Pediatric Burns, Treatment & CEA
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Objectives
• Examine pediatric burns & classification
• Describe skin & the process of using cultured epithelial autografts (CEA)
• Explore the use of CEA through a case study
• Discuss current & emerging treatment options

Incidence of Pediatric Burn Injuries
• Every day, over 300 children ages 0 to 17 are treated in emergency rooms for burn-related injuries and 2 children die as a result of being burned (CDC)
• 250,000 children (0-17) are burned each year (Burn Foundation, 2017)
• 15,000 hospitalized each year (Burn Foundation, 2017)
• 1,100 die each year from fire & burn injury (Burn Foundation, 2017)
• Scalding injuries are more prevalent in children <5 years of age, while flame/fire is most prevalent at all other age groups (American Burn Association, 2015)

Incidence of Pediatric Burn Injuries
• Partial thickness burns greater than 10% total body surface area (TBSA).
• Burns that involve the face, hands, feet, genitalia, perineum, or major joints.
• Third degree burns in any age group.
• Electrical burns, including lightning injury.
• Chemical burns.
• Inhalation injury.
• Burn injury in patients with preexisting medical disorders
• Any patient with burns and concomitant trauma (such as fractures) in which the burn injury poses the greatest risk of morbidity or mortality.
• Burned children in hospitals without qualified personnel or equipment for the care of children.
• Burn injury in patients who will require special social, emotional, or rehabilitative intervention.

Local Designated Pediatric Burn Centers
Recognized by The American Burn Foundation
• Lehigh Valley Hospital & Health Network, Allentown, PA (adult & pediatric)
• St. Christopher’s Hospital for Children Pediatric Burn Center (pediatric)
• Temple University Hospital Temple Burn Center (adult & pediatric)
• Crozer-Chester Medical Center: Nathan Speare Regional Burn Treatment Center (adult & pediatric)

Classifying Burns by Total body surface area (TBSA)

Rule of Nines

CHILD

<table>
<thead>
<tr>
<th>Body Part</th>
<th>% of TBSA</th>
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</thead>
<tbody>
<tr>
<td>Head &amp; Neck</td>
<td>19%</td>
</tr>
<tr>
<td>Arm</td>
<td>9%</td>
</tr>
<tr>
<td>Ant. trunk</td>
<td>18%</td>
</tr>
<tr>
<td>Post. trunk</td>
<td>18%</td>
</tr>
<tr>
<td>Each leg</td>
<td>13.5%</td>
</tr>
<tr>
<td>Perineal area</td>
<td>1%</td>
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</table>
Classification of Burns

Superficial Thickness Burn (First degree burn)
- Involves only the first layer of skin epidermis only
- Skin is pink/red with mild edema
- Heals without treatment or scarring in 3-6 days

Partial Thickness Burn (2nd degree)
- Epidermis & portion of dermis
- Healing Time: within 21 days (3 weeks)
- Characteristics: blister formation, pink or mottled red, pain
- Cause: scald, flash flame
- Complications rare, minimal scarring unless infected
Deep partial thickness (2nd degree)

- Epidermis and dermis
- Healing time: within 3-6 wks
- Characteristics: pale, mottled, insensate, white/waxy, ESCHAR
- Conversion to full-thickness by bacteria, scarring is common
- Skin grafting improves quality & appearance

Full Thickness (3rd degree)

- Epidermis, dermis & underlying subcutaneous tissue
- No potential for re-epithelialization
- Skin grafting required for wound closure
- Characteristics: range in color from pale to bright red. Little to no cap refill. Leathery eschar, white or charred black tissue,
- Insensate, no pain

Full Thickness (4th degree)

- Full thickness
- Extending into the bone & muscle
- Black & dry
- No pain
- Eschar formation

Full Thickness (3rd degree)
Skin composition

- **Epidermis**: which comprised mainly of keratinocytes, melanocytes which give pigmentation and Langerhans' cells which provide immune surveillance.
- **Dermis**: connective tissues that consists mainly of extracellular matrix (ECM) or structural components (predominantly collagen and elastin) which give mechanical strength, elasticity and a vascular plexus for skin nourishment.
- Cells interspersed within the ECM = fibroblasts, endothelial cells, smooth muscle cells and mast cells.

Basement membrane (BM)-

- Between the epidermis and dermis
- Glycoproteins and proteoglycans that separate the 2 layers
- BM contains at least one member of the four protein families or subtypes of:
  - laminin,
  - type IV collagen,
  - nidogen, and
  - Perlecan: a heparan sulfate proteoglycan.

Remember...

- In the epidermis & dermis are:
  - hair follicles,
  - sweat glands,
  - sebaceous glands,
  - blood vessels and
  - nerves

CEA-History

- In the 1970s Professor Howard Green of Harvard Medical School developed a method that involved culturing keratinocytes together with mouse fibroblasts* to form a keratinocyte sheet, a method now known as Green's technique for culturing epidermis.
- In 1984 it attracted worldwide attention when the lives of two severely burned children were saved by this technique, which was used to generate 5000-7000 cm² of cultured epithelium for grafting from what little skin remained to them.

Cultured Epithelial Autografts (CEA)

- Ideal for patients with large BSA burns where limited unburned skin is available for a donor site to graft
- CEA is grown from 1 or 2 small (2-3 cm long by 1 cm wide) biopsy areas of the patients own skin (usually axilla or groin)
- Takes 3-4 weeks to grow...

2 Types of CEA

- **Spray or sheets**
  - Evolved from CEA to aerosol-delivered cell-clusters, and is known as 'spray-on skin'. (Developed by Wood & Stoner, 1993)
  - Image: fionawoodfoundation.com

- **Image**: www.jpte.co.jp
The process

Problems with CEA
- Thin friable skin
- Lack of dermal cells will cause poor “take”
- Prone to contracture
- Time...wait weeks to grow
- High cost

Initial Treatment
- Initial available skin grafting done
- Wounds cleaned & prepared
- All wounds covered with Biobrane®
- Biobrane® is a biocomposite dressing of nylon fibers embedded in silicone to which collagen has been chemically bound

Initial Treatment (cont)
- Biobrane-2 layers
  - Inner layer-nylon allows fibrovascular growth
  - Outer layer-barrier to fluid and bacteria
- Irrigated the burns with 30 mls. sulfamylon & nystatin solution q 6 hours via red rubber catheters strategically placed.
- Re-harvest graft sites when ready
- Wait 3-4 weeks for CEA.
- To the OR for CEA placement

Important Care Items
- **No position changes**: pressure would prevent CEA from taking
- **No bending of L arm or neck**
- **No pressure** like trach tubing on chest
- **No splints** (pressure)
- ***note: CEA was phase 2 wound care**
- Phase 1: was covered wound to prevent infection w biobrane, red rubber catheters with irrigation of sulfamylon & nystatin solution (30 mls) q 6 hrs
- Graft what could be grafted

Outcome- Excellent
- All areas of CEA took except the post wrist which was resting on the bedside table 😐
- Pt was on ventilator 3-4 months
- Prolonged PICU stay
- Daily dressing changes (approx. 3 hours)
- Left. Pt refused to wear pressure dressings, developed contracture of neck
- Needed later surgery for contracture release
Today CEA... Chua et al, (2016)

- Trends...combine dermal substitute Integra & CEA.
- Initial wound coverage with either cadaver skin allograft or collagen-glycoaminoglycansilastic sheet (Integra)
- Follow with CEA application

Emerging Treatments... Chua et al, (2016)

- Stem cells-adult & embryonic
  - Adult-human induced pluripotent stem cells which allows programing of adult somatic cells to embryonic-stage cells Nobel Prize winning technology by Yamanka & team. (clinical trial halted)
  - Problem...finding the microenvironment (in vitro, in vivo) to provide necessary molecular development or cell signals so that stem cells can regenerate a fully functioning skin remains the challenge.

In conclusion

- Burn care continues to evolve
- New promising evolving skin tissue engineering products
- Cost-very expensive
- Outcomes-do they work and how durable are they in the long term (life long)

Cost of Common Skin Substitutes/Replacements

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<thead>
<tr>
<th>Product</th>
<th>Permanency</th>
<th>Cost/100 cm²</th>
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<tbody>
<tr>
<td>Biobrane®</td>
<td>No</td>
<td>$100</td>
</tr>
<tr>
<td>Allograft</td>
<td>No/Yes</td>
<td>$160</td>
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<tr>
<td>Alloderm®</td>
<td>Yes</td>
<td>$912</td>
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<td>Integra®</td>
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<td>Epider®</td>
<td>Yes</td>
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<tr>
<td>Apligraf®</td>
<td>No</td>
<td>$2,310</td>
</tr>
<tr>
<td>Permanderm® (ESS)</td>
<td>Yes</td>
<td>$3,200*</td>
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References