Metabolic and Endocrine Considerations After Burn Injury

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KEYWORDS

• Hypermetabolism • Hypercatabolism • Insulin resistance • Propranolol • Oxandrolone • Nutrition • Catecholamines

KEY POINTS

- Severe burn injury results in a significant and persistent hypermetabolic response.
- The hypermetabolic, hypercatabolic response is mediated by catecholamines, glucagon, and cortisol.
- Patients have supraphysiologic metabolic rates, heart rates, and full-body catabolism that persist for years postburn.
- There are multiple pharmacologic and nonpharmacologic modalities that help mitigate the postburn response and prevent physiologic exhaustion.

INTRODUCTION

Severe thermal injury, defined as burns encompassing more than 30% of a patient's total body surface area (TBSA), is followed by a marked and persistent hypermetabolic response. The response is propagated by plasma catecholamines, glucagon, cortisol, and proinflammatory mediators. Physiologic changes are seen with these injuries for years postburn.[1–3] The response is characterized by full-body catabolism, muscle protein degradation, increased metabolic rates, stunted growth, insulin resistance, increased risk for infection, and multiorgan dysfunction.[2–6]

Following any significant injury, there is a compensatory decrease in tissue perfusion and a decrease in metabolic rate: the ebb state. Subsequently, there is a hyperdynamic state characterized by increases in metabolism, and hyperdynamic circulation: the flow state. In severe burns, the "ebb" phase lasts up to 72 hours after injury. The subsequent magnified "flow" phase in severe burns can be limitless in time and physiologic consequence. When left untreated, physiologic exhaustion ensues, and the injury becomes fatal.[7–10]

Understanding of this response to severe burn injury, advances in critical care management, and infection control in the last two decades has significantly improved morbidity for burn survivors. This article comprehensively describes the gamut of physiologic changes after major burn injury and discusses the effects of various pharmacologic and nonpharmacologic interventions discovered to mitigate the hypermetabolic response (**Table 1**). Numerous therapies imparted to modify this catastrophic response and improve care, quality of life and survival have emerged in the past 50 years, including early excision and grafting; thermoregulation; early continuous enteral feeding with a high-carbohydrate high-protein diet; the use of anabolic agents, such as growth

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Table 1
Summary of the main effects of various pharmacologic interventions to alter the hypermetabolic response to burn injury

Drug	Inflammatory Response	Stress Hormones	Body Composition	Net Protein Balance	Insulin Resistance	Hyperdynamic Circulation	Metabolic Rate
Recombinant growth hormone	Improved	No difference	Improved	No difference	Hyperglycemia	No difference	Improved
Insulinlike growth factor-1	Improved	No difference	Improved	Improved	Improved	No difference	Unknown
Oxandrolone	Improved	No difference	Improved	Improved	No difference	No difference	Improved
Insulin	Improved	No difference	Improved	Improved	Improved	No difference	Improved
Fenofibrate	No difference	No difference	No difference	No difference	Improved	No difference	Unknown
Glucagonlike peptide-1	Unknown	Unknown	Unknown	Unknown	Improved (indirect)	Unknown	Unknown
Propranolol	Improved	Improved	Improved	Improved	Improved	Improved	Improved
Ketoconazole	Unknown	Improved	Unknown	Unknown	Unknown	Unknown	No difference
Recombinant growth hormone + propranolol	Improved	Improved	Improved	Improved	Improved	Improved	Improved
Oxandrolone + propranolol	Improved (preliminary)	Improved (preliminary)	Improved (preliminary)	Improved (preliminary)	Improved (preliminary)	Improved (preliminary)	Improved

The data summarized in the table are extrapolated from previously published data.[1,5,11,16,17,25,80–103,116–122,129–165]