Advances in burn care

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Purpose of review

This article reviews and critiques new developments in the critical care of burn patients.

Recent findings

The practice of restrictive transfusion is slowly gaining traction. Abdominal compartment syndrome is associated with resuscitation volumes of 300 ml/kg per 24 h, and percutaneous decompression may be a treatment option. Adrenal insufficiency is common, but whom and when to treat are unclear. Imaging or noninvasive monitoring may confirm renal perfusion before urine output, and the concept of permissive hypovolemia should be explored. There is progress in the laboratory in smoke inhalation and myocardial depression, but no human translation. Antibiotic pharmacokinetics in large burns are unpredictable, and so aminoglycosides (measurable concentrations) are not obsolete. Selective digestive decontamination remains controversial. Nutritional predictions by formula are inaccurate. Oxandrolone is safe and effective in promoting anabolism in large burns. Deep venous thrombosis prophylaxis remains guided only by expert opinion. Females fare worse than male patients after burns.

Summary

The application of the scientific method to burn care is improving slowly. Randomized controlled trials are becoming more common. There is a need for translation of excellent animal work to the human arena.

Keywords

abdominal compartment syndrome, burns, resuscitation, smoke inhalation, thermal injuries

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Abbreviations

ACS	abdominal compartment syndrome
FiO_2	fractional inspired oxygen
MIC	minimum inhibitory concentration
PaO_2	arterial oxygen tension
REE	resting energy expenditure
rhAPC	recombinant human activated protein C
SDD	selective digestive decontamination
TBSA	total body surface area

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Introduction

This review was conducted by scanning *PubMed* for articles on burns and thermal injuries published during the years 2006 and 2007. The author then subjectively selected those articles that would be of interest to intensivists who may care for burn patients.

Transfusion

Palmieri *et al.* [1•] reviewed transfusion practices in 666 patients with burns involving more than 20% of total body surface area (TBSA) from 21 burn centers. Patients received nearly 14 units of blood each; the mean hemoglobin concentration at the time of first transfusion was about 9 g/dl. Each unit of blood increased the risk for infection by 13%, and mortality increased with the number of units of blood transfused.

Burn surgeons are evolving slowly toward adopting a restrictive transfusion trigger of hemoglobin concentration of 7 g/dl, as introduced in 1999 in a study conducted by Hebert *et al.* [2]. Kwan *et al.* [3•] adopted a restrictive transfusion policy for burns in 1999. Outcomes in patients managed with a transfusion trigger of 7 g/dl were compared with those in historical control individuals. Mean hemoglobin concentrations before transfusion were 9.2 g/dl (control) and 7.1 g/dl (restrictive). Mean daily hemoglobin concentrations were 10.2 g/dl (control) and 8.6 g/dl (restrictive). The restrictive group received fewer blood transfusions per day (0.4 ± 0.4 units versus 0.6 ± 0.6 units; $P = 0.03$), had a better organ dysfunction score, and had a lower mortality rate (19% versus 38%; $P = 0.03$). These findings suggest that a restrictive transfusion policy should be adopted in burns.

Compartment syndromes

Oda *et al.* [4•,5•] reported two papers on abdominal compartment syndrome (ACS) in burns in 2006. In one report [4•], eight out of 48 patients with a mean TBSA burned of $45.9\% \pm 21.8\%$ developed ACS. All patients with ACS received resuscitation volumes of 300 ml/kg per 24 h or greater. The other report [5•] compared hypertonic resuscitation with 'Parkland' resuscitation in terms of decreasing the risk for ACS. The hypertonic group maintained adequate urine output with lower volumes of resuscitation and had a lower incidence of intra-abdominal hypertension (2/14 versus 11/22). As in their other report, the critical volume associated with development of intra-abdominal hypertension was approximately 300 ml/kg per 24 h. This number is a pearl that should

be taken away by the readers of these papers for use in their clinical practice.

Jensen *et al.* [6] reported on four cases of secondary ACS in children. One patient was treated successfully with percutaneous decompression. This adds to the experience of others [7,8,9•] in percutaneous decompression. Although there is enthusiasm for this technique, it must be applied judiciously. Elevated pressures can recur after percutaneous drainage if bowel edema develops.

Endocrine

Palmieri *et al.* [10•] examined function of the hypothalamic–pituitary–adrenal axis in children with burns over more than 20% of TBSA. All patients met the definition of adrenal insufficiency, as described by the Surviving Sepsis Campaign [11], but none of the patients received exogenous steroids, and mortality was not affected by total serum cortisol concentrations. The role of exogenous steroids in the treatment of adrenal insufficiency in burned children requires further study.

Monitoring of resuscitation

Kuwa *et al.* [12•] evaluated the utility of power Doppler ultrasound in measuring renal perfusion. They found that power Doppler ultrasound image intensity correlated better with directly measured renal cortical microvascular blood flow than did urine output in a burned swine model. Arlati *et al.* [13••] conducted a study to compare a noninvasive intrathoracic blood volume-guided and cardiac output-guided approach to resuscitation with a 'Parkland' formula. They achieved resuscitation with less fluid administered, less edema formation, and lower organ dysfunction scores using the former. Most noteworthy is the appearance of the term 'permissive hypovolemia'. Burn physicians are evolving their practice to avoid the negative consequences of over-resuscitation. Eventually, there will be more sensitive markers of organ perfusion than urine output.

Technology

Hoskins *et al.* [14•] automated resuscitation volume based on hourly urine output. The technology consisted of a personal computer, an infusion pump, and a urine flow meter. Automation led to less hourly variation in infusion rate and urine output, and was under the target for urine output less often than was technician-directed resuscitation. This technology is a logical advance in guiding burn resuscitation.

Myocardial inflammation

Horton *et al.* [15,16••] reported two papers in 2006 describing the effects of burn treatment on myocardial inflammation. One experiment [15] showed that hypertonic saline–dextran resuscitation reduced myocardial inflammation associated with a 'second hit'. The other study [16••] examined the effect of immediate burn excision and grafting (30 min after burn) on myocardial inflammation in a rat model. Decreased contractility and relaxation, as well as expression of inflammatory cytokines, could be abrogated by immediate excision and grafting. This supports the modern practice of early excision and grafting. Optimal timing of early excision and grafting is unclear, but if it can be conducted safely then immediate excision and grafting may spare patients the inflammatory storm and painful nonoperative management that occurs until the time of eventual excision and grafting.

Airway

Khan *et al.* [17••] described a technique for securing the airway in cases of microstomia secondary to burn contracture. By introducing a stylet into a laryngeal mask airway and lubricating the apparatus generously, it could be inserted into the oral cavity in an upside-down manner (as when inserting an oropharyngeal airway), and rotated 180° into the proper orientation.

Models of smoke inhalation

Several reports on the ovine model of cotton smoke inhalation appeared in the review period. Wang *et al.* [18] compared high-frequency percussive ventilation with volume-controlled mechanical ventilation, both with adjunctive heparin. The heparinization was based on previous work showing improved oxygenation and clearance of tracheobronchial casts with systemic heparin. Percussive ventilation decreased mortality by 50%. Morita *et al.* [19] reported on use of nebulized vitamin E, and found that it reduced capillary leak in the lung, decreased shunt fraction, improved arterial oxygen tension (PaO_2):fractional inspired oxygen (FiO_2) ratio, and decreased generation of reactive nitrogen species. Maybauer *et al.* [20] reported on use of recombinant human activated protein C (rhAPC) in the treatment of the ovine model, with airway instillation of bacteria to simulate clinical inhalation injury. They postulated that the anticoagulant and anti-inflammatory properties of rhAPC may improve the response to smoke inhalation. At various time points, rhAPC improved the $PaO_2:FiO_2$ ratio and decreased pulmonary microvascular shunt fraction. No bleeding complications were observed. Although interesting and of potential future importance in clinical care, use in humans for this indication would be premature. The final report in the ovine model is that by Palmieri *et al.* [21] on use of continuous nebulized albuterol. Treated animals had lower airway pressures, less lung water accumulation, and higher $PaO_2:FiO_2$ ratio. In an accompanying editorial, Wiener-Kronish and Matthay [22] reported that the Acute Respiratory Distress Syndrome Network is planning a prospective, randomized, multicenter trial of this intervention. The risks for tachycardia and

electrolyte disturbance should keep clinicians from adopting continuous nebulized albuterol until research in humans is available.

Huang *et al.* [23], in a rat wood smoke model of smoke inhalation, studied hypothermia for protection against acute lung injury. Hypothermic rats exhibited less lipid peroxidation and inflammatory cytokine expression than did normothermic rats. It is not clear how to apply clinically any of the information derived from animal smoke inhalation models. How is the clinician to know whether wood smoke or cotton smoke in sheep or rat approximates to burning house smoke in humans? At present, it would be premature to apply these interventions clinically to protect against smoke-induced acute lung injury.

Endotracheal tubes

Sheridan [24••] suggested that the dogma of using uncuffed endotracheal tubes in children is ill-advised if more than transient intubation is needed. Five children required emergent reintubation over a 5-year period because of massive air leak from uncuffed tubes. This can be avoided by using cuffed endotracheal tubes in seriously burned children. The risks associated with an appropriately inflated cuff appear to be lower than the risk for inadvertent extubation in the massively swollen child.

Infection

Chen *et al.* [25] showed that hypertonic resuscitation in a burned mouse model decreased bacterial translocation by increasing phagocytic activity of peritoneal and systemic inflammatory cells. This report may not yet be applicable at the bedside, but it should serve to remind clinicians that the effects of our interventions are not all apparent on rounds or in the clinical laboratory.

Kiser *et al.* [26••] showed once again that pharmacokinetics and pharmacodynamics are unpredictable in major burns. They evaluated 11 patients with burns over more than 30% of TBSA and normal renal function who received levofloxacin for clinical indications. By Monte Carlo simulation, the investigators attempted to determine how often target concentrations would be achieved. For organisms with minimum inhibitory concentrations (MICs) of 1 μg/ml or greater, including those difficult organisms whose MICs are 2 μg/ml (levofloxacin's approved susceptibility breakpoint), target concentrations would not be achieved reliably. Therefore, even though the laboratory may report an organism to be susceptible, it is likely that the necessary antibiotic concentration will not be achieved for organisms with high MICs. This cautions against the use of levofloxacin 750 mg once daily for empiric therapy of serious infections in burn patients.

Conil *et al.* [27••] examined dosing of amikacin in burns. They had previously shown that a once daily dosing regimen of 15 mg/kg per day led to maximal concentration : MIC ratio of greater than 6 in only 13% of cases. To achieve the desired maximal concentration : MIC ratio doses of 25–30 mg/kg per day may be needed, with therapeutic drug level monitoring, particularly in patients with burns over more than 15% of TBSA. Although aminoglycosides have fallen from favor, they still have a role to play when pharmacokinetics and pharmacodynamics are unpredictable.

Selective digestive decontamination

de La Cal *et al.* [28] reported a prospective, randomized, placebo-controlled, double-blind trial of selective digestive decontamination (SDD) in burns over more than 20% of TBSA. The intervention consisted of intravenous cefotaxime for 4 days, and oropharyngeal and enteral administration of polymyxin E, tobramycin, and amphotericin B. There was an adjusted risk ratio for mortality of 0.28 (95% confidence interval 0.10 to 0.80), and fewer patients developed infection (43% versus 74%; $P = 0.01$), favoring SDD. This trial showed a reduction in mortality, but SDD has not been adopted as a standard of care. Why is this? Eggimann *et al.* [29••] have questioned the timing of the deaths in the study. There were five deaths in the SDD group and 15 in the placebo group, 11 of which occurred during the first 2 weeks. Although infections may manifest after the first week, deaths from those infections would be expected later in the course. If the 11 deaths in the placebo group during the first 2 weeks are eliminated, then the mortality difference is lost. Despite the randomized controlled trial being well designed and conducted, the timing of the deaths leaves the issue in question.

Energy expenditure

Suman *et al.* [30•] performed a comparison of predicted resting energy expenditure (REE) against measured REE in burned children. Predictions all underestimated caloric needs measured by indirect calorimetry; measured REE was 152% of predicted for all three formulae used, including the Harris–Benedict equation. The authors recommended that indirect calorimetry be used for severely burned children.

Mlcak *et al.* [31•] examined 100 children with burns over more than 40% of TBSA prospectively to determine age and sex differences in REE. The most interesting finding, in the writer's opinion, is that infants and toddlers do not exhibit a hypermetabolic response at all. The second finding, which comprises the bulk of the report, is that males exhibit a greater increase in REE than do females. This has implications for the nutritional management of children and emphasizes the

Table 1 Summary of recommendations for venous thromboembolism prophylaxis in burns

Risk	Type of surgery	Patient-related risk	Recommendations	Grade
Low	Burns <20% TBSA	−	None or ECS	D
	AND lower limbs unscathed	+	Moderate dose LMWH ±	D
Moderate	Burns 20–50% TBSA	−	Moderate dose LMWH	D
	Burns of lower limbs			
	Grafts from lower limbs	+	High-dose LMWH	D
High	Burns >50% TBSA		High-dose LMWH	D
	Electrical burns		OR UFH intravenously	D
	Biologic hypercoagulability			
	Femoral infusion			

Note that all recommendations are based only on expert opinion. This is an unacceptable state of the science. ECS, elastic compression stockings; LMWH, low-molecular-weight heparin; TBSA, total body surface area; UFH, unfractionated heparin. Adapted from Samama *et al.* [35•].

use of indirect calorimetry, as opposed to predictive equations. In centers in which indirect calorimetry is available, it should be used. In centers where it is not available, its adoption should be considered.

Oxandrolone

Przkora *et al.* [32••] performed a prospective, randomized trial of oxandrolone with and without exercise in children with burns over more than 40% of TBSA. Oxandrolone, along with resistance training and aerobic exercise, increased weight and lean body mass compared with not receiving the combined interventions. Wolf *et al.* [33••] showed that oxandrolone, 10 mg twice daily, decreased length of stay by 28% for patients with burns between 20% and 60% of TBSA. This was a well designed and conducted trial. It had a clear objective and equally clear results. Adults with burns over more than 20% of TBSA should receive oxandrolone 10 mg twice daily from the time that they can receive enteral alimentation until the time of hospital discharge. Adverse events were minor. The authors expressed considerable concern over the potential for hepatic toxicity, but they did not find any difference in transaminase concentrations between groups. In fact, McCullough *et al.* [34] recently reported a case–control series of patients with major burns who received oxandrolone, which they conducted specifically to examine hepatic toxicity. They found no difference in the incidence of hepatic toxicity.

Wound healing

Galeano *et al.* [35•] studied the effect of recombinant human erythropoietin on wound healing in a mouse burn model. After scalding, the animals were randomly assigned to recombinant human erythropoietin or placebo for 14 days. Animals receiving active drug had faster re-epithelialization, increased angiogenesis, and increased wound content of vascular endothelial growth factor. The known risks associated with this intervention mandate that trials in humans be performed before it is adopted clinically for this indication.

Thromboembolism

A review conducted by the French Society for Anesthesia and Critical Care [36•] showed that the risk for deep venous thrombosis following burn injury ranges from 0.9% to 3%, and that the risk for pulmonary embolus ranges from 0.4% to 1.2%. Recommendations for prophylaxis are summarized in Table 1. External compression should be used in concert with chemoprophylaxis whenever possible. Note that the grade of recommendation for all recommendations is D: 'agreement among professionals'. This is an unacceptable state of our science and must be addressed in well designed trials.

Recombinant factor VIIa

Johansson *et al.* [37] described use of recombinant factor VIIa in four patients who developed profuse, life-threatening microvascular bleeding after excision of a mean of 55% TBSA full thickness burn. Bleeding was controlled within 15 min with a 100 μg/kg bolus of recombinant factor VIIa. There were no thromboembolic complications. Recombinant factor VIIa should be reserved for situations in which conventional techniques have been exhausted. Indiscriminate use of this agent should be avoided.

Sex differences

Kerby *et al.* [38] reviewed nearly 35 000 men and 15 000 women entered into the American Burn Association National Burn Repository for sex differences. Women had a 30% greater likelihood of mortality after adjusting for age, race, TBSA burn, and inhalation injury. This sex difference only held true in patients between the ages of 10 and 70 years, which led the authors to speculate that it is due to the immunomodulatory effects of estrogen. With such a large magnitude of difference, prospective studies of outcome in smaller groups could be performed.

Conclusion

The application of the scientific method to burn care is improving slowly. Randomized controlled trials are

becoming more common. There is a need for translation of excellent animal work to the human arena.

References and recommended reading

Papers of particular interest, published within the annual period of review, have been highlighted as:

- • of special interest
- •• of outstanding interest

Additional references related to this topic can also be found in the Current World Literature section in this issue (p. 468).

1 • Palmieri TL, Caruso DM, Foster KN, *et al.* Effect of blood transfusion on outcome after major burn injury: a multicenter study. Crit Care Med 2006; 34:1602–1607.
This paper provides a perspective on the transfusion practices of major burn centers. It establishes the benchmark.

2 Hebert PC, Wells G, Blajchman MA, *et al.* A multicenter, randomized, controlled clinical trial of transfusion requirements in critical care. Transfusion Requirements in Critical Care Investigators, Canadian Critical Care Trials Group. N Engl J Med 1999; 340:409–417.

3 • Kwan P, Gomez M, Cartotto R. Safe and successful restriction of transfusion in burn patients. J Burn Care Res 2006; 27:826–834.
Read this at the same sitting as the report by Palmieri *et al.* [1•]. This paper shows that restrictive transfusion can be safe in burns.

4 • Oda J, Yamashita K, Inoue T, *et al.* Resuscitation fluid volume and abdominal compartment syndrome in patients with major burns. Burns 2006; 32:151–154.
A resuscitation volume of 300 ml/kg per 24 h appears to be a threshold for ACS.

5 • Oda J, Ueyama M, Yamashita K, *et al.* Hypertonic lactated saline resuscitation reduces the risk of abdominal compartment syndrome in severely burned patients. J Trauma 2006; 60:64–71.
Intra-abdominal hypertension was avoided with hypertonic resuscitation. It provides an alternative for clinicians facing frequent ACS.

6 Jensen AR, Hughes WB, Grewal H. Secondary abdominal compartment syndrome in children with burns and trauma: a potentially lethal complication. J Burn Care Res 2006; 27:242–246.

7 Corcos AC, Sherman HF. Percutaneous treatment of secondary abdominal compartment syndrome. J Trauma 2001; 51:1062–1064.

8 Latenser BA, Kowal-Vern A, Kimball D, *et al.* A pilot study comparing percutaneous decompression with decompressive laparotomy for acute abdominal compartment syndrome in thermal injury. J Burn Care Rehabil 2002; 23:190–195.

9 • Parra MW, Al-Khayat H, Smith HG, Cheatham ML. Paracentesis for resuscitation-induced abdominal compartment syndrome: an alternative to decompressive laparotomy in the burn patient. J Trauma 2006; 60:1119–1121.
This simple technique can prevent the need for laparotomy in selected cases.

10 • Palmieri TL, Levine S, Schonfeld-Warden N, *et al.* Hypothalamic–pituitary–adrenal axis response to sustained stress after major burn injury in children. J Burn Care Res 2006; 27:742–748.
Endocrine insufficiency is found to be very common in burned children. Approaches to diagnosis and doubts regarding treatment are discussed.

11 Dellinger RP, Carlet JM, Masur H, *et al.* Surviving Sepsis Campaign guidelines for management of severe sepsis and septic shock. Crit Care Med 2004; 32:858–873.

12 • Kuwa T, Jordan BS, Cancio LC. Use of power Doppler ultrasound to monitor renal perfusion during burn shock. Burns 2006; 32:706–713.
This report may be a glimpse into the future, when image guided measures of organ perfusion will be available.

13 •• Arlati S, Storti E, Pradella V, *et al.* Decreased fluid volume to reduce organ damage: a new approach to burn shock resuscitation? A preliminary study. Resuscitation 2007; 72:371–378.
Resuscitation to noninvasive hemodynamic end-points leads to less fluid administration than devotion to urine output. The concept of permissive hypovolemia enters the literature.

14 • Hoskins SL, Elgjo GI, Lu J, *et al.* Closed-loop resuscitation of burn shock. J Burn Care Res 2006; 27:377–385.
Infusion pumps and urinary catheters may be attached to the same motherboard someday, allowing precise automated fluid infusion rates based on urine output.

15 Horton JW, Maass DL, White DJ. Hypertonic saline dextran after burn injury decreases inflammatory cytokine responses to subsequent pneumonia-related sepsis. Am J Physiol 2006; 290:H1642–H1650.

16 •• Horton JW, Sanders B, White DJ, Maass DL. The effects of early excision and grafting on myocardial inflammation and function after burn injury. J Trauma 2006; 61:1069–1077.
This study provides evidence from the bench of the benefits of early excision and grafting. It is excellent food for thought for practicing burn doctors.

17 •• Khan RM, Verma V, Bhradwaj A, *et al.* Difficult laryngeal mask airway placement in a pediatric-burned patient: a new solution to an old problem. Paediatr Anaesth 2006; 16:360–361.
This is a simple letter to the editor that can save a life the next time you are on call. It is a 'must read' for clinicians who are responsible for the airway.

18 Wang D, Zwischenberger JB, Savage C, *et al.* High-frequency percussive ventilation with systemic heparin improves short-term survival in a LD100 sheep model of acute respiratory distress syndrome. J Burn Care Res 2006; 27:463–471.

19 Morita N, Traber MG, Enkhbaatar P, *et al.* Aerosolized alpha-tocopherol ameliorates acute lung injury following combined burn and smoke inhalation injury in sheep. Shock 2006; 25:277–282.

20 Maybauer MO, Maybauer DM, Fraser JF, *et al.* Recombinant human activated protein C improves pulmonary function in ovine acute lung injury resulting from smoke inhalation and sepsis. Crit Care Med 2006; 34:2432–2438.

21 Palmieri TL, Enkhbaatar P, Bayliss R, *et al.* Continuous nebulized albuterol attenuates acute lung injury in an ovine model of combined burn and smoke inhalation. Crit Care Med 2006; 34:1719–1724.

22 Wiener-Kronish JP, Matthay MA. Beta-2-agonist treatment as a potential therapy for acute inhalational lung injury. Crit Care Med 2006; 34:1841–1842.

23 Huang PS, Tang GJ, Chen CH, Kou YR. Whole-body moderate hypothermia confers protection from wood smoke-induced acute lung injury in rats: the therapeutic window. Crit Care Med 2006; 34:1160–1167.

24 •• Sheridan RL. Uncuffed endotracheal tubes should not be used in seriously burned children. Pediatr Crit Care Med 2006; 7:258–259.
The title and report are sage advice from an experienced pediatric burn doctor. This is a 'must read' before your next pediatric intubation.

25 Chen LW, Huang HL, Lee IT, *et al.* Hypertonic saline enhances host defense to bacterial challenge by augmenting Toll-like receptors. Crit Care Med 2006; 34:1758–1768.

26 •• Kiser TH, Hoody DW, Obritsch MD, *et al.* Levofloxacin pharmacokinetics and pharmacodynamics in patients with severe burn injury. Antimicrob Agents Chemother 2006; 50:1937–1945.
This paper explains why simple reliance on a report from the microbiology laboratory of 'sensitive' or 'resistant' can lead to treatment failures. It is important reading when selecting empiric antibiotics for serious infections.

27 •• Conil JM, Georges B, Breden A, *et al.* Increased amikacin dosage requirements in burn patients receiving a once-daily regimen. Int J Antimicrob Agents 2006; 28:226–230.
Burn patients remain a pharmacodynamic minefield. Aminoglycosides allow us to measure drug concentrations and should not be abandoned.

28 de La Cal MA, Cerda E, Garcia-Hierro P, *et al.* Survival benefit in critically ill burned patients receiving selective decontamination of the digestive tract: a randomized, placebo-controlled, double-blind trial. Ann Surg 2005; 241:424–430.

29 •• Eggimann P, Chiolero RL, Raffoul W, *et al.* Is there really a survival benefit of SDD in burns? Ann Surg 2006; 244:325–326; author reply 326–7.
This is an extremely important letter to the editor that helps to put the findings of de La Cal *et al.* [28] into perspective.

30 • Suman OE, Mlcak RP, Chinkes DL, Herndon DN. Resting energy expenditure in severely burned children: analysis of agreement between indirect calorimetry and prediction equations using the Bland-Altman method. Burns 2006; 32:335–342.
All of the work of calculating energy requirements grossly underestimates caloric needs. Read this and then order an indirect calorimeter for your unit.

31 • Mlcak RP, Jeschke MG, Barrow RE, Herndon DN. The influence of age and gender on resting energy expenditure in severely burned children. Ann Surg 2006; 244:121–130.
This paper further refines the influences on the energy requirements of burned children.

32 •• Przkora R, Herndon DN, Suman OE. The effects of oxandrolone and exercise on muscle mass and function in children with severe burns. Pediatrics 2007; 119:e109–e116.
This randomized trial that proves the benefits of oxandrolone and exercise combined. Consider this part of the new core curriculum for burns.

33 Wolf SE, Edelman LS, Kemalyan N, *et al.* Effects of oxandrolone on outcome •• measures in the severely burned: a multicenter, prospective, randomized, double-blind trial. J Burn Care Res 2006; 27:131–139.
This is a seminal contribution that establishes a new standard of care. Read it today; adopt the practice tomorrow.

34 McCullough MC, Namias N, Schulman C, *et al.* Incidence of hepatic dysfunction is equivalent in burn patients receiving oxandrolone and controls. J Burn Care Res 2007; 28:415–420.

35 Galeano M, Altavilla D, Bitto A, *et al.* Recombinant human erythropoietin • improves angiogenesis and wound healing in experimental burn wounds. Crit Care Med 2006; 34:1139–1146.
Recombinant human erythropoietin, a tool of the intensivist, may aid in wound healing.

36 Samama CM, Albaladejo P, Benhamou D, *et al.* Venous thromboembolism • prevention in surgery and obstetrics: clinical practice guidelines. Eur J Anaesthesiol 2006; 23:95–116.
This report is noteworthy in that it shows that we still rely on expert opinion for thromboembolic disease prevention in burns.

37 Johansson PI, Eriksen K, Alsbjorn B. Rescue treatment with recombinant factor VIIa is effective in patients with life-threatening bleeding secondary to major wound excision: a report of four cases. J Trauma 2006; 61:1016–1018.

38 Kerby JD, McGwin G Jr, George RL, *et al.* Sex differences in mortality after burn injury: Results of analysis of the National Burn Repository of the American Burn Association. J Burn Care Res 2006; 27:452–456.