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Review article

Perioperative care of patients with epidermolysis bullosa: proceedings of the 5th international symposium on epidermolysis bullosa, Santiago Chile, December 4–6, 2008

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Summary

Epidermolysis bullosa (EB) has become recognized as a multisystem disorder that poses a number of pre-, intra-, and postoperative challenges. While anesthesiologists have long appreciated the potential difficult intubation in patients with EB, other systems can be affected by this disorder. Hematologic, cardiac, skeletal, gastrointestinal, nutritional, and metabolic deficiencies are foci of preoperative medical care, in addition to the airway concerns. Therefore, multidisciplinary planning for operative care is imperative. A multinational, interdisciplinary panel of experts assembled in Santiagio, Chile to review the best practices for perioperative care of patients with EB. This paper presents guidelines that represent a synthesis of evidence-based approaches and the expert consensus of this panel and are intended to aid physicians new to caring for patients with EB when operative management is indicated. With proper medical optimization and attention to detail in the operating room, patients with EB can have an uneventful perioperative course.

Keywords: pediatric anesthesia; epidermolysis bullosa; peri-operative

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Introduction

Epidermolysis Bullosa (EB) is a group of disorders that are traditionally thought of in terms of their dermatologic presentation. It has become clearer in recent years that EB has systemic effects, many of which create the need for operative treatment and several of which can have significant impact on perioperative care. A multidisciplinary group of international experts gathered in Santiago, Chile on December 4–6, 2008, to explore best practices for perioperative care in patients with EB. In the absence of controlled trials, the guidelines presented herein represent a synthesis of evidence-based approaches and the expert consensus of this panel and are intended to aid physicians new to caring for patients with EB when operative management is indicated.

Epidermolysis bullosa

EB is caused by genetic mutations in one of thirteen different genes that encode structural proteins that provide mechanical adhesion between the epidermis and dermis (1). All forms of the disease have skin fragility in common, resulting in blisters and erosions, and often secondary infection. Three major types of EB are recognized: epidermolysis bullosa simplex (with intraepidermal blistering), junctional epidermolysis bullosa (JEB) (separation at the level of the lamina lucida), and dystrophic epidermolysis bullosa (dermal blistering just beneath the lamina densa) – which includes both dominant dystrophic epidermolysis bullosa and recessive dystrophic epidermolysis bullosa (RDEB) subtypes. In the most recent consensus classification of EB (1), Kindler syndrome is recognized as a fourth type, termed mixed EB (because of the variable cleavage plane observed). In the more severe and generalized forms of EB, especially RDEB, multiple problems may arise from sequellae of scarring and retraction: microstomia, corneal abrasions and scarring, phimosis, meatal stenosis, pseudosyndactyly, and esophageal strictures. As a result, many patients develop oral mucosal blistering, poor dentition, nutritional compromise eventuating in anemia, failure to thrive, osteopenia, osteoporosis, and dilated cardiomyopathy (2–6) Patients with RDEB are prone to fusion of the digits and severe contractures and 'cocoon' hands. From the second decade of life, patients have a greatly increased risk of developing aggressive and multifocal cutaneous squamous cell carcinomas that are the major cause of death in this group (7). Patients with JEB, especially the more severe Herlitz form, may have laryngeal mucosal involvement and require tracheostomy. Patients with JEB and RDEB are also at risk of developing bladder and kidney involvement and may need urological procedures (6). Thus, there are multiple reasons why these patients may require surgical intervention.

Preoperative evaluation

Patients with EB have a number of important issues to address in the preoperative evaluation. If possible, seeing these patients in consultation a week or two ahead of the operative date is useful because it allows data to be collected and consultation to occur in an unhurried manner that does not risk delaying surgery. Several specific issues will be addressed on a system-by-system basis.

Airway assessment. Careful evaluation of the airway is critical. As illustrated in Figure 1, the airway examination should focus on five areas of concern. First, the mouth opening may be limited, both in vertical and horizontal aspects. This, combined with an overjet (often called overbite), can make tradi-

Figure 1
Typical epidermolysis bullosa airway presentation. Note reduced width of mouth, minimal vertical opening, poor dentition, and ankyloglossia.

tional laryngoscopy and intubation impossible. This becomes more of an issue as the children grow toward adolescence but can occur earlier. The second issue concerns dentition, which can be poor – with caries and overcrowding of the teeth (8,9). Third, the inherent fragility of the skin and mucosal surfaces means that manipulation of the face, buccal mucosa, and gums during airway management needs to be attended to most carefully, and preexisting lesions should be noted. Fourth, ankyloglossia can be pronounced, such that the patient may have little to no tongue movement. In combination with minimal soft tissue bulk, ankyloglossia usually means that although intubation may be difficult, mask ventilation is typically maintained without trouble. Lastly, glottic stenosis may occur from prior airway manipulations and may further compromise the ability to secure the airway. Patients with JEB may be at higher risk for subglottic stenosis, as well as choanal and nasal stenosis, and excessive peritracheal and intranasal granulation tissue (10).

Cardiac evaluation. Increasing evidence for dilated cardiomyopathy has accumulated for patients with RDEB (2–4). The cause may be metabolic, related to selenium or carnitine deficiencies, although this is not firmly established. A number of EB centers have begun echocardiographic screening on an annual basis. Patients with RDEB presenting for anesthetic care should have had an echocardiogram within the past year. If significant findings were present, then consideration should be given to repeating the exam more proximately to the operative date. There is not a known method to optimize cardiac function, beyond standard measures for treatment of dilated cardiomyopathy and optimizing nutritional status. However, this evaluation allows more accurate risk assessment and planning.

Positioning evaluation. Many patients with EB will have joint contractures in addition to the more obvious skin lesions; improper positioning increases risk for damage to the skin. Preoperative evaluation should include positioning and padding assessment of specific needs of particular joints and areas of concern such as especially extensive or painful wounds or blisters. Feasibility of regional anesthesia at a given anatomic site should also be assessed. Regarding intravenous access, skin lesions and joint contractures may limit sites for cannulation. Further, the patient or family may have preferences for tapes, padding or other products with which they have had success, and this is an important piece of the history to consider in setting up IV access and positioning.

Induction readiness. For younger patients, compliance with induction is not assured. Given that a smooth, atraumatic induction is optimal, discussion with parents should include appropriateness for parental presence at induction, sedation or a combination. Data suggest that parents serve their child best if they are a calming force at induction (11,12). Otherwise, planning should focus on preoperative sedation, with something like midazolam.

Aspiration risk. Patients with EB have a higher risk for gastroesophageal reflux. Those with esophageal structures may have pooled secretions and particulate matter that put them at risk for aspiration. If the patient is not taking a proton pump inhibitor, then the use of one or provision of an H2 blocker should be considered. A nonparticulate antacid can be considered for those patients at high risk who are compliant enough to take it or who have gastric access via a gastrostomy tube.

Preparation of the operating suite

Although patients with EB do not require any specific anesthetic, meticulous care in the operating suite is required for the safe management of patients with EB. Perioperative preparation focuses on the physical and logistical aspects of OR care. First of all, the room needs to be warmed, as patients with EB are at risk for heat loss because of their skin lesions and often low body mass index, with a dearth of subcutaneous fat. Infection after orthopedic surgery is always a concern for osteomyelitis and cutaneous infection, and maintaining euthermia as part, overall homeostasis seems to reduce the risk of surgical site infection in the general population (13). The operating table needs to be extensively padded: the use of 'egg crate' foam padding works well and often the padding can be placed on the gurney in the preoperative area so that the patient is transported already in position and then transferred to the OR

table *en bloc*. This maneuver reduces trauma from repeated movement. Alternatively, plans can be made for the patients (alone or with their parents' aid) to transfer themselves to a previously padded OR table, allowing them to control movement and reduce the risk of inadvertent shearing of the skin. Enough padding should be available to support contracted joints (see Figure 2a). A 'kit' for patients with EB can be made, if repeated anesthetics are foreseen (Table 1).

Preparation for intubation will depend on the condition of the airway as found preoperatively. Endotracheal tubes should be at least 0.5 mm smaller than anticipated for age. Water-based lubricants should be available for airway equipment, especially the mask and laryngoscope blade. Methylcellulose-based gel or drops without lanolin, petrolatum or preservatives should be applied to the eyes. Intravenous access can be difficult, and ultrasound availability may be useful in securing percutaneous peripheral or central lines.

Figure 2
(a) Proper padding and maintaining warmth in the operating room. (b) Atraumatic fastening of the endotracheal tube and electrocardiographic leads.

Table 1
Contents of a perioperative epidermolysis bullosa kit*

Clip-style pulse oximeter probe
Methylcellulose eye lubricant
Silicone-based bandage (Mepilex® 15 × 15 cm
Silicone-based tape (Mepitac®) 2 cm × 3 m
Silicone-based bandage (Mepitel®) 20 × 30 cm
Cotton 'tape' Roll, 1 cm width
Water-based lubricant
Self-sticking wrap (Coflex®) 5 cm width
Gauze roll 8.5 cm width
Adhesive remover, silicone-based such as Siltac®

*Padding for the gurney and operating table such as foam 'egg crates' should be kept available but are too large for a kit format.

Intraoperative management

Basic anesthetic care will be reviewed. Given a paucity of data from the literature, the approach to intraoperative care is based on a solid understanding of the pathophysiology of EB. Please see Table 2 for specific anesthetic and surgical concerns for particular procedures.

Induction. The basic principle is to induce anesthesia without causing agitation that can lead to excessive movement and skin damage. If an intravenous line is present, it may be productively used to provide rapid, nontraumatic induction. An inhalational induction should proceed with a particularly gentle approach. Of note, although intubation is often difficult, maintenance of a mask airway is not. However, as swelling of or blister formation around the glottis can cause obstruction of the airway, avoidance of the muscle relaxation until the airway is secured may be prudent. Awake, fiberoptically guided intubation can be considered in patients old enough to cooperate, although this is not usually necessary.

Positioning. The patient should be placed with the extremities in as neutral a position as possible given the high degree of contractures. Support can be achieved with rolls of sheets or towels. The head should be supported and cushioned to prevent blistering or pressure necrosis.

Table 2
Considerations for specific operative procedures

Procedure	*Considerations*
Esophageal dilatation	Aspiration risk because of accumulation of secretions and particulate matter proximal to stricture, reflux of gastric contents unlikely; careful suction at the end, as blood and secretions often accumulate, fluoroscopic monitoring. Balloon dilatation reduces risk for esophageal erosions, and bougie technique may put patients at higher risk for scarring (18)
Dental rehabilitation/extraction	Nasal intubation may be preferable to reduce trauma from sharing the oral cavity between dentist and anesthesiologist; down-size the endotracheal tube
Feeding gastrostomy	Percutaneous approach, without endoscopic assistance, reduces risk for esophageal erosions (19)
Whirlpool debridement	Minimal ability to electronically monitor, use natural airway because of frequent treatments, IV or central lines to be kept above water line; room temperature 25–28°C; intravenous anesthetic
Hand/foot surgery	Consider regional anesthesia for postoperative analgesia, especially for amputations; consider SSI* protocol

*SSI, surgical site infection.

Monitoring. Direct contact of the skin with all types of adhesive tape is contraindicated. All forms of monitoring can be used in patients with EB, although some creativity is required. Nonadhesive (clip-on) pulse oximetry should be used, and because of mitten deformities of the extremities, the ear, nose or lip may be preferred monitoring sites. A layer of cotton padding should underlay the blood pressure cuff. The interval of cuff inflation may be extended, although simple inflation of the cuff does not pose risk to the skin, because it does not create shear forces. Electrocardiographic (ECG) leads should have the adhesive rim removed and be applied to a clear portion of skin on the chest. Needle electrodes provide another means of ECG monitoring. Silicone-based products (e.g. Mepiform™, Mepitac™; Mölnlycke Health Care, Norcross, GA, USA) should be used to ensure solid lead contact and to secure peripheral venous lines. Adhesive surfaces of grounding plates should be removed. Figure 2b demonstrates nontraumatic securing of the endotracheal tube with Mepitac™. Arterial lines should be sutured in place, and nonadhesive dressing used, as for peripheral venous lines. As new adhesive removing products are developed, such as those with a silicone base, use of standard adhesive dressings may become possible.

Eye protection. Because of recurrent eyelid scarring, patients with EB often have difficulty closing their eyes, and adhesive tape normally used to secure the eyelids is contraindicated. Therefore, it is recommended to use a moisturizing ophthalmologic gel, preferably free of preservatives or lanolin, immediately after induction. Methylcellulose-based products are preferred over petroleum-based products. The latter can be irritating, and do not clear from the eyes, so that patient will wake up with blurred vision and rub at their eyes, with the potential for corneal abrasions. After application of the gel, covering the eyes with moistened gauze further maintains moisture on the corneas and protects the eyes from mechanical trauma.

Airway management. The mask airway is usually well tolerated in patients with EB because of minimal soft tissue bulk, and ankyloglossia, which reduces the chances of upper airway obstruction. There are two major skin-friendly approaches to mask airway management. The first requires that copious lubricant be placed on the mask and the anesthetist's gloves to reduce friction on the face. All equipment used for airway management is likewise lubricated. The second technique is to apply silicone-based tape or patches and padding to the facial skin surfaces most likely to come in contact with the mask or anesthesiologist's hands. In this second technique, the mask and physician's hands do not need to be lubricated (see Figure 3a,b).

For the first several years of life, direct laryngoscopy is usually straightforward. As the patients approach adolescence, the severity of microstomia

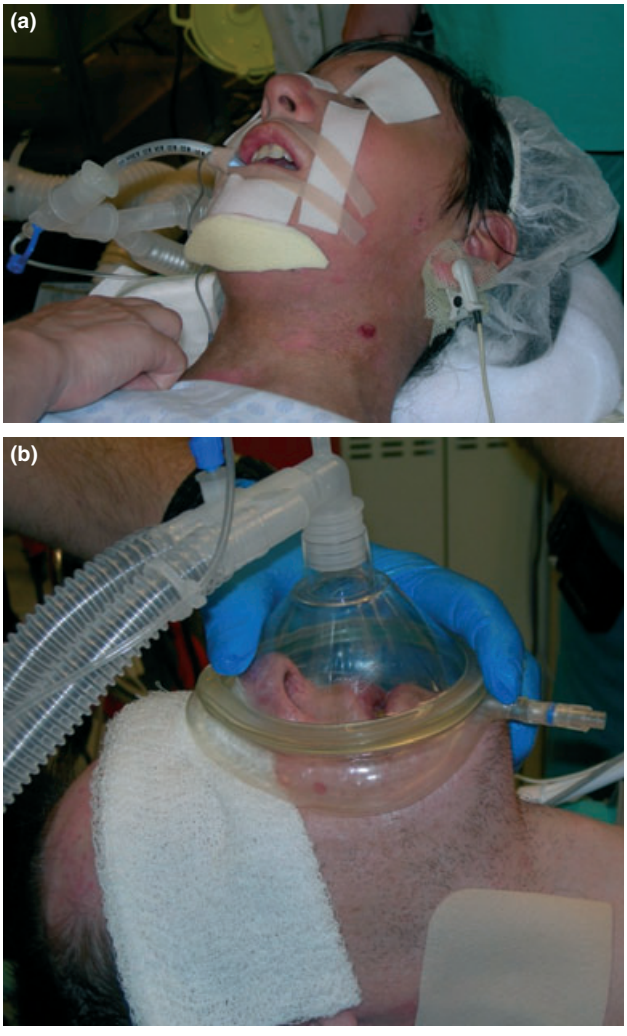

Figure 3
(a) Preparation of the airway – barrier method. (b) Lubrication method.

increases, and alternative means of securing the airway need to be pursued. If a patient is a candidate for direct laryngoscopy, the blade should be well lubricated and applied with minimal movement, once contact with the mucosa is made. Should repositioning be needed, the blade needs to be lifted off the tissues before moving it. The endotracheal tube (ETT), with or without a cuff, should be lubricated and inserted with minimal contact with the soft tissues. There may also be edema or stenosis of the upper airway secondary to gastroesophageal reflux. Nasal intubation may be used (especially for dental work), although a smaller than predicted ETT should be used. Warming it will soften the tube, allowing more gentle passage. Laryngeal mask airways have been used successfully in patients with EB and provide an alternative means of maintaining an airway, but must be done with caution to avoid mucosal trauma from shear forces generated by placement or removal. Finally, given that upper airway obstruction is uncommon in patients with EB, a natural airway with nasal cannula or blow by oxygen is a viable option if reflux is not a feature of the patient's history.

Fiberoptic-assisted intubation is frequently required in older patients. It may be useful to examine the periglottic area with the fiberoptic scope after intubation, for trauma that may affect the airway after extubation; blisters or loose soft tissue at the glottic opening can cause obstruction once the ETT is removed. Findings should be treated prior to extubation. If trauma is extensive, consideration should be given to keeping the patient intubated until the trauma resolves. Deep extubation has the advantage of preventing the patient from gagging on the ETT and causing trauma. However, caution should be taken if the airway management is difficult: the patient may need to be awake and able to maintain and protect the airway, especially with a heightened risk for aspiration of blood or gastric contents (especially after otorhinolaryngologic or esophageal procedures). Oral airways should be used with caution, if at all, because of the risk of mouth and airway blistering. All equipment should be well lubricated. Patients who are undergoing esophageal dilatations or airway endoscopy receive intravenous dexamethasone 0.25–0.5 $mg \cdot kg^{-1}$ (maximum dose 12 mg). This is part of a 5 -day perioperative steroid regimen to reduce postoperative laryngeal and pharyngoesophageal swelling.

Maintenance. It is important that standard general anesthetic care is maintained. Although patients with EB do not require a specific anesthetic technique, an intravenous anesthetic may be useful in possibly reducing agitation and emesis in the recovery room, if venous access will allow. For certain procedures, where infection is a particular risk, use of a surgical site infection protocol may be worth considering. Elements include maintaining a high FiO2 (FiO2 >0.6 for children) with postoperative supplementation of oxygen for 4 h, warm core

temperature (>35.5°C preincision and throughout the case) (14), properly timed antibiotics (0–60 min prior to incision, although if a tourniquet will be used, then tissue antibiotic levels should be attained prior to inflating the tourniquet) with re-dosing per CDC recommendations for each drug. Data are accumulating for the use of this approach in other, major procedures (15,16); the technique has few, if any, downsides. If an opioid-based postoperative analgesic plan is in effect, one should account for preoperative opioid use and tolerance, because use of these medications for chronic pain is common. Failure to do so will preclude attaining good analgesia. Use of nonsteroidal, anti-inflammatory drugs can be very helpful, although increased oozing from skin wounds may be seen if NSAIDs are used frequently on an outpatient basis, and patients need to report if they have used them and had bleeding problems in the past.

Regional anesthesia. Regional anesthesia has been used in this population for many years (17–19). Because of the problems with airway management discussed above, regional anesthesia may be a good alternative, especially in cooperative adult patients. Many reconstructive operations, such as hand releases, are appropriate for intraoperative and/or postoperative regional analgesia. Anatomic landmarks are generally good, and care needs to be taken regarding the condition of the skin at the site of injection. Indwelling catheters can be quite useful (20). Placement is the same as for any patient, although sutures, not tape, should be used to secure the catheter, under nonadhesive dressings (Mepitac™, Mepiform™). Patients are often underweight and dosing should proceed based on weight, as for pediatric patients, even if the patient is an adult.

Emergence. Two major principles need attention. First, agitation and uncontrolled movement should be avoided. If an inhalational technique has been used, then dosing propofol, opioid or lidocaine intravenously may smooth emergence and reduce the agitation that is commonly seen in the younger patients. Careful suctioning should be performed prior to extubation to avoid aspiration of blood and secretions. Blind suctioning should not be performed, and soft catheters are preferred. Extubation is discussed previously.

Postoperative care

Recovery room issues. Young patients generally seem to have more issues with agitation during emergence (21), so care must be taken to avoid skin trauma. If the patient seems to have blurred vision or discomfort with the eye lubricant, then the eyes should be rinsed clear, and the patients prevented from scratching their corneas. Otherwise, pain, respiratory function, and recovery of mental status should be attended to as with any other patient.

Postoperative steroids. At the CCHMC center, steroids are started postoperative day 1, using oral or gastrostomy-administered liquid prednisolone for a 5 -day course (22), beginning with 1 $mg{\cdot}Kg^{-1}$ and decreasing the dose daily. This regimen seems to increase the interval between esophageal dilatations as well as providing an appetite stimulus for these patients. Anecdotally, some of the families report that the patient's skin improves for a period of time after the brief steroid course. Protracted steroid use is not recommended in these patients because of the myriad of detrimental effects when used long term.

Postoperative wound care. There are often areas of epithelial denudation adjacent to incisions that require meticulous wound care to diminish the risk of a surgical site infection. Truncal surgical sites are dressed with nonadhesive dressings (Mepilex ™, Mepilex Lite™, Mepilex Border™, Mepilex Transfer™; Mölnlycke Health Care) and replaced at least daily or more often if soiled. Larger wound sites and some hand dressings are more complicated and may require conscious sedation or general anesthesia to perform a comfortable dressing change.

Pain management. Pain management in EB has been reviewed in detail (23). Many patients with EB will have been on opioid medication for chronic pain, or for their dressing changes and baths. Therefore, dosing postoperative pain management will need to account for their tolerance. The amount of opioid that the patient took preoperatively should be provided as a baseline, and treatment of the new, postoperative pain is in addition to that. Even so, the additional dosing can be higher than expected, so titrating the opioids until the patient becomes comfortable and calculating the doses from that

point can be a useful technique. Itching can be significantly increased by opioids, so a multimodality approach can be useful. NSAIDs, acetaminophen, regional analgesia, and cognitive-behavioral techniques should all be utilized. Regional analgesia can be provided by single-dose nerve blocks or continuous infusions. If a single dose is administered, plans must be made for the transition from the numbness to pain, which can be a significant one, and patients should receive analgesics early into the phase wherein the block wears off. Continuous regional infusions can be used for up to a few days, providing that the insertion site looks clean, there is no fever or other sign of infection. After a few days without pain, the transition may not be as dramatic as with a single-dose nerve block, but the transition to other analgesics should be attended to carefully.

Summary

Patients with epidermolysis bullosa require special and extensive preoperative evaluation, preparation, and intraoperative management. Patients with different subtypes or severity of EB may require some relatively minor differences in perioperative care, but avoiding trauma to the skin, eyes and mucosa is paramount. Anemia and nutritional and metabolic deficiencies are foci of preoperative medical care. Intravenous access and airway management pose technical challenges. With proper medical optimization and attention to detail in the operating room, patients with EB can have an uneventful perioperative course.

References

1 Fine JD, Eady RA, Bauer EA *et al.* The classification of inherited epidermolysis bullosa (EB): Report of the Third International Consensus Meeting on Diagnosis and Classification of EB. *J Am Acad Dermatol* 2008; **58:** 931–950.

2 Fine JD, Hall M, Weiner M *et al.* The risk of cardiomyopathy in inherited epidermolysis bullosa. *Br J Dermatol* 2008; **159:** 677–682.

3 Sidwell RU, Yates R, Atherton D. Dilated cardiomyopathy in dystrophic epidermolysis bullosa. *Arch Dis Child* 2000; **83:** 59–63.

4 Oh SW, Lee JS, Kim MY *et al.* Recessive dystrophic epidermolysis bullosa associated with dilated cardiomyopathy. *Br J Dermatol* 2007; **157:** 610–612.

5 Fine JD, Mellerio JE. Extracutaneous manifestations and complications of inherited epidermolysis bullosa: part II. Other organs. *J Am Acad Dermatol* 2009; **61:** 387–402. quiz 403–384.

6 Fine JD, Mellerio JE. Extracutaneous manifestations and complications of inherited epidermolysis bullosa: part I. Epithelial associated tissues. *J Am Acad Dermatol* 2009; **61:** 367–384. quiz 385–366.

7 Fine JD, Johnson LB, Weiner M *et al.* Epidermolysis bullosa and the risk of life-threatening cancers: the National EB Registry experience, 1986–2006. *J Am Acad Dermatol* 2009; **60:** 203–211.

8 De Benedittis M, Petruzzi M, Favia G *et al.* Oro-dental manifestations in Hallopeau-Siemens-type recessive dystrophic epidermolysis bullosa. *Clin Exp Dermatol* 2004; **29:** 128–132.

9 Wright JT, Fine JD, Johnson L. Hereditary epidermolysis bullosa: oral manifestations and dental management. *Pediatr Dent* 1993; **15:** 242–248.

10 Liu RM, Papsin BC, de Jong AL. Epidermolysis bullosa of the head and neck: a case report of laryngotracheal involvement and 10-year review of cases at the Hospital for Sick Children. *J Otolaryngol* 1999; **28:** 76–82.

11 Kain ZN, Caldwell-Andrews AA, Maranets I *et al.* Predicting which child-parent pair will benefit from parental presence during induction of anesthesia: a decision-making approach. *Anesth Analg* 2006; **102:** 81–84.

12 Kain ZN, Mayes LC, Caramico LA *et al.* Parental presence during induction of anesthesia. A randomized controlled trial. *Anesthesiology* 1996; **84:** 1060–1067.

13 Kurz A, Sessler DI, Lenhardt R. Perioperative normothermia to reduce the incidence of surgical-wound infection and shorten hospitalization. Study of Wound Infection and Temperature Group. *N Engl J Med* 1996; **334:** 1209–1215.

14 Sessler DI. Non-pharmacologic prevention of surgical wound infection. *Anesthesiol Clin* 2006; **24:** 279–297.

15 Bratzler DW, Houck PM. Antimicrobial prophylaxis for surgery: an advisory statement from the National Surgical Infection Prevention Project. *Am J Surg* 2005; **189:** 395–404.

16 Leaper D, Burman-Roy S, Palanca A *et al.* Prevention and treatment of surgical site infection: summary of NICE guidance. *BMJ* 2008; **337:** a1924.

17 Kelly RE. Regional anesthesia in children with epidermolysis bullosa dystrophica. *Anesthesiology* 1988; **68:** 469.

18 Sopchak AM, Thomas PS, Clark WR. Regional anesthesia in a patient with epidermolysis bullosa. *Reg Anesth* 1993; **18:** 132–134.

19 Yee LL, Gunter JB, Manley CB. Caudal epidural anesthesia in an infant with epidermolysis bullosa. *Anesthesiology* 1989; **70:** 149–151.

20 Diwan R, Vas L, Shah T *et al.* Continuous axillary block for upper limb surgery in a patient with epidermolysis bullosa simplex. *Paediatr Anaesth* 2001; **11:** 603–606.

21 Saringcarinkul A, Manchupong S, Punjasawadwong Y. Incidence and risk factors of emergence agitation in pediatric patients after general anesthesia. *J Med Assoc Thai* 2008; **91:** 1226–1231.

22 Azizkhan RG, Stehr W, Cohen AP *et al.* Esophageal strictures in children with recessive dystrophic epidermolysis bullosa: an 11-year experience with fluoroscopically guided balloon dilatation. *J Pediatr Surg* 2006; **41:** 55–60, discussion 55–60.

23 Goldschneider KR, Lucky AW. Pain Management in Epidermolysis Bullosa. *Dermatol Clin* 2010; **28:** 273–282.

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