Table of Contents

Chapter 1
Introduction

Welcome to the Burn and Soft Tissue Service. This manual will serve as an introduction to who we are and what we do as a multidisciplinary burn team. This is also your guide to the management of the service from admission guidelines to discharge planning, burn assessment and wound care, burn resuscitation, surgical technique and reconstructive strategies as well as guidance on the management of ancillary soft tissue wounds. Please note, as the team grows and burn care advances, this manual will change. We hope that this serves as a resource for you during your time on the service and in the future.

Scope of Service:
The Burn and Soft Tissue Surgery Service will primarily manage the conditions/injuries listed below. The 'Wound Grid' is a document that describes admission criteria that has been agreed to with medicine, general surgery and vascular services. Refer to **Wound Management Grid** (See Appendix A). We work closely with the wound care nurses; they are the gatekeepers to our service. If they feel that the patient may require surgical intervention then our service will be consulted.

Primary Service Admission:

- burns, necrotizing infections, cold injuries, exfoliative skins diseases (>15% open wounds)

Consults: If there is a medical reason for the wound, it should be managed by medicine

- decubitus ulcers, cellulitis, diabetic foot ulcers, exfoliative skins diseases (<15% open wounds)

Trauma: generally, go to trauma, unless there are complex closure/grafting needs

- compartment syndrome, large hematomas

General Surgery: we can help if the wound is complex or requires grafting

- simple abscesses, peri-rectal abscess

General Information:
Burn and Soft Tissue Service Pager: 741-3016
Epic Consult Order: Inpatient consult to Burn and Soft Tissue Surgery
See Appendix B for "Burn and Soft Tissue Service 101" – a quick reference for service information

Schedule:

New Resident Orientation: First Day on Service, time TBD prior to starting the rotation
Morning Sign Out: Everyday @ 0530 – R3 Provider Office
Morning Report: Monday through Friday @ 0630. Saturday and Sunday @ 0700 – R3 Conference Room

- Present 24 hr admits, complications, escalations of care, education

BST Daily Rounds**:** Monday, Tuesday, Wednesday, Friday @ 0800, Thursday @1000 - R3 conference room
R3 Wound Rounds: Monday through Friday (except Wednesday) @ 1100 – R3 nurses station

- Review plan for all R3 BST patients, assess wounds requested in advance on white board

PIPS: Tuesday @ 700-800 - R3 conference room - PI Review for Burn/Trauma patients
Multidisciplinary Burn Rounds: Wednesday @ 1200-1300 - R3 conference room

- Present all inpatient burns, document Plan of Care note, education/research discussion

Burn Clinic**:** Wednesday @ 1300- 1500 w/ BST attending of the week & APP

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
0530	Morning Sign Out	Morning Sign Out	Morning Sign Out	Morning Sign Out	Morning Sign Out	Morning Sign Out	Morning Sign Out
0630 – 0700	Morning Report	Morning Report	Morning Report	Morning Report	Morning Report	Morning Report	Morning Report
0700 – 0800		PIPS					
0800	Daily Rounds	Daily Rounds	Daily Rounds		Daily Rounds		
1000				Daily Rounds			
1100	R3 Wound Rounds	R3 Wound Rounds	R3 MDR	R3 Wound Rounds	R3 Wound Rounds		
1300 – 1600			Burn Clinic				
1730	Night Sign Out	Night Sign Out	Night Sign Out	Night Sign Out	Night Sign Out	Night Sign Out	Night Sign Out
Notes		OR Block Time			OR Block Time		

Documentation:

Burn Admission Note: every burn admission/consult
dot phrase: BURNADMIT

Soft Tissue Consult Note: use for all consults other than burns/trauma
dot phrase: BSTCONSULT

Tertiary Note**:** complete for burns within 24 hrs of admission
dot phrase: BURNTERTIARY

Burn Primary Progress Note: use for daily rounding on BST Primary patients
dot phrase: BURNPROGRESSNOTE

Burn Consult Progress Note: use as progress note for consults
dot phrase: BURNUPDATENOTE

Plan of Care Note**:** complete at burn MDR every Wednesday
dot phrase: BURNPLANOFCARE

Discharge Summary:
smart text: MH IP SURG DISCHARGE SUMMARY

Discharge Instructions**:** ensure up to date wound care instructions are included
dot phrase: BURNDCINSTRUCTIONS

Plan for Burns**:** use in daily progress note for burn patients
dot phrase: BURNPLAN

Burn Pre Op Checklist**:** document this preop, the day prior to ALL burn cases
dot phrase: BURNORCHECKLIST

Wound Care Instruction**:** this dot phrase will import all wound care instructions into note
dot phrase: WOUNDORDER

History of Burn Care in Maine

The following historical information is based in part from the 1992 publication byClark and colleagues (Clark, DE, Katz, MS, Campbell SM. Decreasing Mortality and Morbidity Rates after the Institution of a Statewide burn Program. J Burn Care Rehab 1992; 13:261-70).

According to a survey conducted by the State Health Planning council in 1974, it was determined that many Maine hospitals were not physically or professionally equipped to care for severe burns. Furthermore, transfer to out of state facilities created financial hardships for patients and families, and initial stabilization and rehabilitation of severe burns were often inadequate. As a result of this survey, an Advisory Burn Committee was appointed by the Maine Medical Association. A burn unit was planned at MMC as well as secondary burn programs at three additional hospitals across the state. The newly developed system for the care of burns included incorporation and assessment of existing skills, the new Emergency Medical Services communication system, hospital commitments and educational programs.

During this period of time, the 1973 Arab Oil Embargo forced many Maine families to convert to wood burning as a source of heat. With the increase in wood burning stoves and associated burn injuries, the Fire Marshall's office initiated a number of safety programs. In addition to work by the Fire Marshall's office, financial support from the Maine State Federation of Firefighters helped establish the Pine Tree Burn Foundation for Burn Treatment in 1976. The Pine Tree Burn Foundation still exists today, however its focus has shifted from hospital support to primarily prevention efforts.

By the end of 1976, a six bed burn unit without critical care abilities was opened at MMC on the 4th floor. A small group of plastic, pediatric and general surgeons with an interest and training in burn care were assigned responsibility for treating burn patients. Clinical and educational support for the MMC burn program was provided by regional burn centers such as Massachusetts General Hospital and the Shriners Burns Institute.

In 1985, the former burn unit was replaced by a new four bed burn unit in the new LL Bean wing, which is now known as the Special Care Unit section 4 (SCU 4). This unit was able to care for critically ill patients and had its own hydrotherapy room, now renamed as the "Burn Procedure room". Many staff still refer to this room as the "Tank room" reflecting back to when it housed the hydrotherapy tanks.

Since this time, the MMC burn program has gone through many changes. In 1988, due to declining burn patient admission numbers, the unit merged with SCU and thus the program became decentralized. Burn patients now were either cared for in SCU, R3, or Pediatrics (now the BBCH). Other aspects of the program were strengthened. A Burn Resource Nurse was appointed, and an organized system for out-patient burn follow up was established.

In 2014, plans were underway to expand the burn service to include patients with complex surgical wounds and recruit surgeons with specific expertise in burn care. Dr. Damien Carter was recruited and hired in 2015 and became the Director of the newly established Burn

and Soft Tissue Service. During this same time period, out-patient wound services were expanded by the opening of the MMC Wound Center at the Brighton Campus. In 2019, under Dr. Carter's guidance, the SCU 4 Burn Procedure room underwent major renovations to become a state of the art procedure room with wound care and sedation capabilities. The burn program looks forward to continued growth and plans to apply for burn center verification which is the highest acknowledgement of excellence in the burn community.

Physician Leadership
Maine Medical Center Burn Directors

Richard C. Britton, MD
1976 – 1982

David E. Clark, MD
1982 – 1996

Brad Cushing, MD
1996 – 2004

Robert Winchell, MD
2004 – 2013

Damien W. Carter, MD
2015 – Present

Nursing Leadership
Burn Resource Nurse

Susan Campbell RN, MS
1988 – 1989

Susan Reeder RN, MSN, CWCN
1989 – 2020

Hannah Miner RN, BSN, CWCN
2020 – Present

Chapter 2
Burn Clinical Team Members

Comprehensive burn care requires the expertise of a multidisciplinary team. Each member contributes to the management and care of these complex trauma patients. The weekly multi-disciplinary conference is an important meeting for the exchange of ideas regarding patient management to ensure continuous process & quality improvement.

Burn Surgeons/Attendings
The burn attending is responsible for formulating the operative and wound care plans for each patient on the service. They guide the overall clinical management decisions for each burn and soft tissue patient managed or consulted by the service. While the Burn attending's steer the ship, we do not operate in a vacuum and require the counsel and input from members of the burn team. Damien Carter, MD is the Burn service director. Stacey Rotta, MD and Elizabeth Turner, MD also serve as attending surgeons on the BST service.

Burn Advanced Practice Provider(s)
Rosemary Paine, NP, RNFA serves as the Burn APP and functions as the provider level continuity of the service. Rose is a resource to the residents rotating on the service by assisting them in learning to care for these complex patients and helping with the "work" of the service including documentation. Rose is integrated across all aspects of the service including the outpatient burn clinic, OR cases, SCU, floor and tank room procedures, dressing changes and routine floor work as well as initial evaluation burn and soft tissue consultations.

Burn and Wound Resource Nurse
The Burn/Wound Resource Nurse role is held by a nurse who has comprehensive knowledge in burn and wound care and clinical nursing practice, plus the attainment of CWCN certification. This nurse provides clinical expertise through direct and indirect care in complex situations, promotes continuity of patient care, contributes to product selection and management, is an active participant in the field of burn nursing, plans and provides education in the area of burns and wounds to the team and nursing staff, and helps to develop policies, procedures, and care practice guidelines. We welcomed Hannah Miner to the team December 2020. Sue Reeder, the Burn Resource Nurse for many years, has transitioned to the Wound/Ostomy Nurse role at MMC.

Residents
The primary role of residents rotating on the service is to learn. We want them to leave the service comfortable with the surgical management of burns, necrotizing fasciitis, diabetic foot infections and other complex wounds. We all feel it is our responsibility to teach the interns to care for complex wounds as well as the art and science of excision and grafting and extremity amputations. The residents will get extensive operative experience throughout the rotation. They will be expected to manage the service with the assistance & guidance of the APP on the service.

Burn Therapists (PT/OT)
Burn therapists are either physical or occupational therapists. A small cadre of them care for burn patients because of the specialized nature of the care provided. Each burn therapist is responsible for devising the therapy plan for burn patients and guiding the actual therapy. This is a dynamic process that evolves throughout a patient's hospital course. Physical therapy and splinting are of critical importance to functional recovery after a burn injury and thus these folks are thoroughly involved in patient management. The burn therapists also are intimately involved in outpatient follow up and management through clinic.

Rehab Psychologist
Our service has a dedicated rehabilitation psychologist – Diana Sholtz, PsychD. She is tasked with the assessment and management of the emotional and mental wellbeing of our burn patients. Additionally, the rehab psychologist manages the use of non-pharmacologic pain management strategies such as virtual reality (VR) and hypnosis. She is vital in assisting with behavioral interventions for problematic patients that allow therapeutic success for the provider team and therapists. In the outpatient setting, she evaluates and manages patients with stress disorders and assists patients with coping, self-image and other mental health aspects of burn recovery.

Clinical Pharmacist
Katie Smith, PharmD is an integral part of the burn team and assists us in medication management with burn patients during the inpatient phase of care.

Nutritionist
Michele Creech leads a team of registered dieticians that ensure optimal feeding in burn patients. They recommend dietary interventions that provide optimal nutritional support to combat the hypermetabolic response to burn injury. Caloric intake, vitamins, minerals and trace elements must be managed to promote wound healing and facilitate recovery.

ICU Nurses
Our ICU nurses are responsible for management of the acute resuscitation protocol in the ICU as well as providing optimal care for the critically ill burn patients. The ICU nurses have either achieved or are working towards specific institutional burn nurse competencies

R3 Floor Nurses
A cadre of specially trained nurses facilitates the day to day care of burn patients on the inpatient floor. R3 is the designated acute care burn unit. A cadre of specially trained nurses facilitates the day to day care of burn patients. These nurses work compassionately with patients throughout their transition from the acute phase to discharge.

Outpatient Burn Clinic Team
Burn Clinic is on Wednesday afternoon from 1-5. Outpatient team is multidisciplinary and works to support burn patients during the recovery period with challenges such as burn scar management, PTSD, and reintegration back to work.

Chapter 3
BST Service Admission Policies

Placement of Burn Patients

This section outlines where adult burn patients are placed. It includes the admission process, which nursing unit is most appropriate and when outpatient care is indicated.

Initial Evaluation

All burn patients will initially be evaluated in the Emergency Department. After initial evaluation, patients will be transferred to the Burn Procedure Room for further evaluation and specialty nursing care. The SCU coordinator should be notified of burn admissions as soon as possible so that resources can be obtained. Patients transferred from the burn clinic may go directly to the Burn Procedure Room after appropriate arrangements have been communicated. Placement of patients is determined by a collaborative decision from the Attending physician and/or designee, SCU Nurse Coordinator and R3 unit designee as appropriate.

Admit to Special Care Unit (SCU) 4

- Patients requiring ventilator assistance and/or respiratory monitoring due to inhalation injury
- Patients requiring ECG, arterial line or hemodynamic monitoring
- Patients with wounds 20 % TBSA or greater that require fluid resuscitation
- Other extenuating factors (age, associated injuries, uncontrolled pain, previous medical problems that will increase complexity of management)
- Patients with circumferential burns requiring observation of neurovascular monitoring < Q4hrs in frequency

Admit to R3

- Patients not requiring monitoring outlined in the SCU admission section (ventilator, respiratory, arterial line, hemodynamic)
- Patients who require ECG monitoring may be appropriate for R3 COR admission
- Patients with less than 20% TBSA burns. Wound care time should be less than 60-90 minutes for an R3 admission. The decision to transfer should be negotiated in advance with Charge Nurse involvement to determine if needs can be met on R3.

Manage on Out-Patient Basis

- Patients who do not meet criteria for SCU 4 or R3 admission
- Patients have adequate support systems in place to assist them in caring for their burns at home (e.g.: family, friends, or community health nurses)
- Patients for whom the location of the burn will not impede their ability to care for the burn at home
- Note: if appropriate, OT and/or PT should see patient prior to discharge

Criteria for Transfer:

The ABA recommends the following patients are transferred to a Burn Center:

- Partial thickness burns greater than 10% TBSA
- Burns that involve face, hands, feet, genitalia, perineum or major joints
- Full thickness burns
- Electrical burns, including lightening
- Chemical burns
- Inhalation injury
- Burn injury in patients with ~~a~~ pre-existing medical conditions which could complicate management, prolong recovery or affect mortality
- Any patient with burns and concomitant trauma in which the burn injury poses the greatest risk of morbidity and mortality. In such cases, if the trauma poses the greater or the immediate risk, the patient may be initially stabilized in a trauma center before getting transferred to a burn center
- Burned children in hospitals without qualified personnel or equipment for the care of children
- Burn injury in patients who will require special social, emotion or rehabilitative intervention

This list should be used as a guide when deciding whether to transfer or not to transfer a patient. Please consider the location of the patient and the size/severity of each case prior to initiating a transfer. If the burn can be managed as an outpatient, then see the section on *Follow-up* to arrange for outpatient evaluation. If necessary, the referring provider may send pictures for the burn attending to review prior to accepting a transfer.

Chapter 4
Burn Procedure Room and ED Procedures

For adult burn patients, initial evaluation will be completed in the ED, then the patient will be transferred to the SCU 4 Burn Procedure Room for further evaluation and wound care.

Initial care of burn patient in the ED

- Keep the patient warm: remove clothing and wet dressings, have warm blankets available, if temp <36 C, cover areas not being worked on directly.
- Perform physical exam including airway/breathing (facial burns, carbonaceous material in nares, mouth or sputum, breath sounds) and circulatory assessment (cardiac monitor, assess peripheral pulses at least Q30 min).
- For burns >20%, make sure there are 2 IV access sites. Move IV away from burn wounds if possible.
- Vital signs are monitored Q15 – 30 min.
- Obtain patient weight after removing wet dressings and/or linen using the stretcher scale.
- Prepare supplies for fluorescein instillation /woods lamp evaluation (done in the burn procedure room).
- Cover burns with dry dressings until initial burn care is completed in the Burn Procedure room.

Prior to Transfer to Burn Procedure Room

1. Notify SCU Charge RN
2. Notify additional team members of admission if appropriate (Burn/Wound Resource Nurse, PT, OT, SW)
3. Complete the Burn Report Worksheet
4. Nurse to Nurse report should be given prior to transfer
5. Prepare supplies for fluorescein instillation /woods lamp evaluation (done in the burn procedure room)

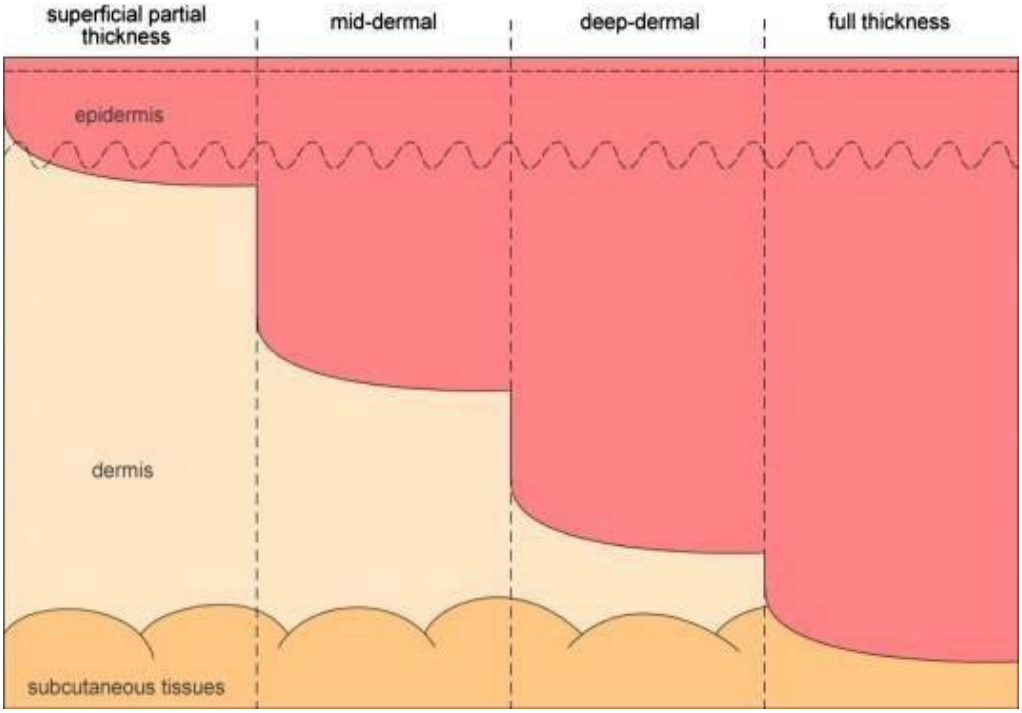
Wound Care

- Initial wound care should be completed in the Burn Procedure Room when the patient is stabilized.
- If wound care is anticipated to take a prolonged time, consider letting the family see patient briefly prior to starting, as appropriate.
- Refer to Chapter 7: Initial Wound Care
- Refer to Chapter 9: MMC Infection Control Guidelines

Chapter 5
Classification of Burns

Burn wounds are classified using the following terminology: superficial, superficial partial thickness, deep partial thickness, full thickness or indeterminate. Characteristics of each type of burn are listed below. After initial debridement is complete, it is the admitting provider's responsibility to assess and document the burn depth and %TBSA for each anatomic location in the admission and tertiary notes.

Overview of Burn Wound Depth:



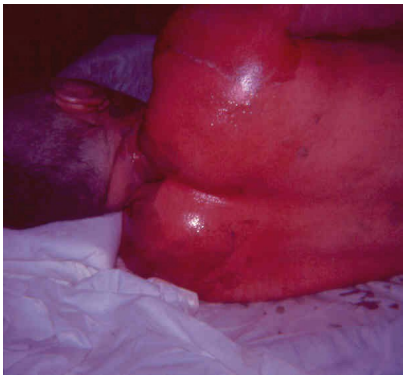
Mechanism of Injury:
Knowing the cause of the burn is an important factor when assessing burn wound depth. Below are some additional examples:

- Scald burns, without presence of grease or fat, tend to be partial thickness unless in the very young or elderly patient.
- Scald burns, caused by grease, tend to be deep partial to full thickness.
- Chemical burns frequently develop into full thickness burns by the nature of the mechanism
- Flash burns tend to be partial thickness.
- Flame burns (direct contact with flame) tend to be deeper (deep partial to full thickness).
    - Note: Knowing the temperature and duration of contact helps to determine burn depth.

Superficial Partial Thickness Burns

Burns that extend into the superficial dermis. Characteristics:

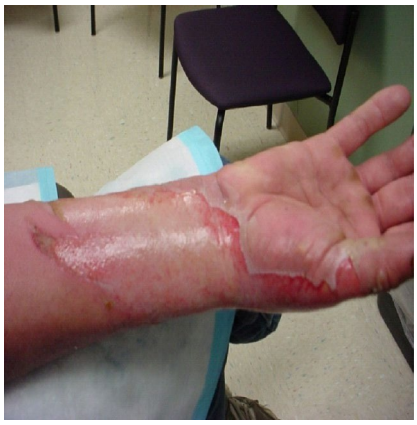
- Red or pink in color, wet/ weeping serous fluid
- Often form blisters, although they may take several hours to form.
- Brisk blanching/ capillary refill
- Hypersensitive to touch. Typically, even air moving over the wound is very painful. Cover the wound as quickly as possible to reduce pain, avoid leaving wound exposed.
- Burns typically heal in approximately 2 weeks



Deep Partial Thickness Burns

Burns that extend to the deeper dermal layers.
Characteristics:

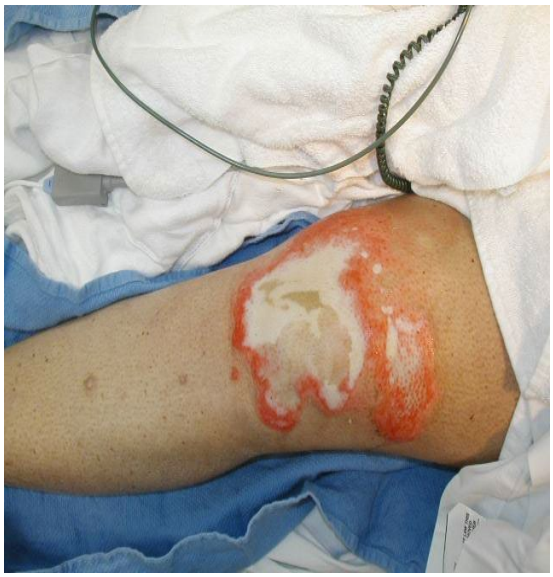
- Appear mottled pink, may have white/ pale areas
- May or may not blister
- Sluggish to no capillary refill
- Less sensitive than partial thickness burns (best to use light touch)
- Heal within 3-4 weeks. Wounds that do not heal within 3 weeks may require grafting.



Full Thickness Burns

Burns that involve the dermis and extend into the subcutaneous tissue.
Characteristics:

- Appear pale, mottled pink to white, may be charred or red
- **Leathery, dry texture**
- No blanching with pressure
- Insensate to light touch. Pain is decreased, however the wound edges may still be painful
- Typically requiring graft to avoid scar formation



Indeterminate Depth: Partial Thickness vs. Full Thickness

Burns that are not clearly identifiable. This is one of the most challenging assessments. Often takes serial assessments over several days to determine depth and healing potential. Healing potential usually peaks in about 3 days – often referred to "allowing the wound to declare or demarcate".

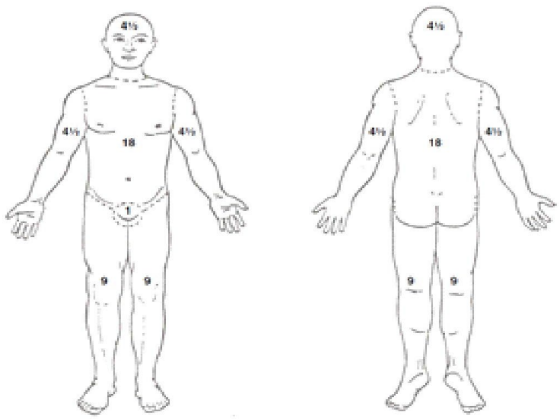
Chapter 6
Assessing Burn Wound Size

Estimation of %Total Body Surface Area (TBSA) in Adults

- Estimate the %TBSA only after the patient has been cleansed/debrided and the wound bed can be properly assessed.
- Only include areas of partial and full thickness burn in the calculations (where the skin is broken) – do not include superficial thickness burns.
- If having difficulty with estimates, it may be useful to calculate the percent of unburned tissue (the reverse) for comparison.
- The %TBSA Burn Man Work Sheet (Appendix C) MUST be completed by the admitting provider and uploaded into EPIC in order to illustrate the location and size of the burn.

Rule of Nines (RON)

This is the most common method used to estimate %TBSA of burn in adults. According to the RON, regions of the body are divided into multiple of 9% (See table below).



Palmar Method

For smaller burns and burns with scattered patterns, the RON may not be the best method to determine %TBSA. In this instance, the size of the patient's hand (including the fingers) is equal to 1 % of their body surface area. This is the same for adults and children.

Pediatric Burn Size

In children, the body percentages are not the same as adults. For example, the head is larger when compared to the rest of the body and the legs are smaller. The RON is not used in children for this reason. There are specialized charts, such as the Lund and Browder Chart that provide more accurate calculations for children.

Chapter 7
Wound Care for Burn Injuries

Wound Photography

Wounds should be photographed on admission and a minimum of weekly using a hospital approved device/ app that protects patient confidentiality. Photographs should be taken after the wounds have been debrided and cleansed (creams and dressings removed).

Wound Care Goals for Burn Injuries

1. Reduce pain
2. Prevent infection
3. Prevent scarring by helping the wound heal as quickly as possible
4. Prepare the wound for healing or grafting

Initial Burn Care

1. Initial burn care should be performed in the Burn Procedure Room/Tank Room.
2. Don mask, eye protection and clean gloves (not sterile) for wound care procedures. For larger burns, a hat and barrier gown is recommended. Knee high booties and plastic aprons with sleeves should be worn during shower procedures.
3. Set up a clean field and use "Clean Technique" to prepare and apply dressings.
4. Keep the patient warm. Have warm blanket available and consider working on one part of the body at a time if the patient is cold.
5. Cleanse burns and skin with soap and water. Showering is preferable if patient is able. If bathing in bed, clean perineum and buttocks last.
6. Shave hair over burns (beard, scalp, legs, back, etc.) including a 1-2 cm border. Do not shave eyebrows.
7. Trim melted/singed hair, then shampoo and rinse.
8. Repeat these steps and **Refer to Chapter 9: MMC Infection Control Guidelines** for detailed instructions for subsequent burn care on unit.

Burn Cleansing Technique

1. Ensure patient is adequately pre-medicated 30-60min prior to wound care. Before burn cleansing, it is often helpful to remind patient to take a deep breath as this promotes vasodilation and may improve pain tolerance.
2. Use a soapy washcloth to gently remove debris, drainage, ointments/creams, and/or carbonaceous material from the wound. Pass washcloth over wound surface making light contact with wound bed. DO NOT SCRUB BURNS. **It is imperative to make gentle contact with the wound surface during cleansing, as this helps to prevent buildup of bioburden.**
3. Rinse off soap.
4. Pat dry and apply appropriate topical and dressings (Refer to Appendix D: Burn Decision Tree)

Blister Care

Blister removal is decided on a case-by-case basis based on some basic principles. If the blister has ruptured, proceed to remove the rest of the loose blister skin. Large fluid filled blisters should also be removed since they often interfere with range of motion and do not stay intact for long. Small blisters on the palms of the hands (that do not interfere with range of motion) or soles of the feet can be left intact since the skin tends to be thick in these locations. Loose intact blisters are often easily debrided by passing over them gently with a soapy washcloth.

Care of Special Areas

Ears - Avoid initial sharp debridement of the cartilage (this is usually allowed to separate on its own). If applying a cream to the ear, place a 2x2 gauze into the ear opening to prevent cream from entering ear canal. Cream should be applied directly to the burn wound.

Hands/Feet - Wrap each finger/toe separately with topical dressing, separate toes by pulling gauze firmly into web spaces (no two burned surfaces should touch). Secure with gauze roll, wrapping each individual digit. Expose distal nailbeds for circulatory monitoring. If burns are circumferential, cut a window in the dressing over pulse point and monitor pulses Q1H. Elevate affected extremities above heart level.

Chapter 8
Burn Wound Dressings & Topicals

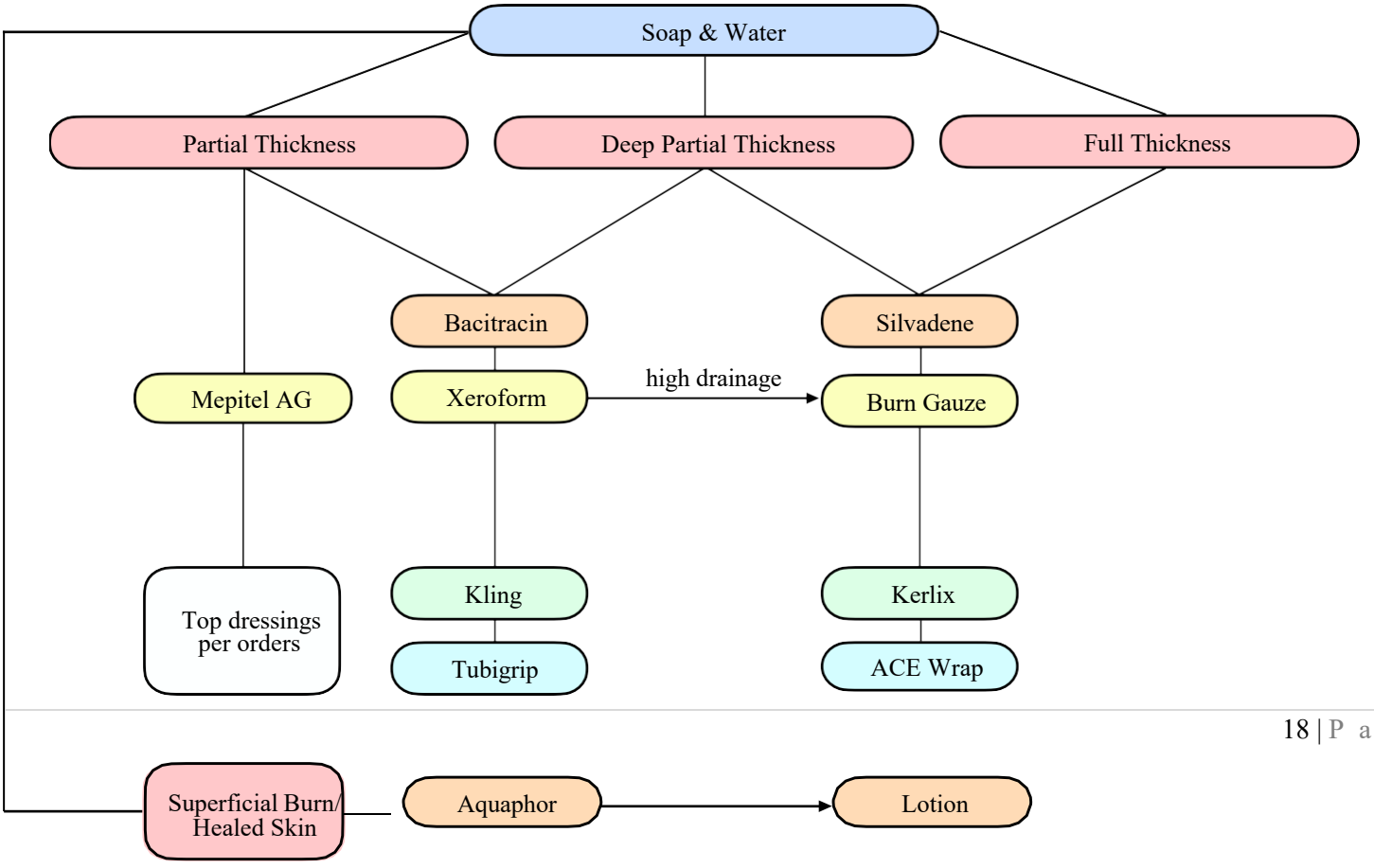
Wound care is determined by wound depth and need for antimicrobial treatment. The decision tree below is a tool to guide wound care based on burn depth. One of the primary functions of a burn dressing/topical ointment is to keep the wound moist. Wounds should not be allowed to form a dry scab or crust because this inhibits the ability of epithelial cells to move across the wound surface. Wounds that have dried out are also more likely to become infected and painful. The following are common burn dressings/ topical agents that you may see used. Qualities of an ideal burn dressing include:

- Easy to apply
- Easy to teach staff, patient, family how to manage
- Keeps the wound bed moist but not *too* moist
- Prevents infection
- Prevents re-traumatization of wound bed
- Reduces pain
- Cost effective

MMC Burn Care Decision Tree

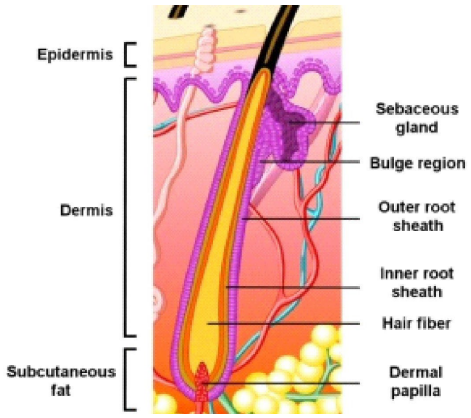
Epithelial Budding

As partial thickness burns heal, new islands of epithelial cells will emerge from each hair follicle. This is called "epithelial budding" and will appear as small white "bumps" on the



wound surface. As this occurs, discontinue creams and change to a protective dressing to prevent damage to the new skin. Examples of good dressing choices would be Xeroform or Mepitel Ag.

On the left shows the epithelial cells (purple) in the hair follicle. On the right is an image of epithelial budding.



Topicals – Ointments, Creams and Solutions

Aquaphor – A moisturizing ointment for healed burn or graft that is dry or flaky. Apply only to healed skin. Transitioning to a mild lotion is preferable for long term moisturizing. Additionally, it is used as a tool to aid removal of adhered dressings (ex. Xeroform). A thick layer is applied on outside of dressing. The hydrophilic function of the ointment penetrates the dressing and allows dried drainage to soften. This helps to avoid trauma to underlying tissue during dressing removal and may improve pain control. Can be mixed with antimicrobial ointments for this function.

Bacitracin – Used for partial thickness/ superficial burns. Commonly used on partial thickness burns, then covered with xeroform and gauze. It is necessary to apply a layer thick enough to keep wounds moist and to prevent dressing from drying out. Ointment must be thoroughly washed off with soap and water before applying new ointment.

Gentamicin – Broad spectrum antibiotic ointment used for facial burns. Should be applied 3x/ day to keep the wounds moist. Ointment must be thoroughly washed off with soap and water before applying new ointment. Bacitracin is also an appropriate choice for facial burns, per provider preference.

Silver Sulfadiazine (Silvadene) – Used for partial/full thickness burns to help soften eschar and provide topical antimicrobial. Typically spread as frosting a cake, ¼ - ½ inch in thickness. May be contraindicated in patients with hypersensitivity, pregnant women, and patients with hepatic or renal failure. Leukopenia may be seen with the use of Silvadene. Cream is usually applied Q12H or daily, and should be thoroughly removed with each dressing change by washing with soap and water and making contact with burn using a wash cloth. Showering with dressing changes may be helpful. Silvadene may cause psuedoeschar buildup on wound surface making wound assessment difficult. Furthermore, Silvadene may delay healing in partial thickness burns.

Mafenide (Sulfamylon) Cream – Cream is used for full thickness burns only, cream applied to cartilage for deeper penetration such as nose and ears. Effective against many gram-negative and gram-positive organisms, including pseudomonas aeruginosa and certain strains of anaerobes. Reapplied q12H. Old cream should be removed prior to applying new cream. Also available in a 5% topical solution which is commonly used as a wet dressing over recent wide meshed skin grafts or skin substitutes. If solution is used, it will be ordered as "soaks" 3x/day so the dressings stay moist.

Mafenide (Sulfamylon) Solution– A 5% topical broad-spectrum antibacterial solution that penetrates eschar. Commonly used as a wet dressing over recent wide meshed skin grafts or skin substitutes, or on full thickness wounds that are already infected, or unexcised burns that have developed colonization. Commonly ordered as TID soaks over Conformant – the outer dressings (burn gauze, Kerlix, ACE wraps) are soaked through 2x/day and all outer dressings are changed daily.

Vashe - Hypochlorous acid solution applied to wounds as a cleanser (5-10 minute soak) or topical agent (moist dressings applied to the wound). Provides wound cleansing, removal of bacteria and biofilm and removal of slough tissue. Solution is non-cytotoxic (safe for healthy tissue). Safe for use in adults and pediatric patients. Supplied in a 475 ml bottle with a shelf life of 30 days once opened. Order from the storeroom.

Primary/Protective Dressings that Promote Moisture

Xeroform - Sterile, fine mesh gauze impregnated with a blend of 3% Bismuth Tribromophenate (Xeroform) and USP petrolatum. It is non-adherent to wound sites and helps maintain a moist wound environment. The 3% Bismuth Tribromophenate (Xeroform), provides deodorizing action. It can be used as a primary dressing. Commonly used over topical ointments, skin grafts or donor sites. If xeroform becomes dry, Aquaphor may be applied over the top of the dressing. Supplied in 5" x 9" individual sheets or a 4" x 9' roll. Avoid wrapping the roll around an extremity, when possible, as it does not stretch if edema develops and can become too tight.

Duoderm (hydrocolloid) - Dressing made of sodium carboxymethyl-cellulose and other gel agents such as pectin and elastomers. Used in smaller wounds to provide moist wound healing, autolytic debridement and promote granulation tissue/ healing. Does not require a secondary dressing. Dressing should overlap the wound by 3-4 cm to obtain good adherence. Change Q1-3 days. Absorptive dressings (Kaltostat or Aquacel Ag) may be used under the Duoderm to absorb excess drainage. Expect Duoderm to soften and mix with wound drainage to form sticky, gelatinous drainage. Thoroughly remove the drainage before assessing the wound – do not confuse drainage with wound infection. Sizes available: 4x4, 6x6 and 8x8.

Primary Antimicrobial Dressings

Aquacel Ag – A silver impregnated antimicrobial dressing comprised of sodium carboxy-methylcellulose (hydrofiber) and 1.2% ionic silver. The silver kills bacteria held in the dressing. This conformable and highly absorbent dressing absorbs wound fluid and creates a soft gel which maintains a moist environment which supports the body's healing process and aids in the removal of unnecessary material from the wound (autolytic debridement), without damaging newly formed tissue. Silver stays active up to 14 days (dressing needs to be moist to activate the silver). **NOTE*: This dressing is not used as often as the mepilex products.

Mepilex Ag Foam– A soft and highly conformable foam dressing that contains silver (antimicrobial). Commonly used on donor sites and partial thickness burns. Adheres with safetac (slightly sticky silicone layer) which is gentler to the skin than tape. The edges are usually framed with 4" hypafix tape. Mepilex AG dressing is secured with ACE wrap only. The antimicrobial action lasts for 14 days, which may reduce the frequency of dressing changes. Dressing should be changed of >75% saturated with drainage. May be removed using a dry or wet technique.

Mepitel Ag– A silicone antimicrobial dressing used on partial thickness burns and wounds. Adheres using safetac (slightly sticky silicone layer) which is gentle to the skin. The mepitel Ag layer usually stays on the wound for several days (maximum of 8 days) and the outer dressings are changed as needed. Reduces pain during dressing changes and improves range of motion (dressing does not adhere to the wound). Secondary dressing is typically Kling (conform gauze).

Secondary/Outer Dressings

Conformant – A sterile, permeable, transparent, polyethylene wound contact layer designed to act as a non-adherent interface between the wound and secondary dressing. Helps to reduce shear. Used over Autografts as the primary dressing, or as the permeable layer under soaks. For sheet grafts, this enables graft inspection for blebs. Typically removed on post op day 6.

Fine Mesh Gauze – A small weave gauze dressing that is less likely to adhere to wounds. May be used with topical creams or solutions. Commonly used over hypertrophic (raised) granulation tissue, may apply ointment on the outer surface of the gauze. May also apply to tissue after Silver Nitrate cauterization.

Burn Dressing - Large (18x18 inch) layered cotton gauze dressing (usually 10-12 ply). Used to absorb large amounts of drainage

Bolster Dressing – A thick dressing that resembles a "pillow" that is sutured in place over recent skin grafts. The bolster has two functions: it can be soaked with antibiotic solution and it helps reduce shear by providing extra layers. The outer "bolster" is usually removed at post op day 3, then replaced with gauze and stretch netting or a burn vest.

Burn Vest– Pre-made gauze "vest" that covers the torso.

Kerlix – gauze rolls used to absorb wound exudate and hold dressings in place.

Conform/ Kling – Small bandage rolls that have a small amount of stretch (elastic woven into the gauze), typically used for fingers and hands. Usually a base layer of gauze is used over the wound, then held in place with the conformant.

Stretch netting – netting used a variety of ways to secure dressings. Available in sizes 3 (fingers) to 11 (large torso).

Compression Dressing – Edema control by application of compression is an important part of wound care as edema negatively impacts healing. Most commonly used compression dressings are ACE wraps and Tubigrip. Refer to section on Edema Control and LE wrapping for details.

Chapter 9
Infection Control Guidelines

Burn wounds are susceptible to infection due to loss of protective integument and presence of devitalized tissue. Reduction of the risk of infection is a priority as it can delay wound healing and cause graft loss.

Personnel

- Wear mask and eye protection and clean gloves (not sterile) for wound care procedures
- For larger burns, a hat and barrier gown is recommended
- Knee high booties and plastic aprons with sleeves should be worn during shower procedures

Patient Environment

- No fresh flowers/plants or pet therapy visits in rooms of large burns (>15 % TBSA of open wound)
- Every effort will be made to assign private room for burns > 15 % TBSA
- If in semi-private room, room with patients who do not have a current wound infection.
- Place on "B" side of room when possible to limit foot traffic past the bed.
- Communicate the above needs to one call as appropriate to assist with bed assignment
- Fans should be turned off during wound care.

Wound Care

- Store dressing supplies in patient's closet or dressing cart. Dressing supplies should not be stored next to flowers/plants and/or incontinence supplies
- Supplies that are open, but not used, may be saved for the next dressing change as long as they are contained and kept clean in the original package. Dressing supplies do not need to be sterile
- Perform hand hygiene prior to wound care. Use Clean Technique for wound care with at least 3 glove changes: clean gloves to removed soiled dressings, change gloves to perform wound cleansing/ debridement, change gloves to apply the clean dressings.
- Bathe patient during the dressing change, it is acceptable to soak off dressings in shower. Wash burns with soap and water.
- Change linens with each major dressing change, or a minimum of every 24 hours
- Limit foot traffic in and out of the room during wound care procedures. Post a sign on the door to indicate that a "procedure is in progress" and to check at the nursing station before entering.
- Environmental services personnel will avoid cleaning the room/ floors during wound care procedures
- Family members of the adjacent bed/patient will be escorted into the room by a staff member and will be asked to limit entering and exiting the room while dressing change procedure is in progress.

Equipment/Supplies

- Specific burn equipment such as splints will be wiped down per manufacturers' instructions with each dressing change

Chapter 10
R3 Wound Rounds

Wound Rounds (11 am M-F on R3) is an opportunity for the Burn and Soft Tissue team to meet with the R3 staff daily and to assess the wounds on the service. There are two parts of Wound Rounds: (1)

BST team will meet in back of R3 nursing station to review the plan for all R3 BST patients with the R3 charge nurse and nursing staff. (2) Wounds for pre-selected patients are assessed at the bedside. The goal is for nurses to prepare their patients and take an interactive role in wound rounds as described below. The BST team is not expected to take the dressing down, they are also not expected to put the dressing back in place. Patients should be selected by BST providers the evening prior, and this should be marked on the R3 white board before 0830. See below listed Wound Rounds roles and responsibilities.

PRIMARY RN - both night and day shift:

- Inform patient if they will be on wound rounds.
- Stock patient's room with wound care supplies and set up a clean zone/dressing station.
- Ensure patient is appropriately pre-medicated with the goal that medications peak during dressing change. (PO meds to be given 10/1030, IV meds to be given 1045/1115)
- Dressing is expected to be taken down by the time the team comes to the bedside. Communicate with charge and other staff if you need extra hands to help with dressing change.
- Take picture of wound with ROVER and upload to the chart. Located at Charge RN desk.
- Discuss with Hannah, burn/wound RN, if a burn patient is discharging pertaining to education.

BURN RESOURSE NURSE:

- Participate in both parts of wound rounds as described above.
- Communicate role in the dressing change with the primary nurse.
- Assist and prepare primary nurse for discharge education.

R3 Wound RN (staffed PRN):

- Make list of all burns/dressings on unit. Organize which patients you will be able to see and when. Prioritize larger, more time consuming burns.
- Communicate plan for the day with the primary nurses regarding pain medications, supply ordering, clean zone/dressing station set up and roles in dressing c hanges.

CHARGE RN:

- Moderate Wound Rounds daily.
- Ensure BST team has updated the white board and all nurses are aware.
- When primary RNs are unable to attend, inform them of updates after rounds.
- Be available to help staff with dressing changes.

MD/APP:

- Update white board with patients selected for wound rounds the day prior or by 0830.
- Attend wound rounds daily, report on all R3 BST patients and assess wounds at bedside.
- If late or unable to attend due to emergencies, call to inform unit.
- Assess pre-selected patients' wounds at bedside and communicate updates with bedside RN.
- Communicate plan to primary nurse and update all orders in the care plan after wound rounds.

PT/OT:

- Coordinate with primary RN to participate in shower or dressing change if applicable.

Chapter 11
Burn Resuscitation Guideline

Approach

Severe burn injury is defined as %TBSA burn >/= 20% in adults and 15% in children. This is the extent of injury usually associated with a profound system inflammatory response. Severe burn injuries lead to extensive capillary leak, tissue edema and third spacing of fluid. Thus, intravascular volume is depleted in a manner that can lead to hypovolemic shock. Additionally, massive cytokine mediated vasodilation leads to a distributive shock component. Furthermore, inhalation injury, older age, cardiac and pulmonary comorbidities, electrical injury and non-burn trauma can add significantly to insensible fluid losses and thus resuscitation fluid requirements.

The goal with all burn resuscitations is to provide enough fluid resuscitation to ensure urine output and avoid burn shock while avoiding over-resuscitation and its associated complications. Additionally, with all trauma patients, one must first consider whether hemorrhagic or neurogenic shock may be a contributing factor. All burn patients with a mechanism suggestive of non-burn trauma should be evaluated based on the standards of ATLS. Burn wound management and fluid resuscitation can be delayed to facilitate management of other more immediately life threatening injuries.

MMC Burn Resuscitation Guideline

We use a *modified Parkland formula to calculate a starting point* for fluid resuscitation. Lactated ringer's is used. We then titrate fluid volume to maintain a urine output between 30-40cc an hour for **ALL** adults. This is the amount of urine output necessary to ensure adequate renal function. The titration algorithm is codified in the **MMC Burn Resuscitation Guideline** (Appendix D) published on the trauma protocol website.

The guideline includes a tool to calculate initial fluid rate and guidance on initiating tube feeds. We begin formal resuscitation when the patient arrives in the Burn Procedure room; this is 'hour zero'. Resuscitation begins with the **Nurse Driven Guidline** for up and down titration of fluids and ends when Maintenance rate is reached based on the 4-2-1 rule. If difficult resuscitation is identified, we then transition to **Provider Driven Strategies** which includes Resuscitation Adjuncts and recommendations for treatment of Refractory Shock/End Organ Failure.

Difficult resuscitation is defined as any of the below and is a cue to utilize adjunct strategies:

- Infusion rate increased 2 or more times in first 6-12 hours of resuscitation
- Ongoing crystalloid requirement expected to exceed 150% of predicted volume.
- By the 12th hour post-injury: hourly infusion rate exceeds 80% of the rate predicted for the 1st 8 hour period.
- Persistent oliguria: urine output <15mL for 2 or more hours in a row
- Unable to maintain MAP >60

Adjunct Resuscitation strategies are initiated at attending discretion. Options include: colloid rescue with Albumin boluses, colloid only resuscitation with FFP or albumin and high dose vitamin C infusion.

Refractory Shock
If unable to maintain MAP > 60 then bolus with albumin, if this is ineffective then Vasopressin may be initiated. This is the preferred vasoactive medication due to the minimal effect it has on the cutaneous blood flow. Other pressors with significant Alpha 1 agonism are known to worsen burn wound conversion and should be avoided if possible.

Continuous Veno-Venous Hemofiltration (CVVH) shall be employed in cases of severe oliguria or anuria. Plasma exchange shall be considered in case of persistent burn shock despite burn excision. CVVH and Plasma Exchange are administrated in conjunction with the Nephrology service. Extracorpeal Membrane Oxygenation (ECMO) should be considered in conjunction with the Cardiothoracic service for cases of refractory acidosis or hypoxemia.

Burn excision should be considered in cases of refractory shock. Our programmatic goal is to excise all deep partial and full thickness burns within 72 hours of admission.

Chapter 12
ICU Care of the Burn Patient

Stress Ulcer Prophylaxis

Stress-related gastrointestinal mucosal damage (a.k.a. stress ulcer or "Curling ulcer") has been associated with severe burn injury, occurring within a few hours of burn trauma. Additional risk factors for stress ulcers in the critically ill include mechanical ventilation for greater than 48 hours or coagulopathy. Early enteral nutrition may be effective in preventing overt GI bleeding in patients with severe burn injury (Raff 1997). However, if patients have additional risk factors as specified above, pharmacologic prophylaxis is still indicated H2- blockers (e.g. famotidine) or sucralfate are preferred. Proton pump inhibitors (e.g. omeprazole, pantoprazole) should be reserved for those patients taking one prior to admission or who have another indication (e.g. GI bleed, peptic ulcer disease).

Venous Thromboembolism Prophylaxis

Refer to the Trauma and Acute Care Surgery Clinical Practice Guideline for DVT (Venous Thromboembolism) Prophylaxis.

Management of the Hypermetabolic Response

Beta-blockers

Catecholamines play a significant role in the hypermetabolic response following severe burn injury. The increase in circulating catecholamines likely contribute to the increased muscle protein catabolism and elevated metabolic rate reported in patients with severe burn injury. Beta-blockers, specifically propranolol, have demonstrated multiple beneficial effects in pediatric and adult patients with severe burn injury (Gibran 2012; Flores 2016). These include reductions in heart rate, metabolic rate, muscle wasting, lipolysis and insulin resistance. In one adult study, propranolol also reduced time to wound healing, time to graft preparedness, area needed for skin graft, and hospital length of stay (Mohammadi 2009).

Beta-blockers are indicated for patients with severe burn injury (defined as TBSA >20%). Propranolol is the beta-blocker of choice, however if a patient was on a different beta-blocker prior to admission for another indication (e.g. heart failure or coronary artery disease), the preadmission beta-blocker should be continued. Propranolol should be initiated at least 48 hours after burn injury, once the patient is adequately resuscitated and hemodynamically stable (Brown 2016). The starting dose is 10 mg orally/enterally every 6 hours, and should be titrated to a 20% reduction in heart rate from baseline (Flores 2016, Guillory 2017). The duration varies greatly amongst clinical trials (10 days to 12 months with a median of 21 days), but here at MMC we recommend continuing until hospital discharge, unless patient has a pre-existing indication for beta-blockade. Patients should be monitored for hypotension and bradycardia (Brown 2016).

Oxandrolone

Anabolic agents have been evaluated to counteract the protein catabolism associated with the hypermetabolic phase of severe burn injury. Oxandrolone, a synthetic analog derived from testosterone, is associated with improved clinical outcomes in patients with severe burn injuries without deleterious side effects. During the catabolic phase of burn, oxandrolone has been shown to shorten hospital length of stay, donor-site healing time, time between surgical procedures, and to reduce net weight loss and nitrogen loss (Li 2016).

Oxandrolone is indicated for patients with severe burn injury (defined as TBSA >20%). Oxandrolone should be initiated at least 48 hours after burn injury, once the patient is adequately resuscitated, hemodynamically stable, and is receiving >75% of nutrition requirements. Oxandrolone should be used with caution in patients with renal insufficiency, chronic liver disease, and heart failure (Miller 2009). The dose of oxandrolone is 10 mg orally/enterally twice daily. If administered enterally, the oral suspension is preferred. The duration varies greatly amongst clinical trials, but here at MMC we recommend continuing until wounds are healed or until hospital discharge, whichever comes first. The most common adverse effect reported with oxandrolone in patients with burn injury is transaminitis (Kiracofe 2019). Patients should be monitored with a CMP once weekly while on oxandrolone therapy. Hold oxandrolone for an ALT or AST greater than 100 mg/dL. Once transaminitis resolves, reinstitute oxandrolone.

Chapter 13
Inhalation Injury

Diagnosis

Diagnostic bronchoscopy can be used to classify inhalational injury according to grade using the Abbreviated Injury Score Grading Scale for Inhalation Injury. Find this grading system in the table below:

Grade	Class	Description
0	No injury	Absence of carbonaceous deposits, erythema, edema, bronchorrhea, or obstruction
1	Mild injury	Minor or patchy areas of erythema, carbonaceous deposits, bronchorrhea, or bronchial obstruction
2	Moderate injury	Moderate degree of erythema, carbonaceous deposits, bronchorrhea, or bronchial obstruction
3	Severe injury	Severe inflammation with friability, copious carbonaceous deposits, bronchorrhea, or obstruction
4	Massive injury	Evidence of mucosal sloughing, necrosis, endoluminal obstruction

Treatment

Patients with grade 3 or 4 inhalation injury should be treated with an inhalation "cocktail" of nebulized heparin, albuterol, and N-acetylcysteine. This combination has been associated with improved lung function and reduction in duration of mechanical ventilation (Miller 2009, Holt 2008, Desai 1998, McIntire 2017, McGinn 2017), and has not shown to increase major or minor bleeding (Yip 2011). The dosing regimen is heparin 10,000 units nebulized every 4 hours alternating with acetylcysteine 600 mg nebulized q4h and albuterol 2.5 mg nebulized every 4 hours. This regimen is continued for 7 days or until extubation, whichever comes first. It can be ordered using the "nebulized heparin for inhalation injury" order panel in EPIC.

Carbon Monoxide Toxicity

Carbon monoxide poisoning is very common with inhalational injury. Carbon monoxide has strong effects on oxygen transport and peripheral oxygen utilization. Carbon monoxide diffuses across the pulmonary capillary membrane and affixes to the iron of heme with 240x greater affinity than oxygen. The amount of carboxyhemoglobinemia is related to the relative amounts of CO and oxygen in the environment, the duration of exposure and the patient's minute ventilation. The symptoms of carbon monoxide poisoning may vary from headache, malaise, nausea, dizziness, altered mental status to seizures. In addition, cardiac ischemia may ensue.

Mechanical ventilation with 100% FiO2 will help with replacement of the carbon monoxide with oxygen to allow for competitive binding of hemoglobin by oxygen. The half-life of carbon monoxide is 250 to 320 minutes, but this decreases to 90 minutes with high flow oxygen. Hyperbaric oxygen may also assist with enhanced recovery from carbon monoxide poisoning but is impractical in the setting of significant cutaneous burn injury.

Cyanide Toxicity

Hydrogen cyanide gas is a byproduct of combustion, and patients with inhalation injury from an enclosed space (e.g. house fire) are at risk of cyanide toxicity. Patients with inhalation injury who are unresponsive and have an unexplained lactic acidosis (lactate >10 mmol/L) may be candidates for treatment of cyanide toxicity. Unfortunately, there is not much clinical utility in sending cyanide levels, as they are a send-out lab and will not be available in a timely fashion.

Hydroxocobalamin (Cyanokit®) is the treatment of choice for cyanide toxicity. It binds cyanide to form cyanocobalamin, which is eliminated by the kidneys. The dose is 5 g IV administered over 15 minutes. A second dose may be given in patients with severe toxicity. Adverse effects are hypersensitivity reactions (e.g. rash, angioedema), transient hypertension, and discoloration of skin, urine, and serum. The discoloration of skin may be problematic in patients with concomitant cutaneous burns. Discoloration of serum interferes with colorimetric laboratory testing (e.g. AST, ALT) for 24-48 hours. Sodium thiosulfate has a slow onset of action and therefore has limited usefulness in cyanide toxicity. Nitrites (sodium, amyl) should be avoided in patients with inhalation injury due to their ability to induce methemoglobinemia, which can be dangerous with concurrent carbon monoxide poisoning. **Generally, patients with suspected inhalation injury sustained in enclosed space who present comatose should have Hydroxocobalamin administered empirically.**

Chapter 14
Burn and Large Wound Pain and Sedation Protocols

Pain, Anxiety, and Post-Burn Pruritus Management in Patients with Burn Injuries

Purpose

These guidelines are intended to facilitate the adequate treatment of pain in patients who experience burn injury. The goal is for the patient to be comfortable, awake, alert, and able to participate in routine daily care, physical therapy, and occupational therapy sessions.

Background

Pain associated with burn injuries is considered the most painful trauma a person can sustain.

- Reasons for burn pain:
  - Regrowth of nerve endings in full thickness burns
  - Damaged nerve endings in superficial-partial thickness burns
  - Abnormal sensitivity to painful and normally non-painful stimuli in normal skin surrounding burn area
  - Donor sites, typically most severe for first 48 hours
  - Primary and secondary hyperalgesia, pain to light tactile stimuli, and prolonged, persistent pain due to altered responses to damaged skin
- Adverse effects to pain:
  - **Physiologic effects**
    Wound healing impediment and interference with wound care and therapies, indirectly increasing morbidity and mortality and prolonging hospital stays.
  - **Psychological Effects**
    Sleep disturbances, post-traumatic stress disorder, and suicidal ideation.

Pain is difficult to manage in the burn population, as it is multifaceted and constantly changing as patients undergo procedures and manipulation of painful wound sites.

- 3 types of burn pain:
  - **Background**: Underlying pain from the initial injury that is ongoing and present even in the absence of activity or procedures
  - **Breakthrough Pain**: More intense, unpredictable episodic pain that is associated with activities of daily living
  - **Procedural Pain** High intensity and short duration, associated with invasive procedures and ongoing daily burn care, such as wound cleansing, dressing changes, and therapy (PT/OT) sessions.
  - As tissue regenerates, neuropathic pain or itching sensations can cause discomfort.

Patients with burn injuries can experience significant anxiety in anticipation of procedures.

- Anxiety can intensify over time and increase the perception of pain
- It is important to take measures to ensure adequate pain control during burn procedures

Pain Assessment

Pain assessment should be conducted per "MMC Policy for Pain Assessment and Management-Adult/Pediatric," with the numeric rating scale (NRS) preferred in patients able to self-report pain and the critical care observation pain tool (CPOT) preferred in patients in the ICU who are mechanically ventilated or unable to self- report pain.

Pain Management

Virtual Reality

Non-pharmacologic

Hypnotherapy
Relaxation therapy
Massage therapy
Music
Regional anesthesia – consult APMS
Post-burn itching: emollients, compression

Pharmacologic

- Strategies for pain management will be dynamic throughout the hospital stay, depending upon the severity of the burn injury, the patient's need for mechanical ventilation, patient location, and type of pain experienced.
- Opioids are the mainstay of pain management in patients with burn injuries.
- Multimodal approach with non-opioid analgesics and non-pharmacologic strategies should be employed to improve pain control and reduce the incidence of opioid-related side effects and hyperalgesia.
- It is important to manage procedural pain well to prevent anxiety over future sessions. Give oral opioids 30-45 minutes prior to dressing changes or wound care and give intravenous medications immediately before starting the procedure. During the procedure, frequently reassess pain and re-medicate as necessary.

Discharge Pain Management

Multimodal pain control should continue after discharge. Consider that patients are often more active when discharged home, resulting in increased pain. Analgesia plan should consider dressing changes and exercises. Analgesic should be weaned in the following order: opioids first, then Tylenol, NSAIDs, gabapentin should be weaned last.

- Opioids
    - Discharge on an oral dose equivalent to which they are taking in hospital. The dose will be weaned in subsequent clinic visits over the next 1-3 weeks. Patients are typically discharged with 7 days of opioid analgesia as acute burn pain lasts until burn and donor sites are healed.
    - Typically, in alignment with PMP, prescriptions include:
        - oxycodone 5-10 mg every 4 hours, #42-84 tabs
        - hydromorphone 2-4 mg every 4 hours, #42-84 tabs
- Acetaminophen/NSAIDs
    - Alternate medications every 3 hours:
        - acetaminophen 650-975 mg Q6hrs
        - ibuprofen 400 mg Q6hrs
- Gabapentin: titrate up to effect until maximum dose, consider renal clearance
    - Will be weaned last.
    - Weaned by decreasing by 100 mg per dose each week until discontinued.
    - If symptoms return then stop weaning.

Please see **table 1** below for options available for treatment of the several types of pain, anxiety, and discomfort, categorized by patient status and location. See **Medication Dosing and Considerations for Pain, Anxiety, and Post-burn Pruritus Management** (Appendix F) for guidance on dosing considerations and precautions/contraindications to use.

Table 1. Pharmacologic Treatment Options for Pain, Anxiety, and Post-Burn Pruritus

	Adult ICU – Mechanically Ventilated	**Adult ICU- Non-intubated**	**Adult Floor/IMC**
Background Pain **Non-opioid**	Acetaminophen PO/FT/ IV Ibuprofen PO/FT or Ketorolac IV Gabapentin PO/FT Ketamine continuous infusion Dexmedetomidine continuous infusion or clonidine PO/FT/SL	Acetaminophen PO/FT/ IV Ibuprofen PO/FT or Ketorolac IV Gabapentin PO/FT Ketamine continuous infusion Dexmedetomidine continuous infusion or clonidine PO/FT/SL	Acetaminophen PO/FT/ IV Ibuprofen PO/FT or Ketorolac IV Gabapentin PO/FT
Opioid	Fentanyl or hydromorphone continuous infusion Methadone PO/FT/IV (for TBSA ≥20%)	Methadone PO/FT/IV (for TBSA ≥20%) Oxycodone or hydromorphone PO/FT	Oxycodone or hydromorphone PO/FT
Breakthrough Pain	Fentanyl or hydromorphone IV bolus	Hydromorphone IV bolus	Hydromorphone or morphine IV bolus
Procedural Pain	Oxycodone or hydromorphone PO/FT Fentanyl IV bolus Ketamine IV bolus	Oxycodone or hydromorphone PO/FT Hydromorphone IV Fentanyl lozenge buccal Ketamine IV bolus Nitrous oxide (tank room)	Oxycodone or hydromorphone PO/FT Hydromorphone IV Fentanyl lozenge buccal Ketamine IV bolus Nitrous oxide (tank room)
Breakthrough Anxiety	Midazolam IV bolus	Lorazepam PO/FT/IV	Lorazepam PO/FT
Procedural Anxiety	Propofol infusion Midazolam IV bolus	Lorazepam PO/FT/IV	Lorazepam PO/FT
Post-Burn Itching	Hydroxyzine PO/FT/IV or cetirizine PO/FT Gabapentin PO/FT	Hydroxyzine PO/FT/IV or cetirizine PO/FT Gabapentin PO/FT	Hydroxyzine PO/FT/IV or cetirizine PO/FT Gabapentin PO/FT

Chapter 15
Burn Excision and Grafting

Burn excision and grafting procedures have a distinct flow and pace that is unique in surgery. Coordination with the anesthesia team throughout the case is imperative. Please refer to **Appendix G: Guideline for Intraoperative Management of Burn Excision and Grafting**. The purpose of this section is to help familiarize the learner with the equipment, techniques and strategies commonly used in burn surgery.

Burn Wound Excision

Deep partial thickness & full thickness burn injuries are usually best managed by excision. While all burn wounds will eventually heal, deep injuries must lift the overlying eschar and granulate to close. This process can take between 4 weeks and 6 months depending on the extent of injury. Surgical excision provides the most expedient option for removal of the burn tissue and closure of the wound. Early excision (<7 days from injury), helps to avoid burn wound infections that can develop from bacterial colonization of the eschar which is an additional benefit. Early excision of large TBSA burn wounds represents the single most significant improvement in burn injury survival in modern history. Burn excision is divided into three types – tangential, fascial and subdermal excision:

Tangential excision is performed by removing successive layers of burn injured tissue until viable wound bed is encountered. This is typically performed with hand cutting dermatomes such as the goulian and Watson knives. Alternatively, gas powered dermatomes can be used as well. This would include the Padget type dermatome and the more recent circular dermatome (Amalgatome SD). We also frequently utilize a hydro dissector (Versajet) in certain circumstances. Tangential excision is the mainstay of burn wound excision as it preserves viable underlying tissue. However, hemorrhage can be substantial with this approach. Several maneuvers are utilized to limit bleeding depending on the circumstances. Options include: epinephrine soaked telfa and laparotomy pads, ace wrap compression, tourniquets on extremities, tranexamic acid solutions, fibrin glues and sealants, and injection of epinephrine/normosol (2mg/1L) solution in the subdermal space (tumescence). While Bovie cautery is utilized in almost all burn excisions, we take care to limit its use to avoid devitalization of the wound bed which is being prepared for grafting.

In fascial excision, skin and subcutaneous tissue are removed en bloc using cautery down to the layer of investing fascia. In massive burns, 4th degree burns and/or situations where blood loss would be problematic or when transfusion of blood products is prohibited (i.e. Jehovah Witness, ECMO with anticoagulation), this technique can be rapid and effectively eliminate significant blood loss. Fascial excision is also indicated for life threatening invasive wound infections or burn sepsis, particularly invasive fungal infections. It is also an important option for large areas of failed graft take in critically ill patients with massive burns. Autograft take on uninjured fascia or muscle is essentially 100% given the robust blood supply. However, this approach is quite deforming and remains a reconstructive challenge.

An alternative to fascial excision is subdermal excision with electrocautery. This approach achieves similar hemostasis, but preserves the aesthetic benefits of the viable subcutaneous tissue. The full thickness of skin is removed, leaving the subcutaneous tissue as a wound bed.

Temporary Wound Closure

After excision of the burn wound, temporary coverage may be employed prior to definitive autografting. There are 2 main reasons to utilize temporary coverage: (1) to reduce insensible losses prior to autografting in larger %TBSA burns and (2) to "test" the viability of a questionable wound bed. Typically, after excision, allograft skin or xenograft skin (currently unavailable) is placed over the wound bed serving as a temporary biologic dressing. Temporary coverage also affords the ability to shorten the duration of the operative procedure and to reduce the deleterious effects of creating additional autograft donor site wounds in the critically ill massive burn.

Staged Grafting

A staged approach is a technique where a dermal substrate like Primatrix, Integra or BTM (see next chapter for details) is grafted on the wound bed prior to definitive management with autografting. This strategy is employed to reduce hypertrophic scarring and improve skin turgor of grafted areas. It is used in critical areas like the hands, neck and face to improve functional outcomes. This strategy may also be used after fascial or subdermal excisions to create a 'neo dermis' amenable to grafting. This may also be employed when deep structures like bone or tendon are exposed to 'bridge' surrounding tissue.

With this strategy, the dermal substrate is generally allowed at least 2 weeks to incorporate into the wound bed. The incorporation process should be monitored frequently to determine when it is 'ready' for autografting. Once incorporated; a thin split thickness skin graft is applied to the wound bed.

Autografting

The goal in autografting is to achieve the most expeditious wound closure, while preserving function – particularly in special areas such as face and hands. The unmeshed split thickness sheet grafts remain the gold standard and should always be used on the face and hands. However, in larger TBSA burns this is impractical and autograft expansion is necessary. This is accomplished by meshing the autograft in different ratios. As a general rule, the larger the expansion, the more contracture and delayed wound healing you can expect. In general, one should attempt to close the wounds with the least ratio of mesh necessary while considering the available donor site. 1:1 and 1.5:1 ratio meshed autografts do not significantly expand coverage, but provide excellent drainage. 2:1 and 3:1 meshed autografts provide a good balance between wound coverage and time to healing (closure). 4:1 or greater ratios suffer from prolonged healing times in the interstices, but provide excellent wound coverage. These may become necessary in situations where limited donor site is available.

Two types of meshers are typically used: the Zimmer card mesher device and the Brennan mesher device. The Zimmer works by placing the autograft on a 1.5:1 or 3:1 mesh pattern card that is "crushed" between two metal rollers. The Brennan is a free standing mesher that has cutting blades set at distinct ratios. The skin graft is placed into the cutter directly without any card. Brennan meshers are available in 1:1, 2:1, 3:1, 4:1 and 6:1 ratios.

Donor Site Harvest

Autografting of excised burn wounds is the gold standard of definitive wound closure in burn surgery. The goal is to harvest an adequate split thickness skin graft (STSG) that includes sufficient dermis to be reliable in wound closure, but also allow the donor site to heal within 14 days to limit incidence of donor site morbidity. Depending on the body region, the full thickness of skin ranges from 18/1000th inch at the eyelid to as much as 70/1000th inch on the back. The epidermal-dermal junction is typically at a depth of 6-8/1000th inch and is consistent throughout the body. Thus, most skin grafts are harvested at a thickness of 12-16/1000th inch. This represents the sweet spot between reducing donor site morbidity and creating a quality skin graft.

It is our practice to reduce donor site bleeding and improve the surface for harvest by injecting a normosol & epinephrine solution in the subdermal space of the donor site. After a rigid donor site is created, a gas powered dermatome is used to harvest the autograft.

Sandwich Technique

Overlay grafting with Allograft is an option we employ when 4:1 meshed grafts are necessary. The allograft is secured over top the autograft in a similar manner and fixed in place. The purpose is to provide an ideal wound healing environment in the un-grafted interstices as well as protect the autograft from shear injury. The allograft functions as a biologic dressing for the interstices.

Epidermal Autografting

We utilize 2 types of epidermal autografts.

- **Autologous Skin Cell Suspension (ReCell)**: This is an epidermal suspension that is 'sprayed' onto the wound bed and can achieve an 80:1 expansion. A small STSG is harvested at a thickness of 6-8/1000th inch and processed using trypsin based enzymatic degradation into a suspension using the RECELL device. These cells are then placed into a suspension and sprayed either on meshed graft, partial thickness burns or donor sites. The epidermal cells decrease burn wound closure time of the selected site. In meshed grafts it speeds re-epithelization of the interstices. It can be used in large burn wounds when donor site is scarce and allow for use of large meshes (4:1 or greater). ReCell is more practical in 30-75% TBSA burn injuries because it can be prepared intra-operatively.

- **Culture Epidermal Autograft (CEA/Epicel):** Cultured epidermal autograft placement is a key procedure in caring for patients with massive burns >70% TBSA. In this procedure a piece of full thickness skin is excised and sent to a lab that specializes in growing cultured epithelial cells. The skin is processed and cultured *ex vivo* in the presence of murine fibroblasts that promote growth. The final result 3 weeks after initial harvest is made up of keratinocytes 2-8 cells thick. Due to the nature of the sheets; sheering and blistering is a common problem and requires intense post-operative care and positioning. This technology allows for burn wound closure that would otherwise be impossible. When used in combination with allograft, the literature reports a graft take of over 72%. Requires IRB compassionate use protocol. We rarely use this option; nonetheless, it should be considered in burns where >60% TBSA excision is anticipated.

Graft Fixation

Our preferred graft fixation method is to use fibrin sealants (typically Artiss). This allows for minimal to no use of sutures or staples and/or bolsters.

Chapter 16
Biological Dressings and Skin Substitutes

Allograft

Allograft is human cadaver skin. Allograft functions similarly to a split thickness autograft with the caveat that since it is harvested from cadavers it will reject within a number of weeks. It allows for temporary wound/burn coverage. In the immunosuppressed patient, allograft may take and allow for definitive closure. Over time, the patient's skin will grow in from the edges and overtake the allograft.

Allograft is kept frozen, but may not be refrozen. Therefore, it is important to have the OR thaw only the amount that you are sure that you will use in the operating room. The allograft will come packaged in plastic and will have mesh covering both sides. The mesh should be removed and requires the same orientation as the patient's own donor skin with the dermis (shiny side) toward the wound bed.

Xenograft

Xenograft is meshed porcine skin that can be used for temporary coverage of wounds or as an overlay with the sandwich technique. It works well in partial thickness burns that do not need autograft, as it allows for dermal regeneration and avoids frequent dressing changes as the xenograft can remain in place until the wound heals. In this utilization, the xenograft will gradually lift as the wound heals and can be trimmed free.

Porcine xenograft may come prepared as a reconstituted product that can be kept at room temperature or fresh that needs to be used immediately. Currently, there is no xenograft available on the market.

Dermal Substrates

Dermal substrates may be biologic or synthetic and utilize the staged grafting approach discussed in the previous chapter. At our institution we primarily use the biologic products Integra and Primatrix; and the synthetic product BTM.

Integra

Integra, was developed through a partnership of MIT and MGH. It had the goal of providing an antibacterial barrier while serving as a scaffold for later dermal regeneration. The inner layer of the material is a 2mm thick combination of fibers of collagen isolated from bovine tissues and glycosaminoglycans. The outer layer is 0.23 mm thick polysiloxane polymer with vapor transmission that mimics normal epithelium. Integra is placed on a wound immediately after it has been debrided. It should be allowed to incorporate for 2 weeks and then the patient should return to the operating room for split thickness skin grafting. There is a silastic covering marked with a black line that should be removed prior to placing a split thickness skin graft. It is affixed to the wound bed in a similar manner as autograft.

Primatrix

Primatrix and Primatrix silver is an acellular dermal matrix derived from fetal bovine dermis. It contains collagen that helps create an ideal environment for cellular repopulation and revascularization. It is stored at room temperature and must be reconstituted in saline prior to application. It should be placed in a clean wound immediately following debridement and be allowed to incorporate for at least 2 weeks prior to autografting.

BTM (Biodegradable Temporizing Matrix)

BTM is a synthetic polymer matrix with a silicone layer overlying that allows for organized granulation tissue formation resulting in a more organized 'neo-dermis' for autografting. It allows for cellular migration into the matrix that results in new blood vessel formation and collagen production. The integration process takes about 2 to 3 weeks but may be left in place for longer. The silicone layer acts as a dressing for the wound until it is ready for autografting. It should be monitored after placement for hematoma formation or abscess accumulation. If there is concern for either, then an incision can be made in the silicone layer to inspect the underlying tissue. Once the wound bed is revascularized, the outer silicone layer is removed in the OR and the wound is autografted.

Synthetic Membranes

Suprathel

Suprathel is an artificial membrane composed of a polylactic acid copolymer that easily adapts to the surface of the wound and adheres with contact. It can be applied to superficial or deep partial thickness burns as a both a dressing and as a test of the wound bed. It can remain in place until the burn wound heals at which point the dressing will release from the wound bed. It can also be used as an overlay dressing on Recell or as a donor site dressing. Suprathel has a unique property that allows it to be transparent after about 12 hours of application to the wound bed. This allows for assessment of the wound bed through the membrane.

Chapter 17
OR Equipment

The circulating nurse will page the attending of record for the case to debrief the procedure being performed and the items that need to be prepared before the case. Below is a summary of commonly used equipment that may be prepared for the procedure:

Klein pump - The **Klein Pump** is used to infiltrate high volumes of tumescent fluid into the subcutaneous tissues, decreasing the time it takes the surgeon to infiltrate the subcutaneous space. The tumescence can be a variety of different formulas, but generally contains a buffer solution (normosol or LR) and diluted epinephrine (2mg epi/1L normosol) to assist with hemostasis of the donor site.

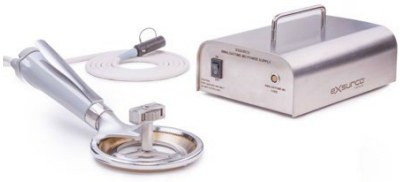
Versajet – The **Versajet** uses water at high velocity (hydrosurgery) to precisely excise all nonviable tissue, bacteria and contaminants from wounds. As the versajet instrument is moved tangentially over the soft tissue surface it creates a smooth wound bed while maximizing viable skin thickness preservation. The handle is available in 15 degree and 45 degree options. The most commonly used option is the 45 degree option. This device cannot debride bone or thick eschar, but is ideal for debridement of granulation tissue, subcutaneous tissue and fascia.

Sonopet - The Sonopet is an ultrasonic debridement tool that allows the surgeon to emulsify and aspirate soft tissue and bone, and carry out very fine detail excision of burned tissue and bone.

Artiss Fibrin Sealant – Artiss fibrin sealant is a spray that can be used to affix skin grafts and biologic skin substitutes in place. The fibrin also offers hemostatic and antimicrobial properties.

Dermatomes

There are two types of gas-powered dermatomes that we have available. The **Amalgatome SD** is pictured below. This instrument requires more pressure to achieve appropriate thickness and using a "pulling" motion rather than a "pushing" motion which is typical of the Zimmer gas-powered dermatome. This device has superior degrees of freedom compared to the Zimmer dermatome.



The second type of gas-powered dermatome is the more commonly used **Zimmer dermatome**. This dermatome utilizes a straight forward push technique to excise tissue or harvest skin.

Meshers

There are two types of meshers that may be used: the **Zimmer mesher** which uses plastic cards to determine the ratio of meshing and the **Brennen mesher** which does not need plastic cards to mesh the skin and is instead placed freely on the mesher.

The **Zimmer mesher** is pictured below:

The **Brennen mesher** is pictured below:

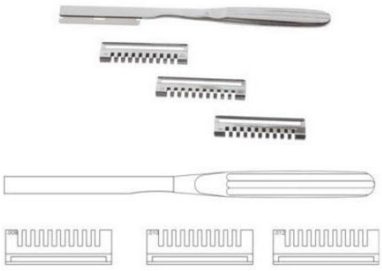
Excision and Preparing the Wound Bed

Norsen debrider

Norsen debrider is a semi-sharp spatula-like instrument that can be used to removed residue and superficial debris from the burn to assist in the assessment of burn wound depth.

For tangential excision, the goulian knife is the workhorse of burn excision. **The Goulian or Weck knife** is composed of a handle, razor blade and depth regulating guard called a Weck guard. Larger cutting blades are utilized at times depending on the size of the area of excision. The most commonly used at this institution is the Watson knife. Less frequently, the Braithwaite is used. Both have a large razor blade with an adjustable caliper. A gas powered dermatome may also be utilized for large areas in place of the large blades. The Amalgatome SD is particularly suited to this function. Fascial and subdermal excision are completed with Bovie cautery.

Goulian handle with Weck guards:



Watson and Braithwaite blades:

Chapter 18
Post-Operative Wound Care

Having an understanding of what type of grafting was done will often help to better understand the post-op care/dressing concepts. In previous chapters, you have learned the differences between the types of grafts and skin substitutes. This chapter includes additional information about the care of these products. Please refer to the **Appendix H: Skin Graft & Donor Post- Operative Management Guidelines** which is a tool for post op graft care.

Autografts

Meshed Grafts

- A contact layer, xeroform or conformant, is placed over the graft, then it is covered with burn gauze, secured with roll gauze and elastic (ACE) wrap. Alternatively, Negative Pressure Therapy (Wound VAC) may be used with a contact layer over the graft. It is common for outer gauze dressings to be soaked with an antimicrobial solution to keep the wound moist and prevent infection. The outer gauze dressings will be changed daily until the 'take down' day. If a bolster dressing is used over the graft site, it will be removed at approximately POD#3 and topical dressings applied per orders.

Sheet (unmeshed) grafts

- Conformant (aka "bridal veil") is a contact layer commonly used over sheet grafts to allow for daily visualization. Since the graft is an intact piece of skin, drainage or blood may accumulate under the graft. These are referred to as "blebs" and should be evacuated daily (this is done by making small slit in the conformant) so that the graft can connect with the wound base. The conformant will stay in place until take down.

Overlay Allografts

- Overlay grafts are essentially a dressing that will separate spontaneously as the graft underneath heals. They are most often covered with Xeroform. Loose, non-adherent overlay grafts may be trimmed with dressing changes.

Dressing 'Take Down'

- **'Take Down' refers to the day which all the dressing and staples are removed and the graft is inspected for 'take'.** This typically occurs on POD#6. If overlay grafts are used, the dressing will come down to the overlay layer.

Skin Substitutes

Primatrix

- Primatrix is applied in the operating room after the burn has been excised. It is usually covered with xeroform or conformant, then a gauze outer dressing. Soaks with an antimicrobial solution may or may not be placed over the top. Outer dressings are usually replaced daily. Once incorporated, the patient will return to the operating room for autografting.

Integra

- Integra is applied in the operating room. The top layer of integra is a clear silicone material. Either conformant, xeroform, or a bolster may be placed over the silicone layer. Soaks with an antimicrobial solution may or may not be placed over the top. Once incorporated, the patient will return to the operating room, the silicone layer will be removed and autografting will be completed.

BTM

- BTM includes a silicone layer which acts as a dressing. Burn gauze and a kerlix roll is placed over the wound. Soaks with an antimicrobial solution may or may not be placed over the top. Once incorporated, the patient will return to the operating room, the silicone layer will be removed and autografting will be completed.

Soaks

Antimicrobial solutions may be applied over any type of graft site to prevent colonization and infection of the wound bed. Typically, either Vashe (hypochlorous acid) or Sulfamylon (mafenide acetate) are utilized. Sometimes, after a quantitative culture is collected from the wound, the antimicrobial solution will be specified based on the species isolated. The goal is for the gauze overlying the graft site to remain continuously moist with the solution.

Technique:

1. Burn gauze is soaked with the solution then applied over the graft and contact layer dressing. Dressing should be moist, not dripping.
2. Wrap in Kerlix gauze and ACE bandage.
3. Use a large syringe to re-soak the dressing 2 or more times each day.
4. Change the gauze layer once daily.

Donor Site Care

The donor site refers to the area where the skin graft was taken. This results in a wound that is often painful and produces a large amount of sero-sanguinous drainage for the first few days. Consider pre-medicating the patient when changing the donor site dressings.

Mepilex Ag Foam

- A lightly adherent, non-bordered foam dressing that contains silver (antimicrobial). Commonly used on donor sites that have intact surrounding skin. Dressing should be applied with a 2" border over healthy skin. The edges are usually framed with 4" Hypafix tape to help keep it in place. Does not require a secondary dressing, may secure with ACE.
    - Covered with ace wrap only.
    - Change dressing only if >75% saturated with drainage.
    - Healing should occur within 10-14 days.

Xeroform

- Sterile, fine mesh gauze impregnated with a blend of 3% Bismuth Tribromophenate (Xeroform) and USP petrolatum. Goal is for donor wound to heal by desiccation (drying out). The xeroform layer will stay in place until wound is healed and may be trimmed away as edges lift.
    - Cover with burn gauze, kerlix and ace wraps
    - Change outer dressing when drainage is visible. Replace dressing as needed if it is not covering the donor wound.
    - Discontinue outer dressings on POD 6 and leave xeroform open to air
    - Healing should occur within 14 days
    - As the wound begins to heal and drainage decreases, may consider applying a layer of Aquaphor over the xeroform to keep it moist and promote comfort.

Chapter 19
Nutritional Support

Nutritional Assessment

The Registered Dietitian (RD) should consider patient's pre-burn nutritional status and assess for malnutrition and refeeding risk on admission. The patient should be weighed on admission or obtain usual weight from family. Patients with >20% TBSA or **partial or full thickness burns covering more than 15% of the body** should be started on enteral nutrition. Non vented patients with <15% TBSA can trial high calorie, high protein diet with oral supplements; some may still need enteral nutrition if oral intake is suboptimal or patient is poorly nourished on admission

Nutrition Support

If indicated, nutrition support should be initiated as soon as clinical course permits. ASPEN Guidelines recommend enteral nutrition (EN) initiation within 6-24 hours of admission. EN is recommended over parenteral nutrition (PN) to help maintain gut integrity. Consider trial of post-pyloric feedings if gastric feeds are not well tolerated or if aspiration risk is high. Presence or absence of bowel sounds and/or high gastric residuals do not correlate well with feeding intolerance and should not be used as an indication for holding EN. The unit RD will post a note with EN recommendations in Epic

Energy Requirements

Indirect Calorimetry (IC) or Measured REE: Considered the gold standard for determining energy needs for burn patients. IC should be completed at least once weekly for eligible pts. A factor of 10-30% (x 1.1-1.3) will be added to measure REE for anabolism. A steady state should be achieved with RQ within physiologic range of 0.67-1.3 for study to be considered valid

Validated Equations: At this time, no algebraic equation has been validated for use with burn patients, however if IC is not available or feasible, the following equations can be used: Mifflin-St Jeor x activity factor x burn factor* or Penn State 2003/2004 x burn factor* or Toronto Burn Equation. RD will calculate energy needs using the appropriate equation

% BSA Burn	Burn factor*
10-20%	1.2
20-50%	1.3-1.5
>50%	1.5-1.8

Weight: For normal weight patients, use admit weight or pre-burn weight (if available) for calculations. For obese patients (BMI >30), use IBW or adjust calculations for obesity (per ASPEN guidelines for obese critically ill). WEEKLY WEIGHTS SHOULD BE ORDERED FOR ALL BURN PATIENTS

Propofol: RD will factor calories supplied by propofol and adjust enteral nutrition recs accordingly

Do not over feed calories as this can lead to hyperglycemia, fatty liver, azotemia and elevated CO2 production. In addition, overzealous calorie provision tends to lead to the accumulation of fat versus lean body mass, therefore is of little benefit

Protein Requirements: Protein catabolism in burn patients can exceed 150 grams/day. ASPEN and ISBI recommend protein range of 1.5-2.0 gm/kg/day (use IBW with obesity). Studies show that protein intake >2.2 gm/kg/day has no further beneficial effect on net protein synthesis. Do not reduce protein provision to preserve kidney function

Micronutrients: Clinical studies have shown an increased need for Vitamins A and C, folate, zinc, copper and selenium. All patients with any burn injury should be put on multivitamin with minerals (therapeutic multivitamin). The RD will calculate micronutrient amounts provided by the tube feeds and the multivitamin and make additional supplement recommendations as needed Daily Recommendations

	Vitamin A IU retinol	Vitamin C mg	Folate mcg	Copper mg	Selenium mcg	Zinc mg elemental
Non burned	2000-3000	75-90	300-400	0.9	40-60	8-12
Burned	10,000	1000*	1000	4.0	300-500	45-50

*administered in two divided doses per day

Nutrition Pearls

- Weigh patient on admission, prior to fluid resuscitation and order weekly weights
- Initiate enteral nutrition (if indicated) within 6-24 hours of admission
- Order weekly Indirect Calorimetry (IC)
- Order Prealbumin and CRP twice weekly
- Order daily multivitamin with minerals (therapeutic multivitamin)
- RD will calculate calorie, protein and extra vitamin/mineral needs and post recs in Nutrition Note
- Do not automatically shut TF off at midnight for OR; do not check gastric residuals unless concerned

Nutritional Evaluation

Weights

Expect pt. may lose up to 10% of pre-burn weight even with excellent nutrition provision. Pt should be weighed on admission (prior to fluid resuscitation) or obtain usual weight from family if available. Weigh weekly without burn dressings if possible; attempt to coordinate with team to obtain weight during dressing change. Weights tracked over time are most useful.

Lab Results

Check Prealbumin and CRP on admission and twice weekly thereafter. When trended, PAB can help in monitoring the efficacy of nutrition therapy. Check mag and phos daily until stable, then 1-2 times per week. Monitor LFTs if on Oxandrolone. Consider weekly nitrogen balance for

>50% TBSA burns.

Glycemic Control

Follow MMC SCU glycemic control guidelines keeping blood sugars between 110-180 gm/dl. Consensus recommendation is 55-60% of energy as carbohydrates without exceeding 7mg/kg/min.

Optimizing Nutrition Support

Perioperative feeding guidelines: Intubated patients with a feeding tube should continue to receive their tube feeds until pt. is called to the OR. For non-intubated patients or planned prone positioning in the OR, feeds should be stopped six hours prior to case start time *See *MMC ICU Perioperative Fasting Guideline* 2017.

Gastric residuals: Per MMC policy, only check gastric residuals (GR) if there is concern for intolerance. Continue feeding patient if GR is < 500 ml. If GR are >500 ml, hold feeds and recheck in 2 hours *See MMC Institutional Policy *Gastrointestinal Tubes: Insertion, re-insertion, Feedings, Care and Maintenance.*

Increased TF volume: The RD may recommend an increased hourly rate to accommodate for time TF is turned off and on.

Beyond the ICU

The hypermetabolic state can persist for over a year after burn injury. Once able to start PO, provide high calorie, high protein diet and oral supplements (burn frappes); cycle tube feeds (provide 50-100% of tube feed volume over 12-16 hours nocturnally); start calorie counts; wean off tube feels as PO intake improves (per calorie count results) and continue to check weekly weights.

Chapter 20
Rehabilitation Protocols and Guidelines

Evaluation and Treatment

- Physical (PT) and Occupational Therapists (OT) are crucial members of the Burn Team.
- PT and OT consults should be placed upon admission – even for patients in the ICU and burn procedure room
- As per department policy initial contact will be made within 24 hours of referral
- In traditional rehabilitation services PTs perform exercise, ambulation/mobility, and concern themselves with the lower extremities; OTs fabricate upper extremity splints, complete activities of daily living (bathing/dressing/toileting/feeding) however in burn rehabilitation there is a great deal of overlap with PT and OT services. The OT/ PT team have a primary focus on ROM and prolonged stretching to prevent scar contracture.

Splinting

- Orders for splints will be requested and specified by the therapist and are to be placed under the orthotic device panel order in Epic.

Positioning

- PT and OT will provide recommendations for positioning including devices, duration, precautions; etc. These recommendations will be communicated in therapy documentation, orders to nursing, and also may be posted in the patient's room.

Range of Motion

- PT and OT will complete range of motion with **all** patients on post-op day 1 following **all** grafting unless otherwise specified by the attending physician.
- Therapists will remove outer dressings down to conformant on sheet grafts to assess for blebs and complete ROM (unless documentation from the attending physician specifically indicates that all dressings should remain in place). We will monitor ROM progress with goniometric measurements to involved/impaired joints at time of evaluation, progress note and re-examinations

Dressing Changes

- The burn therapists typically coordinate with nurses to participate in the daily dressing changes to achieve optimal range/stretching, evaluate the integrity of the skin, and evaluate developing scar tissue contracture.

Edema Management

- PT/OT will make recommendations appropriate regarding including positioning/elevation, and compression techniques to be initiated at the start of care.

Early Mobility

- As research shows, early mobility is a very important factor in optimizing patient recovery and functional achievement. PT and OT will mobilize **all** medically appropriate patients on post-op day 1following **all** grafting procedures unless otherwise specified by the attending physician.

Pain Control

- Additional pain medications will likely be required for the patient to tolerate range of motion, stretching and mobilization activities. It is not uncommon for pain medications to be ordered specifically for these activities.
- Please be aware that over sedation will impede efforts to mobilize patients.

Discharge Planning

- PT and OT are an integral part of discharge planning and should be consulted prior to discharge - even in the ED, burn procedure room, and on weekends. PT and OT will make recommendations for follow up which may include; acute rehabilitation, skilled rehabilitation, home services, or outpatient services. Patients are also provided with PT and OT education materials at discharge.

Burn Rounds

- PT/OT will participate in weekly burn rounds to discuss functional progress, concerns, and anticipated discharge needs.

Outpatient Surgical/Burn Clinic

- PT/OT services are available at burn clinic (currently Wednesdays 13:00-17:00) to evaluate patients' skin, scar tissue, ROM, splinting needs, provide patient and caregiver education, revise ongoing plan of care, make appropriate referrals, and collaborate with outpatient/home care therapists as needed.

Chapter 21
Psychological Care of the Burn Patient and Family

Burn injuries affect the psychological well-being of a patient and that patient's family. Some types of injury, such as deliberate self-harm or risks that could have been avoided, can create additional psychological issues. Disfigurement with changes of facial and body image adds bereavement to the traumatic experience, and how this is addressed in the early stages may be critical long after the burns have healed. How the patient responds to the issues caused by being burned can also have an impact on that patient's care, including such things as pain tolerance, anxiety level, and motivation to do the active (and painful) exercises necessary to regaining and retaining range of motion. In order to deal with the acute pain, which is usually at its worst during dressing changes, a variety of pain medications are used. While this is necessary, it can create additional complications for patients with current or past substance abuse.

There is a lot of work for mental health professionals in a burn unit. Psychiatry, including psychiatrists and psychiatric nurse practitioners, is often called on for psychotropic medications. These are used to manage withdrawal symptoms in active alcoholics, to deal with insomnia, and also to lessen a number of symptoms that can also--or instead--be helped with non-pharmaceutical means. Psychology is a later arrival to the burn unit, and so many of the multiple roles psychologists can play are still being discovered and tried.

These roles include helping the patient to manage pain by a variety of means, including distraction. Distraction can be used either through the psychologist being there for dressing changes and bringing the patient's focus to a place or occurrence far distant from the hospital bed, or by the psychologist teaching the patient distraction techniques which the patient can then use during dressing changes.

A new and exciting development in distraction techniques is the use of virtual reality (VR), in which the patient is immersed in an alternate reality beamed to him or her through a computerized headset. This technology has been tested with a variety of patients, including burn survivors and Veterans. There is excellent research showing the effects of VR in pain management, including brain studies showing the brain's pain receptors are less active when the patient is fully engaged in VR. We at Maine Medical are expecting to have a virtual reality option sometime in 2019.

Other activities of the Burn Unit psychologist include the following:

- Helping patients learn to cope with altered life circumstances--for example, home totally gone, including the home's former contents, like all of one's clothing; temporary or permanent disfigurement; lengthy convalescence and not being able to work for quite a while.

- Educating patients about burn recovery and the surgeries and therapies used in the course of that recovery. Research on surgery has shown that patients who understand the medical procedures they will be undergoing can cope better with those interventions and their sequelae. Of course there are also patients who want to know *nothing* about what is to be done to them, and it is the psychologist's job to figure out which patients these are and then deal with them as they would prefer to be dealt with.

- Helping the burn patient develop coping mechanisms for physical pain and psychological trauma associated with daily wound care and the healing process.

- Helping the burn patient deal with her/his minor children and all the questions such children usually have. If the psychologist has child and family training and experience, as Maine Medical Center's current psychologist has, s/he can also meet with the children and/or the family to help them all adjust to visible and not so visible changes to their parent.

- Helping the relatives and loved ones of the burn patient deal with the trauma of almost losing a loved one, with the burn patient and his/her reactions, and with the necessity in some instances with preparations for hosting the recovering burn patient in one's home.

- Working with the burn patient in targeted therapy to help with whatever that patient is experiencing and having trouble with. What a psychologist brings to the table is training and experience in understanding the personality and needs of each particular individual. This is quite different from assigning patients to diagnostic categories--while sometimes those categories can helpful, they can also obfuscate important unique detailsof the patient in front of you.

The Burn Unit psychologist at Maine Medical Center is at the Unit half time, or 20 hours a week. The Unit does have full time coverage, however, since the hospital has a psychiatry department and a psychiatric inpatient unit. When the psychologist is not present, the psychiatry department covers the Burn Unit. Also, for more acute and/or severe mental health situations--such as a suicidal patient, who may need to be seen daily--the psychiatry department will be the main treating professionals due to their consistent presence and availability. While there is overlap in what psychologists and psychiatrists do, the psychiatry department generally handles burn patients with pre-existing, serious mental health problems while the burn psychologist is more involved with adjusting to the burn injuries and psychological rehabilitation.

Chapter 22
Electrical Injury

Electrical injuries account for only 4% of all burn center admissions, but cause about 1,000 deaths per year. Although the visible wounds are often small, electoral burns can cause devastating injury to skin and deeper tissues.

Electrical burn injury are caused by direct current (DC) or alternating current (AC) and divided into high (>1000 volts) or low (< 1000 volts). Low-voltage burns usually cause only localized injury, but high-voltage burns can cause injury to deep and underlying tissue. Electricity can be further characterized by Ohm's Law:

Current (I) = Voltage (V) / Resistance (R)

Further, the heat generated is defined by the Joule Effect:

$J = Current^2 \times Resistance \times Time$

The higher the current, and longer the contact time, the higher the heat generated and, thus, the higher potential for damage.

Alternating current causes tetanic muscle contractions, which can throw victims away from the point of contact or draw them into prolonged contact. Different tissues possess different resistance. In order of resistance from lowest to highest are nerves, blood vessels, muscle, skin, tendon, fat and bone. Dry skin has a high resistance, and once current flows through dry skin, will flow through muscle. Wet skin has a much lower resistance.

Direct current flows in one direction while alternating current changes direction while travelling. Entrance and exit sites are outdated, and now can be more descriptively called "contact points." However, the path of electricity can be unpredictable and may travel many different paths. Thus, it should be assumed that there could be significant electrical damage throughout the body. The severity of injury is inversely proportional to the cross-sectional area of the body part. Smaller diameters, such as wrists and ankles, have more significant damage compared to more proximal areas of the body with higher diameters. Deep tissues retain more heat so that the periosseous tissues, especially between two bones often have more significant injuries. Electricity also causes other tissue injury including heating, electroporation, and electroconformational denaturing of transmembrane proteins. Heat and temperature can cause denaturating of molecules, with high voltage current causing immediate tissue necrosis. Electroporation causes pores in the lipid bilayers, that allow calcium influx and triggers apoptosis of cells. Electroconformational denaturing of transmembrane proteins refers to changes in polarity of amino acids in response to exposure to electrical fields.

Treatment:
Findings that suggest significant electrical injuries include

- Loss of consciousness
- Paralysis or mummified extremity
- Loss of peripheral pulse
- Flexor surface contact injury (antecubital, axillary, inguinal or popliteal burns)
- Myoglobinuria

Assessment should start with the primary survey

- Airway maintenance with c-spine precautions should be performed if a fall or a blunt force trauma is also suspected. Muscle contraction due to electrical injury can cause vertebral injury, and a C-collar should be applied.
- Breathing – administer oxygen as necessary
- Apply cardiac monitor and monitor for cardiac dysrhythmias
- Stop any burning process and protect from hypothermia

Secondary survey should include

- Head-to-toe examination
- Identify all contact points, with careful attention to hands, feet, and scalp. Most of the time, the contact points will be trivial, but can be associated with significant pain, numbness, or difficulty with movement.
- Determine burn severity and TBSA.
- Perform detailed motor and sensory neurologic exam to assess for any nerve damage or compartment syndrome
- Check and monitor for fractures and compartment syndrome

Resuscitation

- Due to high potential for a greater extent of injury compared to what is visible, resuscitation should start at LR at 4ml/kg/% TBSA. This may underestimate the TBSA especially with significant muscle and deep tissue injury and should be adjusted with urine output.
- Maintain a higher urine output if there is evidence of myoglobinuria, with a target of about 100 ml/hr until the urine clears.
- Worsening myoglobinuria despite aggressive resuscitation should prompt evaluation for muscle necrosis or compartment syndrome, and should be consideration for early operative decompression, debridement, or amputation.

Cardiac Monitoring

- EKG should be performed in all patients. If there are dysrhythmias or ectopy present, the patient should be placed on telemetry for an additional 24-48 hours.
- Non-specific ST-T changes are the most common EKG abnormality, and atrial fibrillation is the most common dysrhythmia.

Traumatic Injuries

- Approximately 15% of electrical burns also sustain traumatic injuries, most often from a fall, or thrown from the point of electrical contact. In additional, tetany can cause significant fractures and injuries.

Low voltage electrical injuries: if there are no symptoms and EKG is normal, will not usually have any significant injury and can be discharged.

High voltage electrical injuries (>1,000V) will require monitoring as described for the possible above injuries and complications.

Chapter 23
Chemical and Radiation Burns

Chemical burns account for approximately 3% of all burn center admissions. Chemical burns are not often recognized immediately, and can cause injury for a prolonged period due to increasing exposure and reaction. Chemical burns cause damage by denaturing proteins in the skin. This can be due to reduction that bind free electrons, oxidation, corrosion, protoplasmic poisons that bind or inhibit calcium or other organic ions, vesicants that cause ischemia and necrosis, and desiccants that dehydrate tissue and cause an exothermic reaction. They can cause injury by absorption through the skin and mucous membranes, ingestion, or inhalation.

Chemical burns can be classified by into three basic categories: alkalis, acids, and organic compounds.

Alkalis, such as lye and hydroxides, are often found in cleaners, drain and toilet bowl cleaners, industrial cleansers, and cement. Damage is caused by liquefaction necrosis and protein denaturation, and often are much deeper than other chemical burns.

Acids are found in many bathroom cleansers, calcium or rust removers, and industrial cleaners. They cause damage by coagulation necrosis and protein precipitation, and cause a thick leathery eschar.

Organic compounds such as phenols and petroleum, cause damage by acting as a solvent on the fat in cell membranes. In addition to the damage to the skin, the systemic absorption can also cause damage to the kidney and liver.

Treatment:

The extent of the burn depends on several factors: concentration, amount, manner and duration of skin contact, extent of penetration, mechanism of action, phase of the agent (liquid, solid, gas), and temperature of the agent.

The primary management of chemical burns is to stop the burning process by removing contaminated clothing and copious, prompt irrigation. Irrigation should be thorough and may require a significant amount of time. Dry chemicals should be brushed away. Care should be taken to minimize risk of exposure to other patients, healthcare workers, and facility, and should be performed as part of the decontamination plan for the facility. Water has been shown to be the most effective irrigation. Neutralizing agents can cause exothermic reactions and further the burn process, and should be avoided.

As in all scenarios, assessment should start with the primary survey.

- Airway maintenance and patency should be ensured.
- Adequate breathing and oxygenation should be assessed, to keep in mind that chemical burns can occur with inhalation.
- Cardiac and hemodynamic stability monitored.
- Expose all areas and stop the burning process by removing contaminated clothing and removing chemicals and provide copious irrigation.
- Ensure adequate IV access for resuscitation.

Secondary survey should include

- Head-to-toe examination
- Identify and assess depth of wounds, keeping in mind that chemical burns can be deeper than they appear and can potential to evolve deeper.

Resuscitation should follow general burn resuscitation by assessing TBSA burned and using modified Parkland formula with goal-directed resuscitation.

Specific Chemicals

Anhydrous ammonia – Ammonia is a strong base with a pH >12, and often found in many household cleaning solutions and fertilizer. They often appear superficial, but can be evolve to be full thickness. When it becomes in contact with body moisture or water, anhydrous ammonia can become corrosive causing deep burns. Particular attention should be made if exposed to the eye as it can cause significant corneal injury and permanent damage.

Hydrofluoric Acid – Hydrofluoric acid is used in many different ways including as a cleaning agent, glass etching, creating Teflon, fireproofing, and as a rust removal. Hydrofluoric acid can cause skin damage, eye damage, and respiratory problems. It can act as both an acid and a poison. It can cause coagulation necrosis, and chelates calcium and magnesium to cause hypocalcemia and hypomagnesemia. This can cause potentially fatal cardiac dysrhythmias. Treatment includes removing clothing, irrigation for 30 minutes or more, and application of calcium gluconate to the area. In select extremity HF acid burns, intravenous and/or arterial catheter directed calcium gluconate may be considered.

Chapter 24
Frostbite

Due to our location, Maine Medical Center treats several patients with frostbite each year. The purpose of this guideline is to guide the diagnosis and classification of frostbite and to provide an algorithm for treatment with either conservative management, intra-arterial thrombolytic therapy (IATT), or intravenous thrombolytic therapy (IVTT).

Frostbite is a cold thermal injury caused by prolonged exposure to cold temperatures. It has the potential to cause significant morbidity and disability. Traditionally, the treatment of frostbite has been conservative with expectant management utilizing amputation and reconstruction when necessary. Recently, more aggressive treatment with thrombolytic therapy has gained widespread use with impressive clinical outcomes. With both conservative and aggressive initial treatment, frostbite injuries may take months to demarcate. At this time, a surgical evaluation is made to determine if amputation or reconstruction is indicated.

Pathophysiology: In the first stage of injury, direct cellular damage caused by intracellular freezing results in direct cell death and extracellular freezing leads to cellular membrane damage. This results in intracellular dehydration, electrolyte imbalances and subsequent cellular death. In the second stage of injury, the coagulation pathway is activated by cellular death. A cycle of vasoconstriction and vasodilation occurs which leads to thrombosis and ischemia. The accumulation of inflammatory mediators, subsequent localized edema and additional platelet aggregation exacerbates this ischemic cycle.

Classification: Grade when affected area is re-warmed. If extremity is cold to touch, active rewarming in a warm water bath is recommended (submersion of affected area in water @ 42°C). Injury may demarcate within the first 72 hours. Classify injury before and after re- warming using grading scale above.

Grade 1: partial thickness skin freezing with numbness, erythema, hyperemia and the absence of blisters
Grade 2: full thickness dermal freezing with erythema, hyperemia and serous or milky blistering. *Grade 3*: dermal and subcutaneous freezing with hemorrhagic blisters on presentation and skin necrosis and eschar formation after two weeks
Grade 4: full thickness dermal, subcutaneous tissue, muscle, tendon and bone freezing with mottled, deep red or cyanotic coloring and mummification of tissues after several weeks

Imaging

- **Doppler ultrasound:** assess pulses
    - if hands affected then check digital doppler signals

- **Angiography:** assess macrovascular perfusion
    - Digital subtraction angiography: for injuries to hands

Thrombolytic Therapy

Either intra-arterial or intravenous alteplase treatment will be considered in patients with severe frostbite injuries. See detailed protocols posted on the Trauma clinical practice guidelines
(Frostbite CPG) page.

- Grade 1 or 2 -- proceed with conservative management
- Grade 3 or 4 injury isolated to hands
    - consider Intra-Arterial Thrombolytic Therapy (IATT)
- Grade 3 or 4 injury isolated to feet
    - consider Intravascular Thrombolytic Therapy (IVTT)
- Grade 3 or 4 injury to hands AND feet
    - Attending discretion to determine IVTT vs IATT

Anticoagulation

- All grade 2- 4 injury:
    - low molecular weight heparin (enoxaparin) 1 mg/kg BID for 7 days
    - aspirin 325 mg for 3 months
- See frostbite CPG plan for patients undergoing IATT or IVTT

Wound Care

- Protective dressings with several layers of gauze to avoid trauma to affected tissues
- Petroleum gauze and antimicrobial ointment to partial thickness injuries
- Iodosorb/Iodoflex or silver sulfadiazine to full thickness wounds
- Aloe vera ointment to intact skin

Considerations

- Re-warm with warmed fluids, warm blankets, Bair hugger
- Elevate affected extremities
- Bedside debridement of bullae which impede range of motion
- Pain control: NSAIDs for analgesic and anti-prostaglandin properties, acetaminophen, opioids, gabapentin/pregabalin for neuropathic pain
- Physical and Occupational Therapy evaluation and treatment
- Patient Education: avoid re-freezing, avoid trauma to affected areas

Chapter 25
Exfoliative Skin Diseases

The burn soft tissue service is frequently asked to consult on a myriad of non-burn exfoliative diseases. The variety and complexity of diseases in this field is vast and beyond the scope of this manual. There are a few infrequent diseases that often require the wound care and critical care management capabilities of a burn center. These diseases are reviewed here:

Stevens-Johnson syndrome (SJS) & Toxic epidermal necrolysis (TEN)

Erythema multiforme, SJS and TEN represent a continuum of rare, but severe exfoliative disease. There is considerable controversy regarding the classification of these diseases and the terminology can be confusing. All are characterized by blistering disease of mucosal membranes (to varying degrees), maculopapular rash and Dermoepidermal separation of skin on pathology. Erythema Multiforme is distinguishable by the absence of a Nikolski sign. Epidermal slough up to 30% TBSA is classified as SJS. >30% is characteristic of TEN. Refer to table below for assistance in characterizing this disease

	Erythema Multiforme	Stevens-Johnson	Toxic Epidermal Necrolysis
Prodrome	Absent	High fever, malaise	High fever, malaise
Acute Phase	4-8 days	4-8 days Burning sensation on skin	Sudden onset, 1-2 days Burning sensation on skin
Skin lesion	Symmetric, primarily extremities, target lesions without blisters	Variable distribution, individual vesicles on erythematous base <30% TBSA. **Nikolski sign (+)**	Diffuse generalized epidermal detachment, absent target lesions, large confluent areas, palmar and plantar involvement, >30% TBSA, **Nikolski sign (+)**
Mucosal involvement	Limited to one surface, usually oral	Severe, 2 or more surfaces	Severe, 2 or more surfaces
Histopathology	Dermoepidermal separation, mononuclear perivascular cell infiltrate	Dermoepidermal separation, more intense dermal infiltrate, areas of epidermal detachment	Epidermal necrosis, dermoepidermal separation, minimal inflammatory infiltrate, large areas of epidermal detachment
Recovery	1-4 weeks	1-6 weeks	1-6 weeks
Mortality	0	0-38%	25-80%

SJS/TEN with >15% TBSA open wound typically requires ICU admission. These patients are typically admitted to the Surgical ICU service and placed on the burn resuscitation protocol as this disease mimics large burn pathophysiology. With TEN, consideration should be given to grafting with cadaveric skin or xenograft to reduce fluid loss and protect the otherwise functional exposed dermis. This maneuver also removes necrotic epidermis which decreases bacterial counts and reduces risk of wound infection. Mortality is usually related to sepsis and septic shock. **In all patients with oral involvement who cannot handle the volume of secretions, consideration should be given to intubation followed by early tracheostomy**. This maneuver has been shown to improve survival in TEN. Dermatology should be consulted and biopsies taken. Opthalmology should be consulted if there is concern for ocular involvement. There are several medical interventions aimed at immune modulation that are managed by dermatology. These options are beyond the scope of this manual.

Purpura fulminans

An acute syndrome characterized by rapidly progressive hemorrhagic necrosis of the skin due to dermal vascular thrombosis. Typically associated with severe systemic infections with septic shock and multiple vasoactive medications. Management is focused on effective treatment of the underlying infectious insult, preventing secondary infections and removal of devitalized tissue. It is important to remove necrotic lesions early to prevent secondary infections. Digit and limb amputations are common in this disease.

Chapter 26
Necrotizing Soft Tissue Infections

Necrotizing soft tissue infections (NSTIs) may present acutely following just a few hours of pain, or sub-acutely after several days of pain. The infection most often occurs in the lower extremity than the upper extremity. It can present with a number of different symptoms including, but not limited to: fever, erythema, edema, severe pain out of proportion to exam findings, crepitus, skin bullae, necrosis and ecchymosis. It may strike any region of the body, however if it involves the head and neck or hand region an ENT or hand consult is recommended respectively. There are a variety of subtypes of necrotizing soft tissue infections and these are discussed below.

Types of Necrotizing Soft Tissue Infection (NSTI)

Necrotizing Cellulitis

Necrotizing cellulitis is caused by anaerobic organisms that fall into two categories: those infections caused by clostridium (either clostridium perfringens or clostridium septicum) and those cause by polymicrobial infections.

Crepitus may be observed on physical exam however it is not a requirement. Often, there may be subcutaneous emphysema (air) that may not be palpated on physical exam. In addition, patient's may have swelling, pain with or without palpation and exhibit signs of sepsis including hypotension. The majority of necrotizing soft tissue infections seen on the soft tissue service are actually necrotizing cellulitis, as they rarely involve the fascia. However, it may be difficult to tell whether an infection is a necrotizing fasciitis or necrotizing cellulitis. The distinguishing factor between these two infections is whether there is subcutaneous tissue involvement alone (necrotizing cellulitis), or whether there is fascial involvement in addition to subcutaneous tissue involvement (necrotizing fasciitis). An infection that extends to and involves the underlying muscle would be considered a necrotizing myositis and not just a necrotizing fasciitis.

Necrotizing Fasciitis

Necrotizing fasciitis is an infection that involves the subcutaneous tissues and tracks along the fascial planes resulting in progressive destruction of the muscle fascia and subcutaneous tissues. The infection tracks along the fascia planes as the blood supply to the fascia is far inferior than that to the underlying muscle. Lack of sensation will often precede tissue necrosis.

There are two types of necrotizing fasciitis:

Type I – polymicrobial, the result of both aerobic and anaerobic infection. This infection is more frequent in older individuals who are more likely to have other medical co-existing medical conditions. Most often the co-existing medical conditions are diabetes and peripheral vascular disease.

Type II – monomicrobial, usually caused by group A streptococcus and may occur in any individual.

Necrotizing Myositis

Necrotizing myositis involves the deeper skeletal muscle tissues usually called by group A streptococcus (GAS) or other beta-hemolytic streptococci. The inciting factor of necrotizing myositis may be trauma, a skin abrasion or heavy exercise. This infection is the rarest of all the necrotizing infections with some case reports documenting less than 50 in the past 100 years.

Fournier's Gangrene

Fournier's gangrene is a necrotizing soft tissue infection of the perineal area caused by any of several facultative anaerobes including *e.coli, klebsiella, and enterococci,* as well as anaerobes such as *bacteroides, fusobacterium,* and *clostridium,* or anaerobic *streptococci.* Fournier's gangrene often requires large debridements of the perineal area that require fecal diversion with a colostomy. Fournier's gangrene is often a polymicrobial infection (Type I). It may progress to involve both the anterior abdominal wall, the gluteal muscles and the supralevator areas. Men are more commonly involved than women, however both the penis and labial structures may be involved and require debridement/removal.

Evaluation of Potential Necrotizing Soft Tissue Infections (NSTI)

Laboratory Abnormalities

Laboratory abnormalities in NSTI are very non-specific but include a leukocytosis with left shit, acidosis, coagulopathy, hyponatremia, elevated inflammatory markers including CRP and ESR, elevated serum creatinine, lactate, creatinine kinase, and aspartate aminotransferase.

LRINEC score

LRINEC stands for a Laboratory Risk Indicator for Necrotizing Fasciitis. It is based on white blood cell count, hemoglobin, sodium, glucose, creatinine and CRP (C-reactive protein). Further studies of this score have suggested that it has low sensitivity and should not be used to rule out a necrotizing soft tissue infection. The score may be calculated using MDCalc which can be found online.

Operative Investigation of Equivocal Cases

In cases where the diagnosis of necrotizing soft tissue infection is uncertain a "finger test" may be performed under local anesthetic or in the operating room under general anesthetic. In this test a small incision is made over the area in questions and the tissue is tested for integrity. Infected tissue will not have the normal resistance as the planes have been destroyed. A specimen may also be sent for gram stain.

Management of Necrotizing Soft Tissue Infections (NSTI)

Antibiotic Selection

Antibiotics selected should cover gram positives, gram negatives and anaerobic organisms. Appropriate antibiotics include carbapenem or piperacillin-tazobactim and an antibiotic against MRSA (daptomycin or vancomycin) and clindamycin. IV antibiotics should be commenced as soon as possible after blood cultures have been drawn.

Operative Intervention

A necrotizing soft tissue infection is a surgical emergency. If there is suspected to be a necrotizing infection, the patient should be brought immediately to the operating room for surgical debridement down to healthy bleeding tissue. The patient should be brought back to the operating room every 1-2 days until there is no longer any necrotic tissue.

In the case of Fournier's gangrene, infrequently a patient will require diversion of stool to avoid contamination of the wound. This can be accomplished by giving the patient a diverting colostomy during a subsequent operation following initial debridement and stabilization of the patient. In cases where the penile urethra has been compromised a suprapubic tube may be placed. The testicles can be tucked in medial thigh pockets for safe keeping until the infection has resolved. Reconstruction of the genitals can be considered at a later date once the perineum has healed following debridement.

Management of Septic Shock Associated with NSTI

Severe necrotizing soft tissue infections may cause septic shock resulting in hypotension, rising creatinine, and lactate. Patients should be aggressively resuscitated with IV fluids and vasopressors as necessary. Renal failure may occur secondary to acute tubular necrosis related to the hypotension that ensues as a result of the infection. Control of the infection with debridement and treatment with IV antibiotics are key to resolving the patient septic shock. Group A streptococcus infections are most often associated with septic shock and requiring vasopressor support. Although rare, clostridia infections can cause extensive necrosis of the muscle and fascia with minimal skin changes.

Chapter 27
Discharge Planning and Outpatient Wound Care Instructions

Burn care extends for months to years after their inpatient admission. Prior to discharge there are several criteria patients must meet to be successful. In the early stages after discharge, burn clinic is focused on wound care, mobility concerns and pain control. In the later stages, care is focused on scar management, contractures and symptomatic management. Psychological rehabilitation is ongoing at every stage after discharge.

Criteria for Discharge:

- May vary depending on if patient is going home or to rehab.
    - Pain is controlled on oral analgesia.
    - Wound care plan manageable by patient/family, home nursing or rehab facility.
    - Patient is able to mobilize without assistive.
    - Follow up plan is confirmed.

Burn Clinic

- *When*: Wednesday 1:00 - 4:00pm
- *Where*: Acute Care Surgery Clinic - 887 Congress St. 4th floor
- *Who*: burn attending of the week, inpatient burn APP, outpatient burn APP, Burn and Wound Resource Nurse, PT, OT, rehab psychologist, clinic nursing staff
- *What*: burn specialty clinic with multidisciplinary team
    - Follow up for inpatient burns
    - New burn consults
    - Follow up for patient seen in ED (MMC or other ME/NH hospitals)

Other Clinics

Attending's and outpatient NP hold clinic at the Acute Care Surgery Office on other days. Non burn patients may follow up with any BST provider.

Scheduling

- BST Service Patients
    - Send a staff message in Epic to: P MMP Acute Care Surgery Admin Pool
    - Request when you would like the patient to be seen (burn clinic vs other clinic)
- ED/Outpatient Providers to set up follow
    - Email burnfollowup@mmc.org
    - Include patient name, DOB, reason for visit

Burn Clinic:

A multidisciplinary clinic to meet all the needs of burn patients after discharges, as well as new burn and scar consults. Held every Wednesday afternoon. Attendants include burn attending, inpatient burn APP, outpatient burn APP, Burn and Wound Resource Nurse, PT, OT, rehab psychologist, clinic nursing staff. See section on "Follow up" for more information.

Pain Control:

Multimodal pain control should continue after discharge. Consider that patients are often more active when discharged home, resulting in increased pain. Analgesia plan should consider dressing changes and exercises. Analgesic should be weaned in the following order:

- Opioids
    - Discharge on an oral dose equivalent to which they are taking in hospital. The dose will be weaned in subsequent clinic. Patients are typically discharged with 7 days of opioid analgesia as acute burn pain lasts until burn and donor sites are healed.
    - Typically, in alignment with PMP, prescriptions include:
        - oxycodone 5-10 mg every 4 hours, #42-84 tabs
        - hydromorphone 2-4 mg every 4 hours, #42-84 tabs
- Acetaminophen/NSAIDs
    - Alternate medications every 3 hours:
        - acetaminophen 650-975 mg Q6hrs
        - ibuprofen 400 mg Q6hrs
- Gabapentin: titrate up to effect until maximum dose, consider renal clearance
        - Will be weaned last.
        - Weaned by decreasing by 100 mg per dose each week until discontinued.
        - If symptoms return then stop weaning.

Wound Care:

Wound care at discharge should be individualized to each patient. Ensure that instructions are cleared explained in discharge paperwork. See section of wound care for more specific information. Some considerations include:

- Frequency of dressings should be daily or every other day. Avoid BID dressings.
- Consider dressings that do not require wound care. i.e. mepitel Ag or mepilex Ag
- Recommend applying lotion to healed burns, grafts and donor sites TID.
- If Home Health Services are involved, consider faxing wound care instructions directly to agency.
- Patient, family and caregivers are to be re-educated how to perform wound care at each clinic visit.
- Ensure patient has enough supplies:

- If patient has home health services: provide 2-3 days of supplies, agency will order after additional supplies
- If patient does not have home services: provide supplies to complete dressings until burn clinic appointment

Scar Management:

Scar management is multifactorial including treatment of symptomatic, functional and cosmetic issues.

- Symptomatic: Itching and neuropathic pain
  - Treatment:
    - emollients: frequent lotion application, at least TID
    - scar massage: massage of hypertrophic scar to soften tissue
    - desensitization: exposing burns to different sensations to decrease hypersensitivity
    - laser therapy
    - pharmacologic: gabapentin, scheduled, as above; hydroxyzine, prn
- Functional: Contractures preventing ROM or wound healing
  - Treatment:
    - Occupational Therapy: stretching/ROM
    - laser therapy
    - surgical scar release
- Cosmetic: Hyperpigmentation:
    - a pink to dark red discoloration that will slowly fade over a 6-12 month period
    - patient may not experience a complete resolution of discoloration
- Treatment:
    - laser therapy and or surgical tissue rearrangement

Compression Garments

Custom fit pressure garments are used for hypertrophic burn scars. They may help to flatten hypertrophic scars. Compression may also help with symptomatic scars. Referrals to MedCor will be arranged through our clinic for measurement and fittings.

Laser Therapy

CO_2 laser is a treatment used for most scar issues. In hypertrophic scars, collagen fibers seems to lie is a disorganized pattern. The exact mechanism of the laser is debated, however, it is thought that the laser penetrates the scar and causes the collagen to form a more organized matrix. The mechanism is thought to be related to activation of dermal and subcutaneous mesenchymal stem cells. Treatment can soften and flatten hypertrophic scar, reduce neuropathic pain and itching and decrease hyperpigmentation.

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Wound Management Grid
FINAL DRAFT – 8.21.2018

--The Burn and Soft Tissue service will provide unlimited provider consultations to other services for wounds (24/7)
--Inpatient CWOCN service is available for nurse consults M-F daytime, excluding holidays

WOUNDS THAT REQUIRE ADMISSION:

Primary Reason for Admission	Primary Admitting Service
Burns	Burn and Soft Tissue
Frostbite	Burn and Soft Tissue
Necrotizing Soft Tissue Infections/ Necrotizing Fasciitis	Burn and Soft Tissue
Patients admitted directly from MMC Wound Healing program at Brighton	Burn and Soft Tissue
Necrotic foot with pulses	Burn and Soft Tissue
TEN/SJS =>15% surface area open wound	Burn and Soft Tissue with consult to Medicine
Sacral decubitus ulcers, aged 64 and younger	Burn and Soft Tissue
Sacral decubitus ulcers, aged 65 and older	Medicine with consult to Burn and Soft Tissue if necessary
Non-traumatic diabetic foot ulcers	Medicine with consult to Burn and Soft Tissue; BST to involve MMC Wound Healing & Hyperbarics and/or Podiatry as necessary
DRESS, TEN/SJS	Medicine with consult to Burn and Soft Tissue
Cutaneous abscess	Orange Service/General & Acute Care Surgery
Wound with no pulses/vascular deficits (regardless of infection)	Vascular Surgery
All else	Medicine

- For patients with skin necrosis and sloughing, consult the Burn and Soft Tissue service.
- Patients who are transferred to SCU due to their wound infection will be managed by surgical SCU
- Patients who are accepted in transfer by either Medicine or Burn and Soft Tissue where the facts on arrival turn out to be different than conveyed on the phone should be reassessed and the grid implemented if necessary
- The grid is a guideline and should not supersede collaborative conversation. Please discuss between teams whenever necessary.

Burn and Soft Tissue: 741-3016
Medicine:
Inpatient Wound/Ostomy/Continence Nurses: 741-1512

Patients with the following conditions should be referred for outpatient treatment at our MMC Wound Center at Brighton (662-HEAL).

1. All wounds considered chronic: No progress in 4 weeks and not completely healed in 8 weeks since onset. If timing is unclear, feel free to refer the patient.

2. All wounded patients that have compromised healing regardless of time frame above, such as:
   - Poor nutrition or malnourishment
   - Chronic steroid use
   - Connective Tissue Disorders
   - Late effects of radiation / radiation injury
   - Diabetics with plantar foot ulcers
   - Surgical Dehiscence greater than 30 days. If less than 30 days, patients should see the surgeon who provided the initial care.
   - Ostomy Issues (acute and chronic)

Wounds with indications for treatment by hyperbaric oxygen therapy at MMC Wound Healing & Hyperbarics at Brighton

- Acute peripheral arterial insufficiency**
- Acute traumatic peripheral ischemia**
- Central Retinal Artery Occlusion
- Chronic refractory osteomyelitis
- Compromised skin graft / flap – critical need for treatment within 48h**
- Crush Injury/Compartment Syndrome
- Diabetic Wounds
- Gas gangrene
- Idiopathic Sudden Sensorial Hearing Loss
- Late effects of Radiation
- Necrotizing Infections
- Uncontrolled edema/stasis dermatitis without wound but needs compression

**Immediate referral

When patients are being discharged to home, feel free to use the EPIC referral or call 662-HEAL.

For patients being discharged to a location besides home, leadership from BST, Medicine, and inpatient CWOCN service agreed to services emailing the MMC wound center with details on patient. The MMC wound center will then follow up to schedule a patient for outpatient follow up.
This email is being set up as of 8/21, will be shared on final version of document.

BURN & SOFT TISSUE SURGERY

BST Pager: 741-3016

WHO:
Burn Director: Damien Carter
Attendings**:** Elizabeth Turner, Stacey Rotta, Laura Withers
Burn/Wound Nurse**:** Sue Reeder
APP**:** Rosemary Paine, Alison Traver

WHAT: see wound grid
Admits: generally, this is what we admit as primary
- burns, necrotizing infections, cold injuries, exfoliative skin diseases

Consults: there's a medical reason for the wound, it should be managed medicine
- decubitus ulcers, cellulitis, diabetic foot ulcers

Trauma: generally, go to trauma, unless there are complex closure/grafting needs
- compartment syndrome, large hematomas

General Surgery: we can help if the wound is complex or requires grafting
- simple abscess, peri-rectal abscesses

WHERE/WHEN:
Morning Sign Out: Everyday @ 530 - R3 Work Room
Morning Report: M-F @ 630; S&S @ 700 - R3 Conference Room
Present 24 hr admits, complications, escalations of care, education
BST Daily Rounds**:** M-W, F @ 800, Th @ 1000 - R3 conference room
Wound Rounds: M-F@ 1100 - R3 nurses station
Discuss R3 patients, evaluate wounds scheduled, book wound on white board day prior
Burn Clinic**:** Wed @ 1300- 1500 w/ BST attending of the week & APP
PIPS: Tues @ 700-800 - R3 conference room - *PI Review for Burn/Trauma patients*
Multidisciplinary Burn Rounds: Wed @ 1200-1300 - *R3 conference room*
Present all inpatient burns, discuss plan w/ team, educational offering

ROUNDING:
Primary: progress note daily
Consult**:** brief note at least weekly or whenever the plan changes
SCU patients: White Surgery is the primary team, brief note daily

R3 WOUND ROUNDS
- Review all R3 patients with charge nurse and nurses
- Each evening, tell charge nurse and write on white board which patient you would like to see on the following day.
- Nurses will premedicate patient and have dressing removed for the team to see.

ORDERS:
Use Burn Admission Order Set (will be updated)
Update, "Wound Care" order daily with changes and post op.

CHARTING:
Burn Admission Note: every burn admission/consult
dot phrase: BURNADMIT
Soft Tissue Consult Note: use for all consults other than burns/trauma
dot phrase: BSTCONSULT
Tertiary Note: complete for burns within 24 hrs of admission
dot phrase: BURNTERTIARY
Burn Primary Progress Note: use for daily rounding on BST Primary patients
dot phrase: BURNPROGRESSNOTE
Burn Consult Progress Note: use as progress note for consults
dot phrase: BURNUPDATENOTE
Plan of Care Note: complete at burn MDR every Wednesday
dot phrase: BURNPLANOFCARE
Discharge Summary:
smart text: MH IP SURG DISCHARGE SUMMARY
Discharge Instructions: ensure up to date wound care instructions are included
dot phrase: BURNDCINSTRUCTIONS
Plan for Burns: use in daily progress note for burn patients
dot phrase: BURNPLAN
Wound Care Instruction: this dot phrase will import all wound care instructions into note
dot phrase: WOUNDORDER

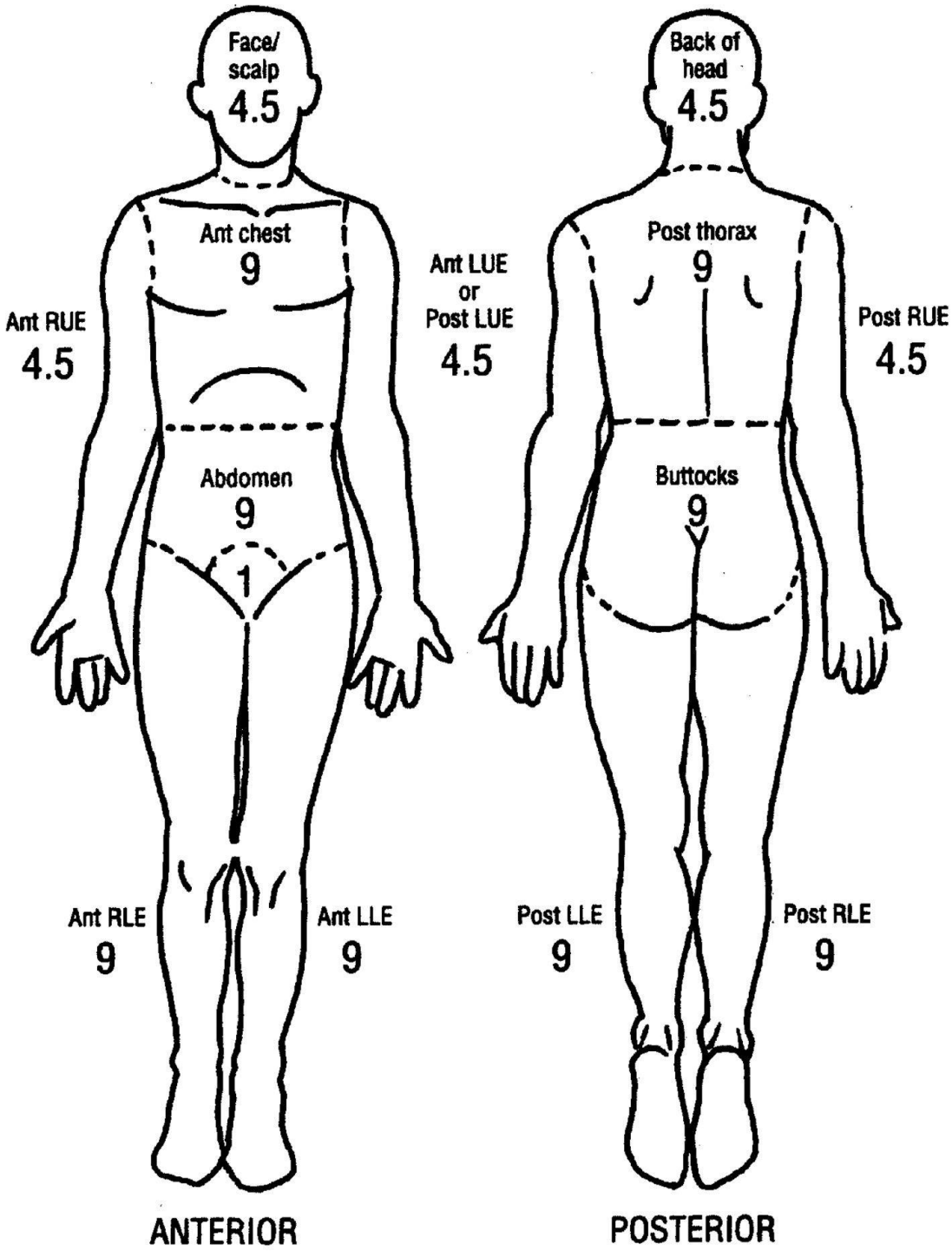
FOLLOW UP:
BST Service Patients
- Send a staff message in Epic to: P MMP Acute Care Surgery Admin Pool
- Request when you would like the patient to be seen (burn clinic vs other clinic)

ED/Outpatient Providers to set up follow
- Email burnfollowup@mmc.org
- Include patient name, DOB, reason for visit

EXTRA:
Update Sticky Note frequently with any changes and weekend plans on Friday
Report complications to traumapi@mmc.org

Patient Label

BURN MAN TBSA %



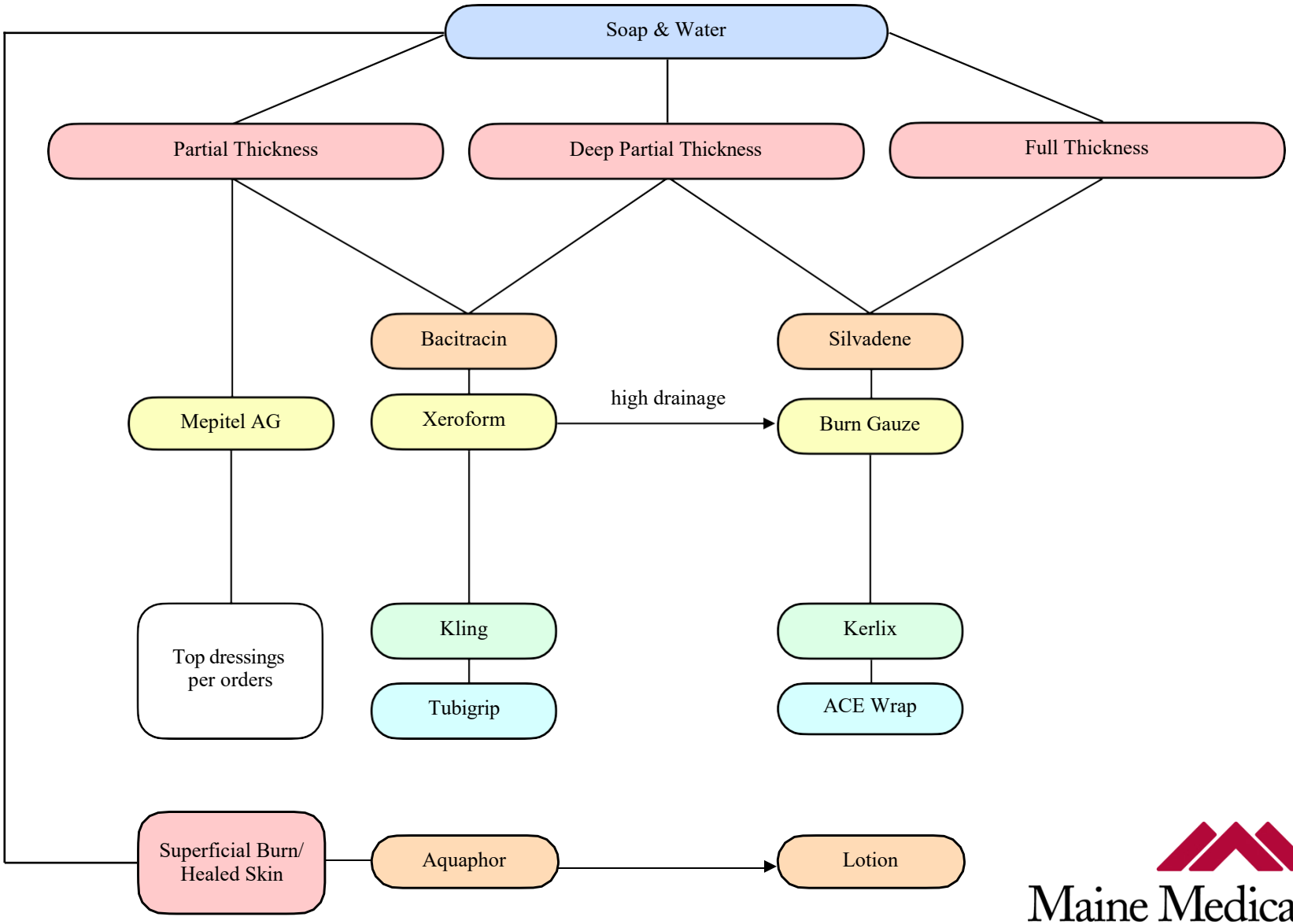
Date of Admission:

Admitting Provider:

TOTAL TBSA % =

KEY
Partial Thickness
Deep Partial Thickness
Full Thickness

Burn Care Decision Tree



Maine Medical Center
MaineHealth

MMC Burn Resuscitation Guideline

For adults age > 16 years with > 20%TBSA and without concomitant trauma.

Formal resuscitation will begin on arrival to the tank room, this is **'hour zero',** and ends after 24 - 48 hours.

If *difficult resuscitation* is identified, then **provider driven strategies** will commence; utilizing strategies listed on page 2.

RESUSCITATION GOALS: Urine Output of 30 ml/hr and Mean Arterial Pressure of 60

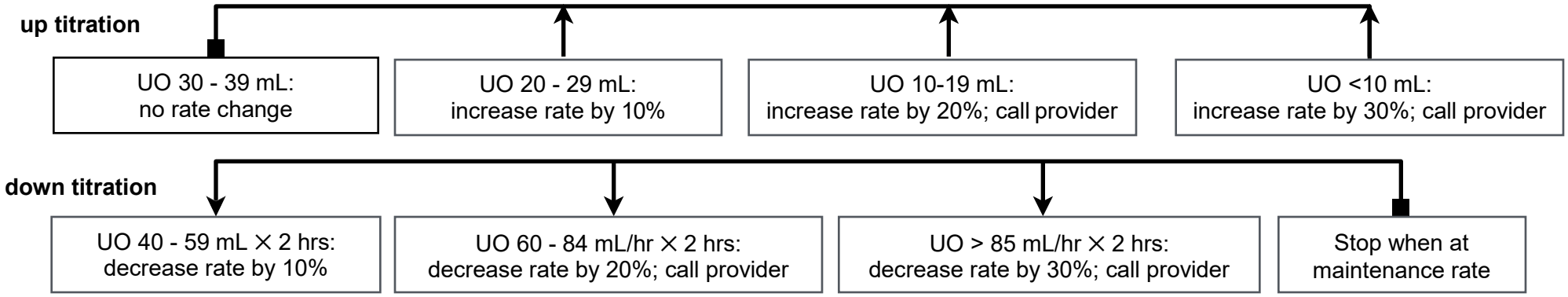
Complete the following at 'hour zero':

- ☐ Calculate the 24 hour *estimated* fluid volume and *initial* fluid rate. Confirm initial rate with attending physician.
- ☐ Start initial fluid rate at 'hour zero' and titrate fluids hourly according to the **nurse driven protocol**.
- ☐ Empty the foley bag.
- ☐ Place NG/OG and start Vital AF at 85 mL/hr (no advancement schedule) until formal recommendations from dietician are obtained.

Calculate estimated 24 hr fluid volume:_____% TBSA × _____kg × 3 =_____mL

Calculate initial fluid rate: (estimated 24 hr volume □ 2) □ 8 hrs =_____mL/hr LR

Nurse Driven Protocol



Maintenance Rate = (4 - 2 - 1 rule)

To continue after resuscitation is complete or as otherwise indicated by the team.

If tube feeds are not at goal, then maintenance rate may need to be increased.

4 mL/kg for first 10 kg + 2 mL/kg for second 10 kg + 1 mL/kg per kg thereafter=_____mL/hr LR

Identify Difficult Resuscitation

The below findings indicate standard resuscitation is not sufficient. Call provider to initiate adjunct strategies listed on page 2.

Rate increased 2 or more times in hours 6-12	Total crystalloid volume to exceed 150% of estimated 8 hr volume	12 hrs post injury: fluid rate exceeds 80% of the initial rate	Persistent oliguria: UO <15 mL for 2 or more hours	Unable to maintain MAP > 60

Strategies for Difficult Resuscitation

Provider Driven Strategies

Utilize these adjuncts when standard resuscitation is not successful and difficult resuscitation has been identified.

Resuscitation Adjuncts

High Dose Vitamin C Infusion

- Weight based continuous infusion x 24 hrs
- Use as part of total resuscitation rate.
  - Vit C Rate + LR Rate = total resuscitation rate as calculated on page 1
- Titrate down LR per above algorithm until weight based infusion of Vitamin C is reached
  - Continue Vitamin C at weight based rate until 24 hr infusion is complete, then switch to maintenance rate of LR.

Colloid Rescue

Increase rate per Nurse Driven Protocol
AND
give 250 mL (12.5 gm) 5% albumin over 1 hour

↓

Increase rate per Nurse Driven Protocol
AND
give 250 mL (12.5 gm) 5% albumin over 1 hour

↓

If still not meeting goals after albumin bolus x 2 then transition to:
Colloid Only Resuscitation

Colloid Only Resuscitation

Start infusion of only albumin or FFP at half the rate of crystalloid infusion. Titrate colloid per Nurse Driven Protocol.

Refractory Shock/End Organ Failure

Hypotension

- Indication: unable to maintain MAP > 60, despite above fluid resuscitation strategies
  - Give 500 mL (25 gm) 5% albumin bolus
  - If ineffective, then start vasopressin, avoid other pressors.

Continuous Veno-Venous Hemofiltration (CVVH)

- Indication: persistent shock and/or oliguria (<15 cc/hr x 3 hrs)
- Consult: Nephrology to initiate
- Vascular access: Burn/SCU team to establish
- IVF (crystalloid/colloid): titrate to maintenance rate
- CVVH Goal: remove 50-100 mL/hr

Plasma Exchange

- Indication: burn shock despite early excision
- Contact: Nephrology to initiate
- Vascular access: Burn/SCU team to establish

Extracorpeal Membrane Oxygenation (ECMO)

- Indication: Refractory acidosis, Refractory hypoxemia
- Consult: Cardiothoracic surgery to initiate

Burn Excision

- Goal to excise burn within 72 hours from admission
- Excise earlier for cases of refractory shock

Please refer to the MMC Burn Manual for further details of the above strategies.

Table 1. Pharmacologic Treatment Options for Pain, Anxiety, and Post-Burn Pruritus

	Adult ICU – Mechanically Ventilated	**Adult ICU- Non-intubated**	**Adult Floor/IMC**
Background Pain **Nonopioid**	Acetaminophen PO/FT/ IV Ibuprofen PO/FT or Ketorolac IV Gabapentin PO/FT Ketamine continuous infusion Dexmedetomidine continuous infusion or clonidine PO/FT/SL	Acetaminophen PO/FT/ IV Ibuprofen PO/FT or Ketorolac IV Gabapentin PO/FT Ketamine continuous infusion Dexmedetomidine continuous infusion or clonidine PO/FT/SL	Acetaminophen PO/FT/ IV Ibuprofen PO/FT or Ketorolac IV Gabapentin PO/FT
Opioid	Fentanyl or hydromorphone continuous infusion Methadone PO/FT/IV (for TBSA ≥20%)	Methadone PO/FT/IV (for TBSA ≥20%) Oxycodone or hydromorphone PO/FT	Oxycodone or hydromorphone PO/FT
Breakthrough Pain	Fentanyl or hydromorphone IV bolus	Hydromorphone IV bolus	Hydromorphone or morphine IV bolus
Procedural Pain	Oxycodone or hydromorphone PO/FT Fentanyl IV bolus Ketamine IV bolus	Oxycodone or hydromorphone PO/FT Hydromorphone IV Fentanyl lozenge buccal Ketamine IV bolus Nitrous oxide (tank room)	Oxycodone or hydromorphone PO/FT Hydromorphone IV Fentanyl lozenge buccal Ketamine IV bolus Nitrous oxide (tank room)
Breakthrough Anxiety	Midazolam IV bolus	Lorazepam PO/FT/IV	Lorazepam PO/FT

Procedural Anxiety	Propofol infusion Midazolam IV bolus	Lorazepam PO/FT/IV	Lorazepam PO/FT
Post-Burn Itching	Hydroxyzine PO/FT/IV or cetirizine PO/FT Gabapentin PO/FT	Hydroxyzine PO/FT/IV or cetirizine PO/FT Gabapentin PO/FT	Hydroxyzine PO/FT/IV or cetirizine PO/FT Gabapentin PO/FT

Appendix I. Medication Dosing and Considerations for Pain, Anxiety, and Post-burn Pruritus Management

Drug	Indication	Dosing	Considerations
Non-Opioid Analgesics			
Acetaminophen	Background pain	No risk factors for hepatotoxicity: 975 mg PO q6h or 1 g IV q6h (if NPO) Cirrhosis or chronic alcohol abuse: 975 mg PO q8h or 1 g IV q8h (if NPO)	Monitor liver function tests once weekly
Clonidine	Background pain Anxiolysis/ Sedation	2. mg PO/SL q8h 0.2-0.4 mg PO/SL q6h	Avoid in patients with bradycardia or hypotension
Dexmedetomidine	Background pain and light sedation; Procedural sedation	0.1-1.4 mg/kg/hr continuous IV infusion	Avoid in patients with bradycardia or hypotension

Gabapentin	Background neuropathic pain	Age <65 years and with normal renal function (CrCl ≥60 ml/ min): 300 mg PO q8h Age ≥65 years or moderately impaired renal function (CrCl 30-59 ml/min): 200 mg PO q12h Severe renal impairment (CrCl<30 ml/min): 200 mg PO q24h	Titrate every 3-5 days to effective dose, maximum 1200 mg 3 times daily for patients with normal renal function. Abrupt discontinuation should be avoided. Taper is recommended every 3-5 days. This is usually the last medication to be tapered upon patient discharge due to dual indication for itching and neuropathic pain.

Ketamine	Background pain Procedural pain	0.05-0.4 mg/kg/hr continuous IV infusion 0.2-0.5 mg/kg IV daily PRN	Consider in patients with a history of opioid tolerance, TBSA ≥20%, or patients who are not responding to routine pain management Monitor for psychomimetic (hallucinations, dissociation) effects. Benzodiazepines, such as lorazepam, are treatment of choice if this occurs. Monitor for sympathomimetic (hypertension, tachycardia) effects The safety of prolonged durations of continuous infusion (>4 days) has not been established Avoid use in patients with poorly controlled cardiovascular disease, active psychosis, pregnancy, severe hepatic dysfunction, or intraocular or intracranial pressure elevations due to structural abnormalities
Drug	**Indication**	**Dosing**	**Considerations**

NSAIDs	Background pain	Able to take PO: ibuprofen 400 mg PO/FT q6h NPO: ketorolac 15 mg IV q6h x 5 days	Caution is advised when using NSAIDs in burn injury and patient selection is key. NSAIDs have been implicated in causing acute kidney injury in burn patients, and limited durations should be considered. **Exclusions:** New GI anastomosis, acute or chronic renal dysfunction, peptic ulcer disease and recent GI bleed (last 6-12 months), TBI/Spinal fractures/ spinal cord injuries (unless approved by neurosurgery). Long bone fractures (unless approved by orthopedics). Avoid concomitant use with therapeutic anticoagulation or corticosteroids due to increased risk of GI complications. Use caution in patients with significant cardiovascular risk factors (e.g. CAD, previous MI). If used in this population, recommend shortest duration possible. Avoid ibuprofen in patients with established cardiovascular disease on aspirin as ibuprofen interferes with antiplatelet activity.
Opioid Analgesics			

Fentanyl	Background pain (ICU-MV) Breakthrough pain Procedural pain	25-200 mcg/hr continuous IV infusion 25-100 mcg IV q30 min PRN 50-100 mcg IV q5 min PRN, or if able to take PO, 200 mcg lozenge buccal daily PRN	Concern for accumulation in severe hepatic impairment Re-dose fentanyl if patient is alert and still experiencing pain during procedure
Hydromorphone	Background pain (ICU-MV) Background pain	0.5-10 mg/hr continuous IV infusion 2-4 mg PO q4h PRN moderate to severe pain or pretreatment for procedures or therapy sessions	May be considered in patients tolerant to fentanyl
Drug	**Indication**	**Dosing**	**Considerations**
Hydromorphone (continued)	Breakthrough pain Procedural pain	0.5-2 mg IV q2h PRN 1-2 mg IV q30 min PRN	
Methadone	Background pain	5 mg PO/FT/IV q8h and titrate every 3-5 days until pain control achieved	Consider in patients with TBSA $\geq$20% or history of opioid dependence/ tolerance Methadone has a variable half-life of 7-65 hours, and steady state concentrations will not be achieved for 3-7 days. Do not stop abruptly. Wean methadone dose by 10-25% every 2-3 days. May discontinue once total daily dose is 10-15 mg. Our goal is to discontinue prior to discharge, if possible. If possible, obtain 12-lead EKG prior to initiation and with dosing titration.

Anxiolytics			
Lorazepam	Breakthrough anxiety (ICU) Procedural anxiety (ICU) Breakthrough or procedural anxiety (floor/IMC)	0.5-1 mg IV q4h PRN 1-2 mg IV q1h PRN 0.5 mg PO q4h PRN	
Midazolam	Breakthrough anxiety (ICU) Procedural anxiety (ICU)	0.5-2 mg IV q4h PRN 1-5 mg IV q1h PRN	Midazolam is metabolized to an active metabolite which is excreted renally. Use extreme caution in patients with acute or chronic renal impairment or severe hepatic impairment.
Propofol	Procedural sedation (ICU-MV)	5-60 mcg/kg/min continuous IV infusion PRN	Avoid in patients with hypotension
Post-Burn Pruritus			
Cetirizine	Itching	Normal renal function (CrCl >50 ml/min): 10 mg PO/FT q12-24h Impaired renal function (CrCl <50 ml/min): 5 mg PO/FT q24h	
Hydroxyzine	Itching	25 mg PO/IV q4h PRN	Monitor for anticholinergic side effects (sedation, dry mouth, urinary retention). Use caution in elderly patients.

Gabapentin	Post-burn pruritus	Age <65 years and with normal renal function (CrCl ≥60 ml/ min): 300 mg PO q24h Age ≥65 years or moderately impaired renal function (CrCl 30-59 ml/min): 200 mg PO q24h Severe renal impairment (CrCl<30 ml/min): 100 mg PO q24h	If patient has concomitant neuropathic pain and itching, refer to pain dosing above. Titrate every 3-5 days to effective dose, maximum 300 mg 3 times daily for patients with normal renal function in post-burn itching trials. Abrupt discontinuation should be avoided. Taper is recommended every 3-5 days. This is usually the last medication to be tapered upon patient discharge due to dual indication for itching and neuropathic pain.

FT = feeding tube; ICU-MV = intensive care unit and mechanically ventilated; IV = intravenous; NSAIDs= non-steroidal anti-inflammatory drugs; PO = oral; PRN = as needed; SL = sublingual

MMC Perioperative and Intraoperative Management of Burn Patients Guideline

Document Owner: Terry Couture	**Original Creation Date:** Not Set
Approved By: Not Assigned	**Next Periodic Review Date:** Not Set
Effective Date: Not Set	

I. **Purpose:**
To assist anesthesia providers caring for patients with burns in the perioperative and intraoperative setting. Not for initial resuscitation of acute burns or burn patients who are in shock.

II. **Scope:**
Maine Medical Center

III. **Definitions:**
None

IV. **Guideline:**
ICU or Floor Preparation of the burn patient for the OR for excision and grafting (burn team responsibility checklist):

1. vascular access: two 20 gauge or larger gauge peripheral iv's that run well and are not positional; alternative is CVL. If peripherals, then one of these must be available for boluses and transfusion (no infusions running other than maintenance fluid).
2. CBC within past 12 -24 hours
3. T&C two units PRBC's and FFP ON HOLD for OR. If TBSA burn < 10%, may omit T&C per Burn Team discretion
4. appropriate NPO order (see NPO guidelines, especially for intubated and trach'd patients, in PolicyTech)
5. Foley catheter in situ w functioning temperature probe, unless foley has been deemed unnecessary for patient management in the ICU or floor.

Perioperative Management (Anesthesia team responsibility):

1. Preoperative:
   a. NPO guidelines: confirm appropriate management has occurred; continue TPN if patient has been receiving it; continue enteral feeding if post pyloric feeding tube and consistent with NPO guidelines (scroll to the bottom of this page).
   b. Evaluate on a case by case basis for suitability of regional analgesia of the graft donor site by the Block Team (see 2 h vii 2 below)
   c. OR room temp UP 30 min *prior* to patient entering OR. Goal 90 F. Please pre-brief the following items with surgeons (Burn Surgeons: Drs. Damien Carter, Stacey Rotta, Elizabeth Turner, and Laura Withers):

i. Esophageal warmer: have available for each case but do not open until usage confirmed w attending surgeon. As a point of reference, burn excisions > 8% BSA will most likely have esophageal warmer.
ii. Is Bair hugger use anatomically possible given the surgical sites in the field? Can upper body, lower body Bair be used?
iii. All patients are to have the standard fluid filled warmer under patient.
(Surgeon and OR tech): **Will injection fluid be used for tumescence of donor site prior to harvesting? Pre-warmed fluid (2mg Epi/1L normosol).**

d. Review anticipated degree of bleeding, magnitude and duration of operation; what % BSA will be excised? (see 2c below)
i. -Resuscitation plan: in general, limit crystalloids as these cause tissue edema and graft failure. Will vary by case, but as a point of reference, do not exceed 2 liters of crystalloid for excision and grafting procedures. (see 2d below)
ii. -lab results (current H/H and T&S- confirm no antibodies or discuss approach to patient w antibodies). What blood products do the teams want on call to the OR?
iii. -will TQT be used?
iv. -Foley? ICU patients will most likely have a Foley. Patients from the floor will receive one in the OR based on the duration of the planned procedure and how far out the patient is from his/her acute burn. Discuss w surgeon in OR pre-procedure.
e. Minimize position changes

2. Intraoperative
a. Check the ETT (cm at lip) or trach site (secured) and confirm bilateral BS
b. NO succinylcholine
c. If the procedure is the patient's first excision (usually bleed more) or otherwise significant bleeding is expected, or if there is hemodynamic instability from bleeding, resuscitate volume losses with PRBC's and give FFP in a 1:1 ratio to PRBC's. Usually platelets are not needed unless platelet count was low pre op. Expect an EBL equal to about 3% of patient's blood volume for every 1% TBSA excised. Remain in close communication w surgeons regarding resuscitation volumes used as case proceeds.
d. IV fluids: If there isn't significant bleeding or instability, and if the procedure is not the patient's first excision, then use non-blood solutions for resuscitation: prefer 5% albumin for iv fluid rather than crystalloid. Do not give large volumes (> 2L) of crystalloid. If boluses are required to support blood pressure then switch to PRBC's and alert surgeon.
e. Pressors: During grafting procedures avoid pure alpha agonists as these cause vasoconstriction in the skin.
i. First choice pressor is VP 0.04-0.08 units because there are no VP receptors in the skin, hence no iatrogenic vasoconstriction in at-risk skin and grafts. Phenylephrine is contraindicated because of its alpha agonism in skin.
ii. Second choice, if VP inadequate, is NE, as sparingly as possible and wean as soon as possible.
f. Temperature: maintain aggressively >,= 36.0C
i. Room temp all the way up to achieve T=90F
ii. Bair hugger if possible
iii. Fluid filled circulating warmer under patient
iv. Fluid warmer for iv fluids and PRBC
v. Esophageal warmer if agreed upon

vi. Prewarmed betadine for prep?
vii. Surgeon and OR tech will discuss and plan prior to procedure whether they will use prewarmed injection fluid for building up donor site
viii. Consider plastic bags over head and extremities not included in the surgical site
ix. plan ahead for blankets and plastic coverings for long transport if going to CFT

g. Review with surgical team at least once an hour AND WHENEVER we start/stop or make significant changes to:
   i. hemodynamics
   ii. resuscitation type and volume; EBL
   iii. pressor needs
   iv. temp
   v. Remind surgeons of cumulative operative time (Longer procedures are associated with more volume resuscitation and more difficult temperature maintenance; surgeons may defer some work if procedure time has been long.)

h. Analgesia:
   i. continue infusions of analgesics and sedatives form ICU and ADD to those:
   ii. ketamine 0.5 mg/kg load in divided doses (may need to increase dose because of upregulation of NMDA receptors in burns); glycopyrrolate as needed
   iii. dexmedetomidine infusion
   iv. acetaminophen unless contraindicated
   v. opioids, often in high doses: fent, hydromorphone, morphine, methadone
   vi. continue other multimodal meds (gabapentin, antidepressants or anticonvulsants) on schedule
   vii. still in development on a case by case basis: regional anesthesia:
      1. Infiltration of l.a. by surgeon prior to harvesting?
      2. Anes Block team: peripheral n. blocks for harvesting- lateral femoral cutaneous n., TAP and PVB's; neuraxial if anatomically feasible and patient is hemodynamically stable

3. Post-operative:
   a. Extubate or remain intubated per usual criteria with consideration for airway edema. Disposition: SCU or PACU as appropriate.
   b. Take all available measures to maintain temperature during long transport if going to CFT.

<u>Addendum to NPO from ICU to OR Guidelines</u>:

Patient population affected: burn patients with > 20% TBSA burns

Clinical goal: minimize nutritional and caloric deficits in highly metabolic burn population with > 20% BSA burns by minimizing interruptions to enteral feeding.

Management of enteral feeding

1. In patients with a cuffed secured airway (ETT or cuffed tracheostomy tube): CONTINUE enteral tube feeds at preoperative rate *throughout operation and transporting back to ICU.*
   a. EXCEPTIONS:

1. prone positioning intra op
2. airway procedures (tracheostomy, ETT change, etc.)

For patients who meet these exceptions follow the usual Guidelines for NPO from ICU to OR, i.e. stop tube feeds after midnight; meds may be given via enteral tube.

2. In patients who do NOT have a secured cuffed airway: NPO after midnight except clears are okay up to 2 hours prior to the OR.

Please note, if burns are < 20% BSA in a patient with a secure cuffed airway, then please follow the usual NPO from ICU to OR guidelines in PolicyTech i.e. ICU staff stop enteral feeding and suction feeding tube *on call to OR*.

V. Attachments:

None

VI. References:

None

draft

Skin Graft & Donor Post-Operative Management Guidelines | Maine Medical Center

Graft type		Contact Layer	Outer Dressings	Soaks	Dressing Change Frequency	1st Take Down	Cleansing	Post Take Down Care
Autografts	Split-thickness Mesh	Conformant	Burn Gauze/ Kling or Kerlix/ ACE	Y/N	ACE: daily No soaks: Outer gauze daily Soaks: Apply moist burn gauze daily, re-soak Q6hrs	POD 6: Remove Conformant + staples	Before POD 6: Use NS to remove outer dressings Concern for colonization? 10 min Vashe cleanse After POD 6: Soap & water, shower	Contact layer: Xeroform Lotion when healed
	Split-thickness Sheet			N	ACE: daily Outer gauze: daily Check for blebs POD 1-3			
	Full-thickness	Conformant/ Xeroform/Bolster		N	Bolster dressing to remain in place until take down.	POD 6: Remove bolster		
	Autologous Cell Suspension (ReCell)	Telfa Clear		N	ACE: daily Outer gauze: daily	POD 6: Remove Telfa Clear Refer to ReCell Grid	Normal Saline	Contact layer: Mepitel One Lotion when healed
Temporary Coverage/ Skin Substitutes	Cadaver Skin (Allograft)	Soaks: Conformant No Soaks: Xeroform	Burn Gauze/ Kling or Kerlix/ ACE	Y/N	ACE: daily No soaks: Outer gauze daily Soaks: Apply moist burn gauze daily, re-soak Q6hrs	Change contact layer POD 3, then Q3 days Staple removal in OR	Before POD 6: Normal Saline to remove outers Concern for colonization? 10 min Vashe cleanse After POD 6: Soap & water, shower	Return to OR for autografting If not autografting, Xeroform is Contact layer Lotion when healed
	Primatrix/Integra							Dry gauze dressings or soak. Return to OR for autografting
	Biodegradable Temporizing Matrix (BTM)	Burn Gauze				OR after POD 14		
	Suprathel	Rylon	Xeroform, Burn gauze, Kling or Kerlix/ ACE	N	Change outer burn gauze daily and PRN, leave Xeroform until POD 6	POD 14-21, or when Suprathel lifting from wound bed.	After POD 6: Soap & water, shower	Lotion when healed
Donor Sites		Xeroform	Burn Gauze/ Kerlix/ ACE	Y/N	ACE: daily Change outer gauze daily and PRN saturation D/C outers after POD 6	Leave Xeroform in place until healed Goal is to allow dressing to dry Trim away Xeroform edges as they lift	Before POD 6: Normal Saline to remove outers Concern for colonization? 10 min Vashe cleanse After POD6: Soap & water, shower	Lotion when healed
		Mepilex AG Foam + Hypafix Tape	ACE only	N	POD 1: Check Mepilex AG, reinforce with Hypafix tape to border the foam ACE: daily	If >75% saturated or before POD 14: replace Mepilex Ag Foam	Soak with NS or shower to remove	
		Suprathel	Rylon, Xeroform, Burn gauze, Kling or Kerlix/ACE	N	Change outer burn gauze daily and PRN, leave Xeroform until POD 6	POD 6: Change Xeroform, then change Q3days. Leave Rayon in place	After take down may shower	

Skin Graft & Skin Substitute Post-Operative Management Guidelines | Maine Medical Center

Graft type		Contact Layer/ Primary Dressing *	Outer Dressings	Soaks	Dressing Change Frequency	Cleansing	1st Take Down	Post Take Down Care
Autografts	Split-thickness Mesh	Conformant	Gauze/ Stretch Netting/ ACE	Y/N	ACE: daily No soaks: Outer gauze: PRN saturation Soaks: Outer gauze: apply moist daily, re-soak Q8hrs	Before POD 6: Normal Saline, use to remove outers Concern for colonization? 10 min Vashe cleanse during drsg change After POD 6: Soap & water, shower	POD 6: conformant takedown, switch to Xeroform	Xeroform daily until re-epithelialized Allograft overlay: trim as it lifts Lotion when healed
	Split-thickness Mesh with Allograft Overlay	Xeroform or Conformant					POD 3: takedown of Xeroform, change Q3 days and PRN	
	Split-thickness Sheet	Conformant		N	ACE: daily Outer gauze: PRN saturation Check for blebs POD 1-3		POD 6: conformant takedown, switch to Xeroform	
	Full-thickness	Conformant/ Xeroform Bolster		N	Bolster dressing to remain in place until takedown		POD 3-6: Remove bolster	
	Autologous Cell Suspension (ReCell)	Telfa Clear		N	ACE: daily Outer gauze: daily	Normal Saline No Vashe	POD 6: Takedown Telfa Clear Dressings per prders	Contact layer: Mepitel One Lotion when healed
Skin Substitutes	Cadaver Skin (Allograft)	Soaks: Conformant No Soaks: Xeroform	Gauze/ Stretch Netting/ ACE	Y/N	ACE: daily No soaks: Outer gauze: PRN saturation Soaks: Outer gauze: apply moist daily, re-soak Q8hrs	Before POD 6: Normal Saline, use to remove outers Concern for colonization? 10 min Vashe cleanse After POD 6: Soap & water, shower	Change contact layer POD 3, then Q3days Staple removal typically in OR	Return to OR for autografting. If not autografting: Contact layer: Xeroform, Lotion when healed
	Primatrix/ Integra							Return to OR POD 14-28 for autografting
	Biodegradable Temporizing Matrix (BTM)	Gauze					OR after POD 14-21	
	Suprathel	Raylon	Xeroform/ Gauze/ Stretch Netting/ ACE	N	Raylon: Remain in place until healed Xeroform: Change Q3 days Gauze: change <POD 3 **only** for large saturation, then PRN ACE: daily	Keep dry, no ointments Shower per orders only	Takedown Xero POD 3, then change Q3 days Suprathel/Raylon remain in place until healed	Typically healed/peels off by POD 10-14 Lotion when healed

*Negative Pressure Wound Therapy may be used as bolster over both STSGs and skin substitutes. VAC is applied in OR, selected on a case-to-case basis. A contact layer (Conformant or Adaptic) may or may not be used. 1st VAC takedown is typically day 3-6 per BST team orders.

Donor Site Post-Operative Management Guidelines

Burn & Soft Tissue Service | Maine Medical Center

	Contact Layer	Top Dressing Change Frequency	Primary Dressing Removal	Post Takedown Care	Considerations
Donor Site Dressings	**Mepilex AG Foam** Applied in OR, replaced PRN by nursing Cut to fit, apply foam adherent side down, extend 1-2" border onto healthy tissue	No top gauze required ACE wrap for 24hrs, change daily and PRN for comfort POD 1-3 remove staples and apply **Hypafix** tape to border. Check site daily and reinforce tape PRN	POD 10-14 **Only** replace foam <POD 10 if >75% saturated or lifting from wound bed, causing discomfort Soak off with soapy water in shower Remove gently, avoid trauma to wound bed	Lotion TID to healed skin May apply baci/xeroform or Baci/band aid to open areas PRN	KEEP DRY. Cover with plastic in shower. If dressing gets wet, change immediately. Imperative for dressing borders to be secured. Check site daily and reinforce tape PRN Remove after POD 10 in clinic or at home No soaks
	Xeroform Applied directly to wound bed in OR, reinforced PRN by nursing	Top dressing: gauze and ACE Discontinue top dressings on POD 1-3 and allow site to dry If donor site is close to skin graft and top dressings cannot be d/c, **must remove top gauze POD 1 and change daily** to prevent adherence	Leave in place until healed, trim edges as they lift	Lotion TID to healed skin	Concern for colonization? Apply 10 min Vashe cleanse OK to shower and get dressing wet after POD6 Do NOT apply ointments on top of Xeroform, allow to dry
	Suprathel Applied in OR Becomes translucent after 48hrs Covered with Raylon (white perforated contacted layer) and additional contact layer (typically Xeroform)	Raylon/Xeroform to remain in place Change outer dressings (gauze, stretch netting, ACE) prior to POD3 **only** for Moderate-Large saturation Xeroform takedown POD 3, then change Q3 days	Leave Raylon in place for 1-2 weeks until healed, remove per orders only	Suprathel remains in place until underlying tissue heals, then eventually peels off Lotion TID to healed skin	Do NOT apply ointments or soaks on top of Xeroform, Keep dry Shower per orders only after 1-2 weeks May shower with Raylon in place