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International variances in carbon dioxide absorbent colour indicators

To the Editor:

We recently provided general anesthesia to 16 children undergoing patent ductus arteriosus repair at the Angkor Wat Hospital for Children in Siem Reap, Cambodia. Prior to the first surgery, a thorough machine check was conducted, which demonstrated proper functioning of all elements, including the CO_2 absorbent, which was uniformly white in colour. Midway through the first case, it was noted that in spite of adequate minute ventilation with a tidal volume of 10 $mL \cdot kg^{-1}$, that the $PETCO_2$ ranged from 50–55 mmHg, and that during inspiration the $PETCO_2$ decreased to only 12 mmHg. We suspected incomplete CO_2 absorption.

Upon investigation, and much to our surprise, we learned that the fresh Spherasorb CO_2 absorbent (Intersurgical Ltd., Wokingham, UK) was pink in colour and turned white with exhaustion. After the CO_2 canister was filled with fresh soda lime, the patient's hypercapnia resolved. The confusion originated from our assumption that fresh CO_2 absorbent is always white, which is the case at our home institution, in San Diego, California. In fact, Spherasorb has two types of indicators: one that changes from white to violet, and one that changes from pink to white. In contrast, Baralyme (Chemtron Medical Division, Allied Healthcare Products, St. Louis, MO, USA) has a single formulation that turns the crystals from white to violet with exhaustion.

It appears that the two colour schemes (pink to white, and white to violet), developed independently of each other many decades ago, as different pH sensitive dyes were used as markers for exhausted absorbent. While the American and European manufacturers chose the white to violet route (using ethyl violet dye), in the United Kingdom the pink to white option is employed (using titan yellow dye).[1]

According to Intersurgical Ltd., countries that use soda lime with a pink to white colour change include: the United Kingdom, much of Australia, New Zealand, India, Pakistan, Bangladesh, Hong Kong (which influenced China), Indonesia, Malaysia, and Sri Lanka. (all countries with a British colonial link.) Most other countries use soda lime that turns from white to violet with absorbent depletion. An additional factor to consider is that the pH and the resulting strength of colour depends on the moisture content of the exhausted soda lime. Higher exhaustion moisture content, as seen with low flows and large absorbers, results in a higher pH and weaker colour change.[2,3] In addition, if the soda lime remains in the absorber for 10–48 hr, some of the NaOH regenerates and the pH increases, changing the colour of the soda lime back to its "fresh" appearing colour. This is often mistaken for a regeneration of CO_2 absorbing potential. Also, desiccated baralyme may turn a yellow colour,[4] further complicating the use of colour as a visual reference to the adequacy of absorbent capacity. Thankfully, the use of capnography allowed us to search for, and solve the problem. The experience highlighted the importance for anesthesiologists undertaking work overseas, to recognize international variances in CO_2 colour indicators and the need to identify the indicator as part of the routine preoperative machine check.

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Fast-track ambulatory anesthesia: impact on nursing workload when analgesia and antiemetic prophylaxis are near-optimal

To the Editor:

We were very interested in reading the excellent publications of Dr. Song *et al.*[1] and Dr. Awad *et al.*[2] from Dr. Chung's research group addressing bypass of the postanesthesia care unit (PACU bypass) after

ambulatory surgery. Specifically, they advise that PACU bypass may merely shift nursing workload from the PACU to the phase 2 recovery unit (P2RU). As background, we originally reported in knee surgery outpatients that in addition to PACU bypass [odds ratio (OR) = 2.9], other factors were independently associated with the need for at least one P2RU nursing intervention, including general anesthesia with volatile agents (OR = 1.5), and receiving indicated nerve blocks (OR = 0.6).[3] We later reported that PACU bypass was independently associated with approximately $400 cost savings to the hospital, per knee surgery outpatient having undergone anterior cruciate ligament reconstruction.[4]

In our 2002 report,[3] we overlooked the variable of multimodal antiemetic prophylaxis and the specific effect of postoperative nausea and vomiting (PONV) on P2RU workload. We later reported[5] that multimodal antiemetic prophylaxis with two or more agents (perphenazine and dexamethasone in over 90% of cases) reduced all postoperative nursing interventions for PONV after regional anesthesia. It seems unlikely that multimodal antiemetic prophylaxis would increase P2RU workload, and the use of volatile anesthetics associated with increasing P2RU workload has already been established in our retrospective study[3] and in the 2004 prospective study by Dr. Song *et al.*[1]

We also need to reiterate that our original report[3] addressed only outpatient knee surgery, and that not all outpatient orthopedic surgery is knee surgery (knee pain originates from 1, 2, or 3 nerves). Outpatient shoulder surgery in our institution is routinely performed under interscalene nerve block and propofol infusion without volatile agents or airway devices. We previously reported[5] that this care plan was associated with a 9% PONV rate (13/146) when perphenazine and dexamethasone were used as multimodal antiemetics, and a 16% (50/303, $P < 0.005$) PONV rate when one or fewer antiemetics were used. After additional query of our original database of these 449 shoulder surgery outpatients, we found that PACU bypass rate was 94%. There was no associated increase in the need for any P2RU nursing interventions after PACU bypass, but this finding is likely underpowered due to the low incidence of PACU admission. However, antiemetic prophylaxis with perphenazine and dexamethasone in these patients was associated with a reduced need for P2RU intervention by 50%. Hospital discharge times were 162 min (151, 173, 95% confidence interval) in patients receiving perphenazine-dexamethasone, *vs* 178 min (169, 186; $P = 0.034$) in patients who did not receive perphenazine-dexamethasone. These anecdotes from our quality-control database query are not peer reviewed. These data should not be interpreted as anything except reasonable justification for continued hypothesis testing regarding the role of volatile agent avoidance and multimodal antiemetic prophylaxis, in an effort to achieve both PACU bypass, without additional increases in P2RU workload.

We are not surprised by findings of authors such as Dr. Song *et al.* that PACU bypass leads to increased P2RU workload both after general anesthesia,[1] and in the absence of a routine peripheral nerve block that would provide near-complete analgesia for the area of surgical trespass.[1] We also believe that success with PACU bypass (i.e., preventing downstream workload) may be improved by the routine administration of multimodal antiemetics, regardless of calculated risk.[5] Further study is encouraged.

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