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50 Years of Burn Care at Shriners Hospitals for Children, Galveston

Karel D. Capek, MD^a, Derek M. Culnan, MD^b, Manubhai H. Desai, MD^a, and David N. Herndon, MD, MCCM, FACS, FRCS^a

^aShriners Hospitals for Children- University of Texas Medical Branch, Galveston, TX, 77550

^bJMS Burn & Reconstructive Center at Merit Health Central Hospital, Jackson, MS, USA

Abstract

Over 50 years ago, Shriners Hospitals for Children expanded their philanthropy to include care for burned children. In so doing, the effects of their work weightily expanded from rehabilitation and quality of life outcomes to include survival proper. As the first facility dedicated to the care of burned children, originally designated the Shriners Burn Institute, the Galveston hospital remains the cornerstone of this endeavor. Shriners maintain charitable pediatric hospitals, provide care irrespective of the patient's or the family's ability to pay, and promote research. The sole criterion for admission at Shriners Hospitals for Children is the determination by a surgeon at a Shriners hospital that "the child's trouble may be corrected or improved." This philanthropic effort to provide medical care for children is one expression of the human commonality recognized by Shriners. In this manuscript, we provide some background information on how this hospital came into existence, and a global summary of its interventions toward greater survival and more complete rehabilitation of burned children. Based on the findings presented herein, we assert that there is less suffering, and less loss of life due to childhood burns today than in previous years. We attribute much of this improvement to the simple voluntary collective decision by Shriners to provide alms for burned children.

Keywords

sepsis; burn; inflammation; hypertrophic scar; survival; charity; Shriners Hospitals for Children; Masonry; Shriner

Introduction: Shriners Hospitals for Children

For the past 50 years, the Shriners Hospital for Children, Galveston has been providing comprehensive care for burned children as well as expanding the frontiers of medical care and research into burned and critically-ill pediatric patients. In this manuscript, Shriners and surgeons recall how we became involved in burn care, what our mission is, and what results this work over the past half-century has yielded. The Shriners Hospitals for Children system differs at its root from not-for-profit hospital models, in that care is explicitly provided

irrespective of the patient and family's ability to pay. This model originated with, and is maintained through, voluntary charitable donations. We note that it is not unique to Shriners Hospitals for Children, although we believe it to be the first hospital system conceived along these lines.¹ In most cases, contributions come from entities and individuals whom will never know or meet the patients who receive care. A number of virtuous cycles are circumscribed via its action.²⁻⁴ Patients and their families derive healthcare benefit without the usual costs and associated anxiety. Donors derive utility, in many cases reporting inestimable benefit, from their participation in these recoveries. Providers and staff derive utility from the opportunity to provide care in a setting where financial suffering is not inflicted upon their patients, and from the knowledge that any compensation received for their work has been freely given. The world at large benefits when common resources (such as tax revenue) can be directed elsewhere because of donor's willingness to voluntarily assume these patients' burdens. While best perceived from the donor perspective, the nonmonetizable compensation from participation in this work usually dwarfs the countable for all involved parties. The system (patients, donors, and providers) benefits when care is streamlined, as a greater number of patients are then able to receive care, and a greater per-donation value/quantity of care is realized. In fine, the system as a whole and in each part thrives on virtue itself, and each part nourishes the others. It is lessened by entitlement, waste, selfishness, errors, and breach of this solemn trust.

Burn Care at Shriners Hospitals for Children

After the Salk vaccine definitively addressed the problem of polio, declining patient enrollment at the orthopedic hospitals prompted Shriners International to consider where their assistance could most greatly benefit children. Childhood burn injuries were identified as a cause of great suffering, disability, disfigurement, and death. Consultation with contemporary giants of military medicine, including General Truman G. Blocker Jr. (Figure 1) and Colonels Vogel, Moncrief, and Artz, validated a consensus that burn care was on the cusp of significant advances that could be brought to fruition by dedicated study and exchange of ideas⁵⁻¹². These events occurred contemporaneously with early vestiges of the American Burn Association, both being prompted by groundbreaking work at the United States Army Institute for Surgical Research (ISR) in San Antonio.^{13,14} Better early treatment of burns was expected to improve survival, reduce disabling scar contractures, and improve quality of life. In 1966, the Shrine Burns Institute opened in Galveston as the first hospital structure dedicated to the care of burned children. Additional centers have been established at Boston, Cincinnati, and Sacramento. At the start, only half of the children admitted with total body surface area (TBSA) burns of 64% or greater survived their injuries.^{15,16}

In its nascent years, burn care at Shriners Hospitals for Children was characterized by advances in the treatment of burn shock and wound closure. It was appreciated that the fluid resuscitation of children was exquisitely sensitive to body habitus and surface area.^{17,18} In 1969 the first report of children surviving massive (>70% TBSA) full-thickness burns was published by Burke et al. from the Shriners Hospital in Boston.¹⁹⁻²² Topical treatments for burn wound infection also played a major role in reducing burn mortality.²³ The air-fluidized (clinitron) bed was conceived through collaboration between Hargess (a biomedical engineer) and the burn surgeons Artz and Blocker; these beds remain of unrivaled utility for

patients with posterior burns and donor sites and are more effective than conventional treatments in healing large pressure ulcers.^{24–27}

Ketamine anesthesia in the treatment of pediatric burns was pioneered and reported by Sally Abston. With her partners Manubhai Desai and David Herndon, she put early excision and grafting into practice, reporting improved survival in burned children.²⁸ At a time when gastric (Curling's) ulcers caused significant morbidity after burn injury, Abston reported a lower rate of this complication when burned children were fed with a milk diet.²⁹ She reported the failure of supplemental total parenteral nutrition to improve outcomes, and was among the first clinicians to recognize subclinical mesenteric ischemia as a cause of bacterial translocation and a driver of multi-organ failure syndromes.^{30–32} She also reported that endogenous thromboxane, released during septic episodes, was a potentially treatable mediator of this pathophysiology.³³

Manubhai Desai reported improved survival from smoke inhalation injury when children were treated with a protocol of nebulized heparin, N-acetyl cysteine, and albuterol.^{34–37} He was at work when fungal sepsis was a major cause of morbidity and mortality, and his introduction of topical nystatin to the regimen at Galveston essentially led to the eradication *Candida* sepsis.^{38–41} His work also clarified that apparent partial-thickness scald burns in children can be observed for 2 weeks, resulting in a smaller area of burn excision without increases in infection, wound complications, or cost.⁴²

The research and clinical care of burn scars and contractures was greatly aided by the 1970 arrival of Mario Dobrkovsky to Galveston. His arrival may have been consequent to an amicable interaction between Truman G. Blocker Jr. and František Burian. Respectively, they represented the English- and Slavic-speaking countries at the International Congress of Plastic Surgery. Burian was director of the Burn Unit at the Charles (Karlovy) University in Prague and one of the fathers of modern plastic surgery; his interaction with General Blocker is remarkable given the political chasm between the United States and the Soviet Union at that time^{43–46}. At Galveston, Dobrkovsky was better known for his gentle demeanor, clinical care, and teaching of his colleagues than for his research contributions. Ted Huang later recalled that it was Dobrkovsky who taught ¾ fasciocutaneous Z-plasty techniques to him and other plastic surgeons at Galveston. Yet, Dobrkovsky's bibliography demonstrates that he was ahead of his time with respect to burn care well before he immigrated. His pioneering use of amnion and chorion for burns, and study of bone and growth-related problems of the burn patient, the biological half-life of albumin, the factors influencing homograft take, and the use of systemically-administered tetracycline fluorescence to differentiate full-thickness from partial-thickness burns attest to his forward-thinking influence.^{47–53}

At Galveston, his first contribution was as senior author on "The Silent Epidemic: Burn Injuries in Texas."⁵⁴ His remaining work (together with Larson, Abston, Linares, and others) focused on the clinical biology of scar formation in burned children.^{55–61} These studies laid the foundation for the dynamic study of scar modulation and demonstrated the histological effects of then-available scar treatments, splinting, and pressure dressings.^{56,61,62} Providing a bridge to the basic science of scar formation, they described the pathobiology of scar

formation and noted the “whorl and nodule compact collagen” histology. This work supported and informed the clinical treatment of scars. Pressure garments were used and reported by Duane Larson (as first Chief of Staff at the Shrine Burns Institute) together with Sally Abston. E. Burke Evans, an orthopedic surgeon and medical director of the burn rehabilitation department, complemented this regimen with innovative splint design and methods of contracture release using Ilizarov external fixators.⁶³ Overall, one of the most consequential discoveries at Shriners in Galveston concerned the central role of myofibroblast cells in scar formation. The report of Bauer, Larson, *et al.* was the first reported observation of myofibroblasts in hypertrophic scars and permitted a revolution in the understanding of scar formation and remodeling.⁶⁴

In 1981, David N. Herndon came to Shriners Hospitals for Children, Galveston as chief of staff. His work impacted all areas of burn care, leading to worldwide improvements in the standard of burn treatment, patient survival, and quality of life. These are evidenced by the standard of care textbook for burn treatment, now in its 5th edition,^{65,66} as well as discoveries arising from the National Institute of General Medical Sciences P-50 Research Center in Injury and Perioperative Science, which have recently been reported elsewhere.^{67,68} Since 1980, surgeons at the Galveston hospital have published well over 1,000 peer-reviewed articles detailing advances across the spectrum of burn care and rehabilitation, including some of the most heavily-cited works in burns.⁶⁹ Over 200 post-doctoral fellows have been trained in burns, developing this body of research and providing its foundational body of clinical care.

A recent study of burn survival included 5,737 consecutive pediatric acute burn admissions at Shriners Hospitals for Children, Galveston between 1989–2017; there were 175 pediatric non-survivors.^{70,71} These patients were 62% male. The median age was 6 years (interquartile range 2–15). The median TBSA burned was 13% (interquartile range 4–36%). The median length of stay was 6 days (interquartile range 2–17). These figures indicate that patients generally stayed for 0.4 days/percent TBSA burned. In 2016, the global cost of clinical activities was less than \$9,000 per inpatient day (primarily ICU), inclusive of all acute burn, outpatient, and reconstructive operations occurring during the year. When adjusted to 2005 dollars using the consumer price index-U, this figure is somewhat larger than that reported by Gibran *et al.* for children with burns greater than 20% of the total body surface, although this global figure includes costs of ongoing (reconstructive) care and all other yearly expenditures for hospital operations that were not included their analysis.⁷²

The observed percent of the total body surface area burn resulting in 50% lethality (LA₅₀) was above 98% for this series. For the pediatric patients, the historical mortality probability estimators of Curreri *et al.* and Shirani *et al.* both yield expected mortality figures in excess of 700 patients.^{73,74} The observed to expected mortality odds ratios of 0.2 and 0.22, indicate a five-fold increase in observed survival compared with pre-1989 expectation (Table 1). A well-constructed and validated model (thermal injury mortality model) comprising almost 40,000 patients between 2000–2007 with data in the national burn repository was reported in 2010.⁷⁵ This model indicated that even under the then-standard of care, 293 deaths prior to hospital discharge were expected in the Shriners cohort. Comparison with the observed survival indicates that patients who were cared for at Shriners Hospitals for Children,

Galveston between 1989–2017 were almost twice as likely to survive compared to patients with equivalent age, TBSA burned, and inhalation injury status currently treated at the average US burn center reporting to the National Burn Repository (Table 1).

With increasing survival, the reconstructive problems particular to massively-burned children were first encountered. Ted Tsung-Che Huang was a medical student and resident at the University of Texas Medical Branch in Galveston at the inception of the Shrine Burns Institute, and was present as faculty when many of the initial survival-enhancing developments were first employed. He accepted the reconstructive challenges of this first cohort of massive burn survivors. As staff surgeon, he described pragmatic approaches to previously-intractable scar problems, employing local fasciocutaneous flaps.⁷⁶ These he colloquially termed $\frac{3}{4}$ Z-plasties because the angle of the interposed flap was 75% of the standard 60° Z-plasty. He performed this reconstruction over 10,000 cases due to its robustness, patient acceptance, and versatility for all anatomic locations where symptomatic burn scars were found. He formulated reconstruction of the massively-burned child and taught these techniques to a generation of burn reconstructive surgeons. Dr. Huang's publications include reconstruction of burned hands^{77,78}, Y to V mucosal advancement flaps for burn microstomia^{79,80}, complex eyelid reconstruction^{81–84}, reconstruction of the burned breast^{85–88}, reconstruction of neck contractures^{89,90}, reconstruction of scar contractures affecting the major joints^{91,92}, and the role of post-burn intense exercise in reducing the need for subsequent contracture releases.⁹³

Robert McCauley provided numerous contributions to burn care and reconstruction, notably the pathophysiology of frostbite and treatment thereof, including some of the earliest reports of the importance of thromboxane-mediated vasoconstriction.^{94,95} His extensive experience in the functional and aesthetic reconstruction of burned patients is also evidenced by the textbook he edited on this subject.⁹⁶ He also participated in studies that identified the scalp as a preferred split-thickness skin graft donor site.^{97–99} Finally, he helped to report on the benefits and pitfalls associated with the use of cultured keratinocytes for wound closure in massively-burned patients.^{97–101}

The psychological response to burn injury has also been an area of study, as increasing survival allowed focus on post-burn quality of life.^{102–104} Burned children at Galveston have participated in National Institute of Disability, Independent Living, and Rehabilitation Research Burn Model System database. This repository improves burn treatment by providing insight into experiential and psychosocial aspects of burn survivorship, as well as easy to understand topical summaries for both burn patients and providers.¹⁰⁵ Distress experienced after burn injury comes in many forms, and Walter J. Meyer, pediatrician, endocrinologist, and psychiatrist at Galveston has led a team of physicians and ancillary staff to better understand and treat the aftereffects of burn injury including pain, itch, post-traumatic stress disorder, endocrine derangements, and affective symptoms.^{104,106–109}

In children, normal growth is a convenient global marker for health, and burn injury is a cause of growth delay.¹¹⁰ Recently, a randomized, controlled trial showed that the treatment of prepubertal children with the combination of oxandrolone and propranolol shortened the period of growth arrest and normalized the growth rate.¹¹¹

The epidemiological description and prevention of burn injuries remain areas for further progress; however, notable achievements in these areas include promulgation of federal flammability standards for children's sleepwear and for water heater installation. Recently, the recognition of a high incidence of severe childhood scald injuries in Mexico related to cooking practices may allow further prevention efforts and reduction of human suffering.¹¹²

Conclusion

The Shriners are an international organization composed of Freemasons who, among other charitable activities, fund and administer a network of children's hospitals around the world. These are the aims of Shriners Hospitals for Children's involvement in pediatric burn care: zero mortality, zero disability, absence of scar, absence of pain and distress, and no more incident burn injuries. To that end, they have been at the forefront of burn care and burn research for the past 50 years, pioneering treatments in excision and grafting, fluid resuscitation, nutrition and metabolism, and burn reconstruction, which have benefitted the children in their care as well as patients worldwide. Despite demographic headwinds due to an aging population, the near-absence of self-promotion, and a custom that a request to join must be freely made, all patients are provided for irrespective of ability to pay. This care is funded by the philanthropy of Shriners International and the generosity of donors, from sources as large as business conglomerates and as small as bake sales. Through these efforts, burn mortality has been dramatically decreased. Along with affiliated organizations, such as the Daughters of the Nile and Ladies Oriental Shrine of North America, Shriners continue to give for the benefit of burned children and their families worldwide. Several of the pioneers in burn care did not just practice medicine and surgery at Shriners Hospitals for Children; as Shriners themselves, they practiced the tenets and ethos of Masonry. As an organization, Shriners provides medical care to children regardless of ability to pay and funds revolutionary research because it is the right thing to do.

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Figure 1.
General Truman Graves Blocker, Jr., M.D. President (1967) of the University of Texas
Medical Branch and the fulcrum for the first Shrine Burns Institute during its early years.

Table 1

Observed versus expected survival, p values and 95% confidence intervals are by Chi-square. See text for additional details.

Shriners Hospitals for Children Galveston, All Acute Burn Admissions, 1989–2017, Ages 0–18 years				
Total N = 5737	Actual Observed	Expected Curreri-1980 model	Expected Shirani-1987 model	Expected Osler- 2010 model
Nonsurvivors	175	791	728	293
Odds Ratio	--	0.2	0.22	0.6
95% Confidence Interval	--	0.17–0.23	0.18–0.26	0.49–0.72
p-value	--	<0.0001	<0.0001	<0.0001