherally inserted central catheter (Power PICC) IV connectors.

Another example of the use of color to improve safety involved a company that produces color-tinted IV tubing. A system of tinted IV lines produced by ColorSafe IV Lines (www.colorsafelivelines.com) offers gravity-drip IV administration sets in a variety of colors—orange, red, pink, purple, violet, green, yellow, and blue. The sets are to be used in combination with corresponding wrap-around colored labels, which are provided with each tubing set. It is unclear how these sets could be used with infusion pumps, although the manufacturer explained that the tubing could be used for pumps that allow the use of nondenicated administration sets (e.g., some types of syringe pumps).

The company correctly pointed out that tubing misconnections are a risk that increases as the number of parenteral, epidural, and enteral lines attached to the patient increases. The company assumes that health care practitioners can distinguish the lines from each other more easily and can trace the colored IV tubing from the patient to the source bag with a similarly colored label.

On the plus side, the colored tubing might very well be helpful in tracing an IV line from bag to point of catheter insertion. However, clinicians who are aware of any problems associated with color-coding or color differentiation of health care products should carefully evaluate the product before considering it for use.

**Color memory.** Human factors studies have established that people have poor memory recall of specific colors, particularly with shades of similar colors such as purple, blue, and violet. People generally do not discern subtle distinctions in color unless the colors are adjacent to each other. Without efforts to boost memory, people also tend to remember the meaning of only a small set of colors. Thus, color-coding that involves an extensive line of colors, such as those used for ophthalmic agents, might not be memorable or distinguishable.

**Color mix-ups.** With color-tinted IV tubing, yellow tubing may look too similar to epidural tubing, which features a yellow stripe running down its length. Clear tubing that is used to infuse a solution of multivitamins, antibiotics, or antifungal

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**Definitions**

**Color-coding:** the systematic, standard application of color to aid in classification and identification. One example is the black cap on all vials of potassium chloride concentrate injection. No other products can use black caps; therefore, all practitioners can identify a drug vial with a black cap as potassium chloride concentrate.

**Color enhancement and differentiation:** the use of color to make certain features, such as a warning, stand out or to distinguish one item from another. For example, one company’s vaccine for adults is packaged in an orange box, whereas a pediatric formulation is packaged in a blue box. The color itself, however, is not a standard code applied systematically to classify and identify the product, as with color-coding.
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drugs may look similar in color to the yellow-tinted tubing. Red and blue chemotherapy products infused through clear lines may resemble color-tinted tubing that has been assigned to a different drug or class of drugs.

The meanings of various tubing colors, as assigned by a hospital, may differ from some longstanding color schemes, such as a color code that is assigned to certain drugs used with labels applied by an anesthesiologist. The color tint of the tubing may look different than expected if it contains an opaque white solution or a solution with color, although ColorSafe IV Lines says that the labeling recommends using clear solutions only.

A red drug like DOXOrubicin may give yellow tubing an orange tint. Purple or violet tubing may lead to an accidental association with enteral equipment or Power PICC vascular tubing (C. R. Bard). In addition, a nurse could attach a different colored tubing to an IV bag dispensed from the pharmacy with a color-coded label, potentially causing confusion, tubing misconnections, or administration of a drug through the wrong access port.

Color misperception. Some performance-shaping factors, such as a patient’s dark room at night or color blindness in a staff member, can result in misperceptions of colors that are assigned to health care products.

Lack of color standardization. For the most part, the various colors used in health care are not standard. Because of the lack of a universal definition for colors, one company was allowed to produce purple enteral equipment and another company (C. R. Bard) produced purple PICC lines.

Variations in color can also occur within the same health care system (e.g., two units using different-colored pump screens for the same drug) and among different health care systems (e.g., two hospitals using different color-tinted IV tubing for the same drug). Both situations can lead to harmful mixups by reassigned, temporary, or new employees.

Substituting a clear color or a different color of tubing for the intended color during a temporary shortage can also lead to errors. In short, color as a safety feature cannot be relied on until all facilities agree on its meaning and appropriate use.

Safe Medication Practices. Relying on color-coding to ensure patient safety can instill a false sense of security in a high-risk industry like health care. Without careful consideration of the risks, the use of color has led to unintended and sometimes harmful consequences. It is generally agreed that color enhancement and differentiation are more effective than color-coding.1-4 Thus, color should never be used as the primary means of identifying items; it should be used only to help locate and differentiate items.

The meaning of a specific color should be the same in all health care settings, and each color should represent a distinct single entity (e.g., not a whole class of drugs). The overuse or misuse of color as a safety feature in health care can only reduce its effectiveness; therefore, color should be used sparingly and carefully.5,6

REFERENCES


