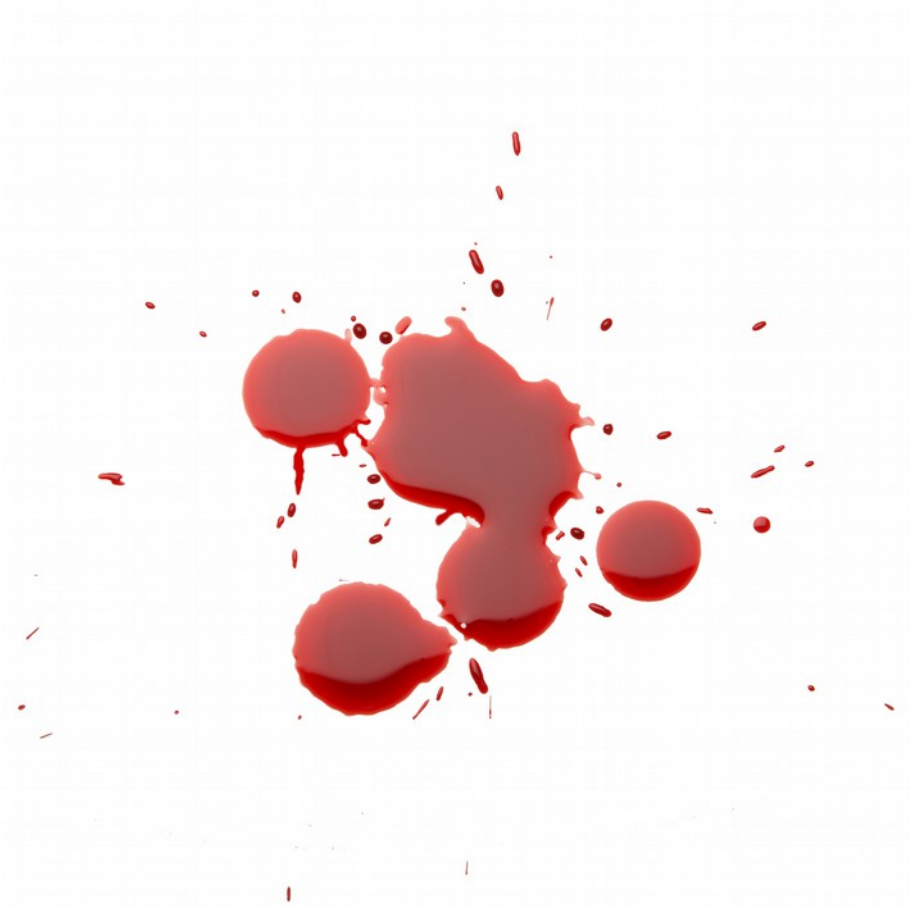
Casualty Simulation Techniques



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Index

The numbers below refer to sections and subsections of this document. Newer versions of this document may have additional or corrected information but the index should be the same. If you wish refer to sections of this document in a lesson plan or another document, please use the index number for reference.

The use of films, charts, graphs, and other visual aids has been highly successful, but no single medium has added more realistically to the efficient training of troops and civilians than simulations of casualties through the effective use of theatrical make-up, modeling clay, and *moulages*.

Lieut. Col. Vincent I. Hack (MSC), U.S. Army
Simulation of Military Casualties
Journal of the American Medical Association
September 12, 1959, Vol. 171, No. 2., 193-195

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1. Introduction

1.1 Why I wrote this

When I began casualty simulation I found that the materials I was supplied with were difficult to use and often didn't work the way I wanted. The materials varied greatly in quality and many seemed to have been selected primarily on price. Given the vast array of professional products available, it took a bit of experimentation to determine which ones gave the best results. I visited makeup and special effects suppliers and talked with working makeup artists to research products useful in casualty simulation. My ethos is to freely share information for the common good and it is in that spirit that I created this document.

1.2 This edition

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An index has been added to make it easier to reference when running a casualty simulation course or workshop. I've tried to organize this guide in a way that makes it easy to use in both training and as a reference. Included are some stub sections, added for completeness and future expansion. Sources are referenced in the text rather than at the end of a section or chapter. For general interest, I've included bits of useless makeup minutiae throughout this work.

2. Basics

2.1 Casualty Simulation

Unlike film and television where visual "look" of the scene is important, the primary goal of casualty simulation is the realistic depiction of wounds in a practise setting. Care must be taken not to create a gory wound just for shock value; every wound created must be based on a detailed knowledge of anatomy, physiology and a sound understanding of the underlying physics. Simulated injuries should always make sense in light of the mechanism of injury and other factors (e.g. body armour, eye protection)

"*We do not rise to the level of our expectations*. *We fall to the level of our training."* (quote from *Archilochus*, Greek Soldier and Poet, 7th Century B.C.) Medics and first responders need realistic simulations to learn how to properly assess and treat casualties before they enter the field environment. Quite often a minor wound will appear horrendous and a life threatening wound will appear minor. Detailed, realistic simulations help increase the levels of confidence and competence during training. Simulated wounds help the medic or first responder to keep everything sorted out while treating the casualty.

Another aspect, often overlooked, is the element of time in casualty simulation. In the real world the casualty's condition will change over time; in casualty simulation makeup is unchanged. Burns turn from dry to oozing, shock deepens, the area over broken bones swells and darkens. The casualty has some limited ability to change his/her actions (if a conscious casualty) over time. Wounds should be appropriate for the amount of time which has passed since the injury was incurred. All wounds caused by the same mechanism of injury should have an appearance consistent with one another for the given time line.

Study articles on trauma and talk with medics and first responders to find out how wounds actually appear in the field. If you have the opportunity, talk with makeup and special effects professionals to discover how they would handle the problem. Always be on the lookout for new techniques to make your work better, faster or easier. Ask the people running the scenario for suggestions or criticism. Keep a notebook to record successful techniques you have used. Share the information with others. You can also join in discussions at makeup and special effects forums.

2.2 Professionalism

Work out your makeup and effects ahead of time, on paper if possible. Tell the organizers of the simulation how much time you'll need and any resources (personnel and supplies) required for the simulation. Quite often those running the exercise don't understand what it takes to do proper casualty simulation in terms of time and

resources. Make sure your casualties are kept warm and comfortable. Instruct casualties on how to act for realism. Make yourself available to touch up your work if it becomes damaged. Do not eat, drink or smoke while applying makeup. Before using any product read the manufacturer's directions and have a thorough understanding of the properties of the product. Before applying any products ask your casualties about allergies they might have to the products you'll be using. You are responsible for removing any makeup or other products you have applied to the casualties. Wash fake blood/tissue/fluids from any items that are disposable so that others will not mistake any of the discarded items for a biohazard. Dispose of sharps in a properly labeled container. Work in a well lighted area with access to clean, warm water. Have proper makeup removal and cleaning supplies available for the products you are using. Check your kit beforehand for outdated supplies and other deficiencies. Keep yourself, your team, and your kit sorted out.

2.3 Techniques Borrowed from Film and High Definition Television

Makeup and special effects artists for film and television share many of the problems of casualty simulation. The makeup must be applied quickly, it must be durable and it must be believable. High definition television has led to several new techniques in the makeup industry; older, less detailed makeup techniques look fake with the extreme detail inherent in HDTV. Among these techniques are the use of gelatin and silicon appliances, airbrush application of materials and the use of alcohol activated paints.

There are, of course, many differences. Makeup artists working in film and television have much more latitude in their work; they are not fettered by reality in the same way that casualty simulators are. The effects they produce do not have to work in real time. A bullet strike, for example, can be created by a squib placed behind an appliance. From a distance, the exploding squib creates a realistic bullet strike. For the close-up shot of the resulting wound, the makeup artist might create a more detailed realistic wound. When the film is edited, the effect appears seamless. This is why some techniques used in film and television are not directly applicable to casualty simulation.

2.4 Product Selection and Safety

There are many professional make-up products on the market. Select the ones that you want to use based on local availability and price. In general you should purchase professional grade products from reputable suppliers. Although you'll pay more for professional products you'll get more coverage and have better working characteristics. In the end you'll save yourself time, money and frustration.

When using any product on the body be sure that it is appropriate. Anything applied directly to the body should be restricted to cosmetics only; do not use poster paint, glue or other materials directly on the body. The Art & Creative Materials Institute, Inc. (ACMI) is a non-profit association of manufacturers of art, craft and other creative materials which has developed standards for art material safety. The ACMI approved product (AP) label: *" . . . identifies art materials that are safe and that are certified in a toxicological evaluation by a medical expert to contain no materials in sufficient quantities to be toxic or injurious to humans, including children, or to cause acute or chronic health problems."* (from the ACMI website, http://www.acminet.org/). Note, however, that the ACMI on their website also states: *"Since the ACMI certification does not extend to "cosmetic" use of a product, ACMI recommends that products evaluated under its certification program not be used in this manner."* Although a product may be non-toxic, it may stain or irritate the skin if not used for its intended purpose. Some non-toxic pigments may be abrasive and cause injury to the eyes. Glues or adhesives may physically damage the skin.

In most cases, products in this document that are not cosmetics are used in such a way as to be isolated from the skin. Objects may be sealed using a make-up sealer. Adhesives like Pros-Aide® form a barrier between the body and the object.

Inappropriate materials used as makeup can have dire consequences. Actor Buddy Ebsen (1908-2003) became seriously ill after inhaling aluminum powder used on his skin to create the Tin Man character for the 1939 film *The Wizard of Oz*. He had to be hospitalized for six weeks with respiratory problems and was eventually replaced in the film by actor Jack Haley. The silver makeup used on Mr. Haley was reformulated as a creme base.

2.5 Makeup Sanitation

It is your job as a casualty simulator to use proper sanitation techniques. Understanding the characteristics of pathogens (infectious agents), the proper terminology, how they are spread and how they reproduce is important for the casualty simulator. According to a study by Dr. Elizabeth Brooks, a biological sciences professor, makeup

can harbour staph, strep and E. coli bacteria (source: "Handle those store makeup testers with care", by Alene Dawson, L.A. Times, April 18, 2010).

- **Bacteria:** Bacteria are single-celled microorganisms. Most bacteria do not harm humans, some are beneficial to humans and some are harmful to humans. Transmission of bacteria can be through contaminated food and water, by direct contact and by sneezing and coughing. Bacteria reproduce asexually by binary fission (cell division). Colonies of bacteria can form physical bonds between both individual bacteria and surfaces creating a biofilm. Biofilms can make efficient surface disinfection difficult. Examples of common bacterial infections are tuberculosis and salmonella.
- **Viruses:** A virus is an infectious agent made of genetic material (DNA or RNA) inside a protein coat. Transmission of the virus can be through bodily fluids (blood, saliva), through contaminated water or by sneezing and coughing. Viruses require a host cell to create copies of the original virus, they cannot reproduce on their own. Examples of common viral infections are influenza and herpes.
- **Fungi:** Some of the species in this kingdom, such as yeasts and moulds, are microorganisms which can cause infections in humans. Fungi can reproduce both sexually and asexually. Of special concern to the makeup artist are the dermatophytes; fungi which cause infections of the hair, skin and nails. This can be spread by infected exfoliated skin adhering to makeup tools. Like bacteria, some fungi can form biofilms. Examples of common fungal infections are tinea pedis (Athlete's foot) and vaginitis.
- **Microorganism:** A small single-celled or multi-celled organism. Examples include bacteria, fungi, algae and some tiny animals such as mites. Viruses are sometimes included in this category although they are not cells or living organisms.
- **Disinfectant:** Destroys microorganisms on non-living objects. An example of a common disinfectant is a 5.25% solution of sodium hypochlorite (household bleach).
- **Antiseptic:** Destroys microorganisms on living tissue. An example of a common antiseptic is 70% isopropyl alcohol solution used to prepare the skin during aseptic procedures such as an injection.

Clean hands: *Always wash your hands before working with a client*, preferably with soap and water. To wash your hands, first place three clean, dry paper towels near the sink. Turn on the water. Make a lather with hand soap and lather your hands for at least 20 seconds. Dry with paper towels, using the third towel to turn off the faucet so you don't contaminate your hands. Aside from clean hands you should keep your nails clean, trimmed and filed.

If you don't have access to a sink use disposable hand wipes. These wipes remove dirt and usually contain a mild antiseptic such as benzaulkonium chloride. Hand sanitizer should be considered a 3rd choice since regular hand sanitizer just moves dirt around rather than removing it as soap and water or hand wipes do.

Gloves: Some artists like to apply makeup directly to clients using their fingers; this is a personal preference. Your skin is constantly shedding cells and working hands get nicked, cut and scratched. Gloves are a barrier that prevents cross-contamination between client(s) and the makeup artist. Gloves are NOT a substitute for clean hands. My gloves of choice are vinyl examination gloves. These are thin, translucent and cheap. Vinyl is a better choice than latex which has allergy issues or nitrile which only comes in colours (usually purple or blue) that can bias your colour sense. Gloves let you move rapidly between clients by quickly changing gloves and shows your client that you are indeed a clean and sanitary makeup artist. You can use the back of the glove as a convenient palette to mix creme colours.

After working with a client, consider the outside of the glove contaminated and the inside of the glove, next to your skin, clean. To remove gloves, grasp the outside cuff of one glove between your thumb and index finger (contaminated to contaminated). Pull off glove turning it inside out as you pull it off. Using your ungloved hand, curl your fingers inside the cuff of the remaining glove (clean to clean) and pull off, turning the glove inside out with the first glove inside the second. Dispose of the soiled gloves in the garbage.

Set up your work area for cleanliness. Use a fresh white cotton towel with a disposable towel on top to layout your clean tools. The disposable towel can be replaced as necessary to keep the area clean. The cotton towel provides additional absorption when drying brushes and for accidental spills. Use disposable cleaning pads and

makeup sponges when possible. Make sure you have a waste bin close by before you start so you don't end up with a pile of dirty, used disposables next to your work area.

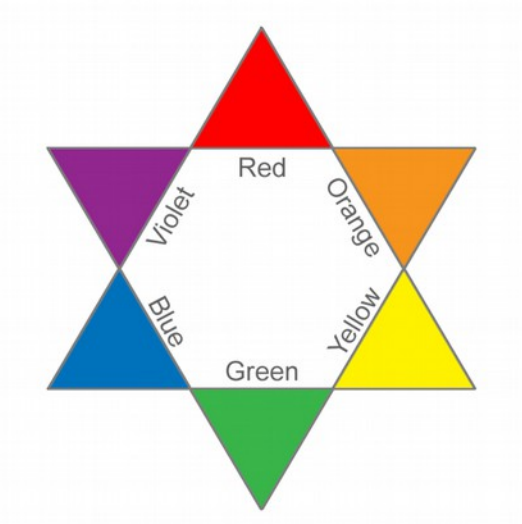
Sometimes you'll have to use the same set of brushes on several clients. Always clean and sanitize your brushes before using on a new client. Use a brush cleaner intended for makeup brushes and follow the directions on the product. Stainless steel makeup spatulas and other tools can be cleaned with an alcohol wipe between clients or whenever you suspect contamination. Alcohol is most effective when diluted with water which facilitates diffusion through the cell membrane of the bacterium. Proper disinfection requires a concentration of at least 60% alcohol; most alcohol wipes are 70% alcohol.

Between makeup sessions I like to clean the brushes used for creme and liquid products with a brush soap and warm water. This ensures that all of the makeup is removed from the brush so there is nothing for microorganisms to grow on during storage and it conditions the brush as well. Follow the manufacturer's directions on the brush soap container.

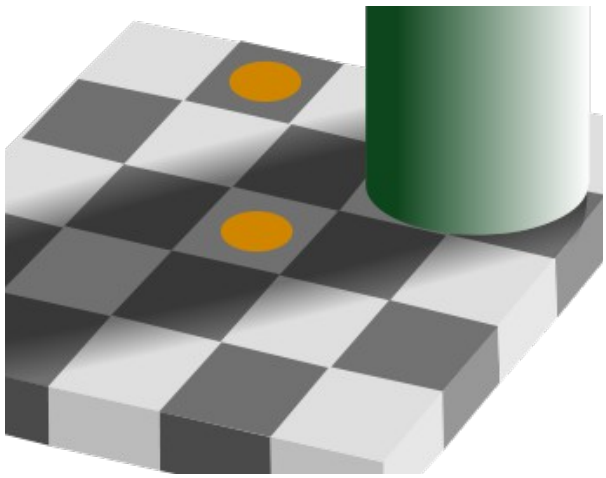
- **Creme products:** Scoop creme products out with a makeup spatula and place on a clean palette. Place the scooped product beside previous scoops (not on top of) to prevent cross-contamination via the spatula. If you use your spatula to mix, clean with an alcohol wipe before scooping more product.
- **Liquid products:** Dispense liquid products onto a clean palette or fresh applicator with a dropper, pump or brush. Setting liquids and sealers applied using a pump sprayer will eliminate cross-contamination. Rigid collodion must be applied directly from the bottle since it dries quickly. The solvent content in the collodion will prevent cross-contamination between casualties.
- **Pencils:** Keep clean pencils capped to prevent breakage and soiling. Sharpen pencils between clients and wipe with an alcohol wipe (70% alcohol). Air dry the pencil and replace cap.
- **Dry powders:** Dry powders, loose or pressed, in general do not provide an hospitable environment for microorganisms to breed. Dry powders are difficult to scoop out with a makeup spatula so it is best to work directly from the pan and use a makeup sanitizing spray on the powders between clients. I use Beauty So Clean spray. Setting powders can be dispensed in small amounts into a shallow dish for more control when loading the powder brush.
- **Cake products (water or alcohol activated):** You can work with alcohol activated paints directly from the cake to the client's skin. Microorganisms on the client's skin will be killed by the alcohol. With water activated cake there are two ways of working. If you don't use very much of the product, use a small, flat synthetic brush to mix and hold the product. Work from that brush as you would a palette. For products such as cake foundation, work directly from the cake and sanitize between clients. In some cases, small amounts of cake foundation can be scrapped off the cake with a make-up spatula and mixed on the palette. This is convenient when you want to mix a custom colour.

2.6 Colour and Depth Perception

The pigments used in makeup modify light by absorbing or reflecting particular wavelengths of light which we perceive as colours. Different pigments absorb/reflect different wavelengths and appear as different colours.



Traditional painters and makeup artists use a subtractive colour palette with three primary colours: red, yellow and blue. The *simplified* painter's colour wheel on the right shows how the primary colours can be mixed to make secondary colours. Mix blue and yellow to get green, red and blue to get violet and so on. Colours opposite each other on the colour wheel will neutralize each other and become a grey colour. Mix red and green pigments and you'll get a grey tone. This is useful in modifying skin tones for conditions such as shock where a lack of blood (red) can be achieved by neutralizing the red with a light green or light blue makeup. Reds are often used to cover tattoos done with blue inks.



Many colours can be made by mixing adjacent colours on the colour wheel. A hue is a pure colour; one of the primary colours or one made by mixing two of the primary shades in different ratios. Shades are made by mixing a hue with black. Brown is a shade of orange which is a secondary colour (hue) made by mixing red and yellow, see the photo above.. Tints are made by mixing a hue with white. Pink is a tint of red, see photo above. If you look at the image to the above right (a modified version of the original checker shadow image by Edward H. Adelson; this image may be reproduced and distributed freely) you'll see what appears to be an orange and a brown spots in a checker board. These two spots are the same colour, one appears darker because of the surrounding tones. The sensation of colour and tone is not absolute but is relative to the surround.

Colours affect our perception of depth and dimensionality. Our eyes evolved in a world in which distant landscapes appear bluish due to the atmospheric scattering of short wavelengths. The image at the right shows this effect which is also known as aerial perspective. Objects close to us lighted by direct sunlight appear warmer (more yellow/red) in colour. Objects at a distance appear cooler (more bluish). Use blue and purple to shade areas you want to have depth; for example, the bottom of deep lacerations.

Perceived depth is dependent upon how the shading is done. Cavities appear darker than the outside due to shadows. Our brain assumes that the light source comes from overhead. The top of the image on the right is the original photo of a white tray, convex side toward the viewer, with the light source positioned at the top left casting shadows on the lower right. The bottom image is the exactly the same one as the top except that it has been rotated 180° so that the highlight now appears on the bottom right. Note how the image now appears concave.

2.7 Skin

In casualty simulation practically all of the effects are applied to the skin. Understanding how the skin looks and functions is critical to realistic casualty simulation.

Skin colour a function the of melanin in the epidermis and underlying layers, the dermis and hypodermis. Melanin comes in two types pheomelanin (red) and eumelanin (brown-black). All humans have some pheomelanin in their skin; women have more pheomelanin than men and, in general, have a more reddish skin tone. Pheomelanin is responsible for the pink hue in the lips, nipples and vaginal lining. The amount of eumelanin varies in human populations, the higher the concentration of eumelanin the darker the skin.

The dermis is the second layer of skin which contains the blood vessels, hair follicles and nerves. Some of the colour of the skin is the result of blood in the dermis. When someone is in shock, the lack of blood causes loss of colour in the skin.

Underneath the skin is the hypodermis or subcutaneous tissue. It contains a layer of fat, thicker in women than in men. The older a person is, the more yellow the subcutaneous fat.

As we age the skin becomes damaged from environmental sources. Sunlight can cause uneven skin pigmentation and can permanently dilate capillaries. Dark spots in the skin, solar lentigines (commonly known as liver or age spots) can be caused by excessive exposure to the sun. Sunlight can also damage the collagen and elastin fibers leading to wrinkles and loose, sagging skin. Nicotine from smoked or smokeless tobacco can prematurely age the skin by vasoconstriction reducing the skin's blood supply.

The structure of the skin, combined with ageing and damage from everyday living, gives the skin its colour. You can see minor skin colour variations in the photographs on the right (1st and 2nd photos, both female, mid-20s) (3rd photo, male, early-90s)

Skin moves in different ways depending upon how it is attached to the underlying structures. In the face, the muscles insert into the skin, giving humans a wide range of facial expressions. The scalp is relatively immobile, attached to the fascia covering the skull. On the palms, the skin is bound in places to the fascia giving the distinctive flexure lines of the palm. The loose skin of the eyelids and foreskin permit fluid movement of those parts.

2.8 Blood

Adult humans, depending on size, have a total blood volume of 5-6 litres. Hypovolemic (reduced blood volume) shock may only become apparent after blood loss of up to 40% of the total blood volume. Each break in the pelvis will, on average, cause an internal blood loss of 500ml. Each femur fracture represents a loss of about 1.5 litres of blood. Oxygenated arterial blood is bright red in colour; deoxygenated blood returning to the heart through the veins is a darker colour. Human blood is only slightly more viscous than water. It is also translucent, not transparent, since it contains cellular material (red blood cells) which give it colour.

Blood exhibits non-Newtonian fluid dynamics. The density of human blood is quite close to that of pure water. Erythrocytes make up approximately 45% of blood volume, 55% of blood volume is plasma. Water content of the erythrocytes is about 64% by mass (reference: Beilin LJ, Knight GJ, Munro-Faure AD, Anderson J. The sodium, potassium, and water contents of red blood cells of healthy human adults. J Clin Invest. 1966 Nov;45(11):1817–1825. Average male has approximately 2.5g of iron in the total volume of blood of 5 to 6 litres.

The amount of blood you will use around a casualty during a simulation will vary based on the type of scenario and the surround. On pavement, blood remains pooled on the surface; even a small amount looks like a large quantity. In contrast, dry sand or gravel will absorb a considerable quantity of blood. You can see this for yourself by pouring water on a sandy area and on a paved area.

2.9 Planning Scenarios

The type of materials and makeup we use for casualty simulation depends on the type of exercise and the skill/training of the casualty simulators available. The lead time varies considerably and is based on a number of factors. Does the makeup need to last a long time under extreme conditions? Are custom prosthetics or specialty makeup needed? How many casualties and how many casualty simulators are available for this exercise? To apply the makeup in a timely manner, a well lit, warm and sheltered area is a must. Depending upon the materials we're using, a source of electrical power might be required. Some of the materials, such as cosmetic latex, are damaged by the cold and must be stored in a heated environment. Bleeds may need to be reset, the wounds cleaned and blood supply replenished. Casualties must also be briefed concerning their injuries so they can give a realistic performance.

A specific scenario can generate a wide variety of injuries; the actual injuries will be designed by the casualty simulation team based on the skill set of the participants and what resources are available. Creating the scenario this way provides a much more realistic and cohesive exercise than starting with the injuries. Here are some things to consider when planning a scenario:

- **Background:** The storyline of the incident. What has happened and how has it happened. Is this conventional warfare? Insurgency? Civilian or military? A natural disaster? A vehicle accident? Is this a tactical exercise (no white light and movement restrictions)?

- **Mechanism of Injury:** The physical forces that caused the injuries. The mechanism of injury may be generalized, as in a vehicle rollover, which causes head, leg and arm injuries. It may be focused; a rock dropped on the foot injures only the foot. There may be multiple mechanisms of injury. An example is a vehicle is hit by an Improvised Explosive Device (IED). The shock wave from the blast can cause internal injuries. Casualties may be struck by fragments propelled by the blast. The casualty can be thrown from the vehicle as it rolls over or be bounced around inside the vehicle. A firefighter may be injured by smoke inhalation or burns, toxic substances, fragments from exploding containers or may suffer a myocardial infarction (MI) from heat and physical stress.

- **Actors:** Who are the casualties? How many? Civilian or military? Refugees? Age? Sex? Level of fitness? Health prior to incident? A tired, malnourished, elderly refugee will react quite differently to an injury compared with a young, fit, well-fed soldier. Relationships between casualties: mother/child, ethnic group, extended family? Are there language or cultural barriers? Grouping together casualties of warring ethnic groups during triage may cause problems.

- **Props:** What physical items are involved in the incident. Vehicles? Buildings? Weapons? Are these damaged? A vehicle may be drivable or may present a hazard if leaking fuel or on fire. It may have been carrying hazardous materials such as explosives or corrosive material. Depending upon the weather, a damaged vehicle may be used to shelter casualties from the environment. Buildings might be unstable, as in the case of an earthquake.

- **Terrain:** What is the locale like? Indoors/outdoors? Sandy, rocky, grass? Hilly terrain or flat field? Near, on or in a body of water? Terrain will help to determine the type of injuries that may be present and the rescue options available.

- **Conditions:** When did the incident occur and what is the weather like? Foggy, dark, snowing, raining? High winds? Darkness? Hypothermia and slip hazards in cold weather.

- **Skill set:** What specific skill set are you exercising or testing? Basic first aid? Advanced casualty care? Health care provider skills? Search and rescue? Vehicle extraction? High angle rescue? The skill set will help determine the complexity of the injuries presented. For example, a tension pneumothorax can be treated by a Tactical Combat Casualty Care (TCCC) trained soldier with needle decompression but a standard first aid trained soldier has limited options.

- **Resources:** What resources do the participants need to successfully participate in the scenario. Specialized rescue equipment? Heavy equipment to clear debris? Ambulance or other vehicle? Aircraft? Night

vision? First aid dressings? Unit medical station? Watercraft? Snowmobiles? Do the participants have proper training on the equipment provided?

Taking the preceding into account, the casualty simulation team can design appropriate injuries to exercise the particular skill set based on the desired scenario. The casualty simulation team may also liaise with engineers for pyro and others for IED simulation.

2.9.1 Safety

Safety is an important factor to consider. Simulated casualties often must remain in position and exposed to the elements for a long period of time. This often precludes simulation in cold weather, especially extreme cold. During cold or inclement weather, casualties should have a warm, sheltered area or vehicle to wait in.

Those taking part in the scenario should be familiar with the equipment and the protocols. Unfortunately participants in training scenarios have been killed. Master Corporal Wheeler was run over and killed by an armoured personnel carrier (APC) during a training exercise at Canadian Forces Base (CFB) Suffield on April 7, 1992. He was playing a casualty at the time of the incident and the driver of the APC did not see him lying on the road. (source: *When a Soldier Falls: Reviewing the Response to MCpl Rick Wheeler's Accidental Death*, a special report prepared by The Office of the Ombudsman for National Defence and the Canadian Forces, January 2005) A volunteer firefighter in South Dakota was killed in a training accident when an airbag was dislodged and struck him in the head (source: *Volunteer fire fighter/fire service products salesman dies after being struck by dislodged rescue airbag - South Dakota*, NIOSH Report F2003-34, July 27, 2004). A Toronto firefighter, Captain Donald Babineau, was killed in a similar training accident in 1987 when an airbag being used to lift a streetcar sent a support flying, striking him in the head (source: *Their Last Alarm: Honouring Ontario's Firefighters, 2nd Edition*, by Robert B. Kirkpatrik, General Store Publishing House, 2004).

Some hazards might not at first be apparent. A medical manikin used for simulation exhaled a large amount of CO_2 which caused a rapid and unexpected rise in the temperature of soda lime used in the anaesthetic machine (source: *Safety in medical Simulation-overlooked or underappreciated?*, Merry, AF and Wheeler, DW, Can J Anesth/J Can Anesth (2011) 58:789-795). Care should be taken that non-functioning equipment such as defibrillators and supplies used for simulation does not make its way into the stores used to treat actual patients. (see *FDA's investigation into patients being injected with simulated IV fluids continues*, FDA website, updated 04/08/15) Real equipment and supplies mixed into practise stores can have disastrous consequences as well (see: *Coroner's inquest found 'a climate of negligence'* by Robert Smol, The Toronto Star, July 26, 2009 and *An Investigation into the 1974 Valcartier Cadets Grenade Incident* a DND/CF Ombudsman Report, June 2015).

Do a scene survey of the area you will be using for hazards. Hazards include mold, rodent dropping, broken glass, rotten wood, slippery surfaces, lack of hand or guard rails, unstable structures, toxic or hazardous waste and many more than can be enumerated here. Use your good judgment.

2.9.2 Coaching Casualties

One of the jobs of a casualty simulation trainer is to coach the casualties on how to act. You don't want them to over act or under act. If you can, write out a short script and character description. Here are a few tips:

- Most people don't have a very good understanding of where the major organs are located or the relative size of those organs. Take time to explain where the relevant organs are to your casualty.
- If pain is referred pain, explain to your casualty what referred pain is and what they would feel. Try to anticipate the examiner's questions and techniques (movement and palpation) to confirm the pain is referred.
- People react differently to injury and pain, depending upon their cultural background, their state of health, their age, and their own personal tolerance for pain. A medic who had served in Afghanistan told me that many seriously injured Afghanis don't complain much about pain; even with horrendous wounds they remain stoic. On the other extreme, I had an uncle who would become wozzy simply at the sight of blood. Try to determine, within the bounds of the scenario, how the patient would most likely react.
- Don't become caught up in the details of creating a complex character. You will need to have the medical history (family and personal) detailed, but try to eliminate any extraneous details.
- Don't ask your casualty to simulate conditions which might cause harm to the casualty. An example of this is hyperventilation which can cause fainting. There are ways that the casualty can simulate hyperventilation but this requires some training and preparation.

3. Materials and Techniques

3.1 Brushes, Sponges and other Tools

Brushes, sponges and other tools are essential yet often overlooked items of your makeup kit. To perform your duties properly you must have the proper type and sufficient quantities of these items AND keep them clean and serviceable.

3.1.1 Brushes

The brushes you'll use will be a mixture of synthetic and natural bristles. I like soft, natural bristles for anytime I'm working directly on someone's skin; applying pigments or powder. Natural bristles tend to be softer and a bit more controllable. On the downside, natural bristles have longer drying times when used with wet media and the fibres are coloured with dye which can wash out. When you're doing casualty simulation being able to clean and reuse your brushes quickly is a major consideration. Synthetic bristles (nylon, Taklon) are good for applying adhesives and blending appliances. The synthetic bristles tend not to absorb liquids as readily as natural bristles. Most brushes consist of a handle (wood or plastic), a ferrule (metal or plastic) and the bristles.

Brush sizes may be given in metric (millimetres), US/Imperial measure (inches), type/use (powder) or in the case of artists' brushes, by a numbering system. Artists' brushes are sized by a numbering system from smallest to largest: 10/0, 7/0, 6/0, 5/0, 4/0, 000, 00, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16, 18, 20, 22, 24, 25, 26, 28, 30. This numbering system is not an absolute measure and sizes will vary between manufacturers. The size is often embossed on the handle (see photograph)

Brushes come in many different types. The most common types you'll run into in casualty simulation are:

- **Round:** Long bristles which come together in a point. Used for precise application of colour.
- **Flat:** Long bristles in a flat end. A good choice for applying adhesives.
- **Bright:** Similar to a flat but with shorter bristles. Use where you need more control than offered by a flat such as painting and blending.
- **Angle:** Similar to a bright but with an angled end. I use a synthetic angled brush to blend gelatin appliances; the angled tip gives a fast, sharp cut through the flashing and the flat portion gives good control for blending.
- **Chip:** A cheap, disposable flat brush, 2-3cm in width. Used to apply adhesives, cleaning fluids and paint.
- **Fan:** A wide fan shaped brush. Used primarily for blending makeup or colours.
- **Powder:** Large, soft brush used to apply powder.
- **Contour:** A soft brush similar to but smaller than a powder brush. This brush has angled bristles.

When cleaning your brushes between casualties, use a commercially available spray brush cleaner/sanitizer. These spray cleaners are good for your dry brushes (powder, contour) and work quickly and effectively. Spray then wipe off any makeup with a tissue. For other brushes, wash in water or other suitable solvent (i.e. alcohol). Do NOT leave your brushes sitting on the bristles soaking in water; this will distort the bristles and ruin your brush. Use an artist's brush washer which has a holder which keeps the bristles off the bottom of the washing container. Don't soak your brushes; water can swell wooden brush handles and weaken adhesives holding the bristles and the ferrule. When storing round and bright brushes, work a bit of artist's brush soap into the bristles, shape with your fingers and dry. This will help to retain the shape of the bristles over the lifetime of the brush. Wash out the soap just before using the brush.

3.1.2 Sponges

You'll use several different types of sponges for different tasks. The triangular makeup sponge is the most versatile item in your casualty simulation kit. You can use it to apply creme or alcohol-activated colours, stipple on liquid latex and to blend colours. Cheap, disposable makeup sponges are often made of latex. If you're casualty is not sensitive to latex and you're not using silicone then latex is an acceptable choice. Otherwise use polyurethane sponges available from a professional makeup supplier. The polyurethane sponges are more expensive but can be used with silicone (the sulphur compounds in latex inhibit curing in platinum cured silicone). Latex sponges are cheap and should be thrown away after use. Polyurethane sponges can be carefully cleaned and dried after use. Always be sure to have enough sponges available. NEVER use the same sponge on more than one person unless it has been properly washed and dried between uses.

When applying colours, either creme or alcohol-activated, pick or tear away parts of the sponge to give it an uneven shape. This will make your application more natural than using the square end of the sponge.

Other sponges you may wish to try are the black nylon stipple sponge and the orange rubber sponge. The black nylon stipple is used for creating realistic looking scrapes by stippling on thick blood or colour. You can also use it to create a broken capillary effect for windburn (heat/cold injury). The orange rubber sponge is excellent as a texture sponge for colour blending appliances and some types of burn injuries. Both of these sponges are usually sold as a large sponge which should be cut into smaller pieces prior to use. These sponges can be washed, dried and reused several times.

3.1.3 Airbrush

An airbrush is a miniature spray gun which can be used to apply makeup. The airbrush is good for mass casualty situations where many people have to be made up quickly. Since your airbrush doesn't touch the skin, you can move rapidly between casualties without having to clean anything. The airbrush is an excellent tool to create realistic subtle blending when creating shock or burn makeup.

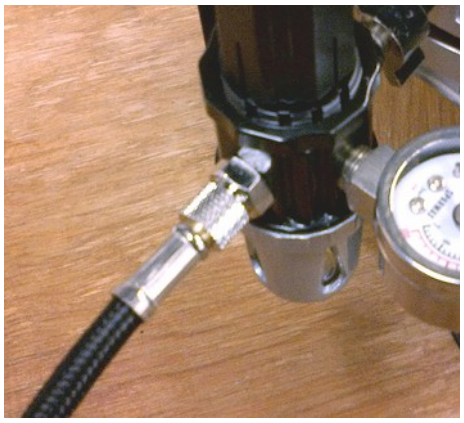
The airbrush uses compressed air supplied by a small compressor. When the air is blown past a fine nozzle connected to the paint reservoir the venturi effect pulls paint into the air stream and atomizes the paint. Most airbrushes used for makeup application are independent double action. Pushing the trigger down on the airbrush controls the valve supplying air. Pulling the trigger back pulls the needle out of the nozzle and lets paint flow.

Paint has been applied by air as long ago as 35,000 years ago by the Aurignacian culture in Europe (source: *How to Paint with Air*, 3rd Edition, by Frank J. Knaus, published by Paasche Airbrush Co., Chicago, 1947 and *Hand Paintings and Symbols in Rock Art* from the Bradshaw Foundation website, 2011) These early artists used a hollow bone as their airbrush and their lungs as a source of compressed air.

To work effectively you'll need access to a reliable power source for your compressor and a sheltered area where the airbrush can be used. Even a small amount of air movement will deflect the spray and

make work very difficult or impossible since makeup is generally applied with a pressure of 8 psi and sometimes as low as 3 psi. **Never** use a pressure any greater than 15 psi (100kPa). The air pressure should not be able to dimple the skin. If it does you are either too close or your pressure is too high.

The following instructions are for the Iwata HP-C airbrush and the Sparmax air compressor. Both are popular for makeup application.



1. Find a suitable place for your airbrush station. The place you choose **MUST** be clean, near a power supply and out of the wind and the elements.
2. The compressor should be located on a solid surface. It vibrates slightly when in operation and can "walk" off a shaky table if you are not careful.
3. Clamp the airbrush holder (the thing with the orange top) to the side of your table. Tighten and check. The angle of the holder should hold the airbrush so that the cup on the top is vertical.
4. The regulator/gauge should be connected to the compressor. If not you'll have to connect the two. Check both fitting for cleanliness and carefully remove any particles from the fittings. The airbrush has very tight tolerances and tiny particles can block the airflow. Line up the "IN" (marked on the regulator) port with the outlet of the compressor. Make sure that the threads are properly aligned. Turn the fitting while holding the regulator/gauge in an upright position. Adjust to finger tightness. **Note:** The compressor directions suggest using Teflon plumbing tape on the threads. This is not necessary since the fitting have compression rings. Small pieces of Teflon tape can block the hose or airbrush. **Do not use Teflon tape.**
5. Once the regulator/gauge is connected to the compressor connect the airbrush hose to the output of the regulator. Make sure that the threads are properly aligned. Adjust to finger tightness.
6. Connect the other end of the hose to the airbrush. Make sure that the threads are properly aligned. Adjust to finger tightness. Place the airbrush in the airbrush holder as shown.
7. The pressure is set by pulling the knob on the top of the regulator up until you hear a click. Looking down from the top of the compressor, turn the knob **counter-clockwise** to decrease the pressure.
8. Plug the compressor in and turn it on using the switch (near the power cord connection to the compressor). This compressor only cycles when it senses a pressure drop in the output.
9. Now turn the regulator knob **clockwise** to increase the pressure. You should hear the compressor cycle and see the needle on the pressure gauge move up. The gauge on the compressor is marked in bar (black scale) and psi (Pounds per Square Inch, red scale). 1 bar is approximately 100kPa or 15 psi. For makeup application you'll be using a **MAXIMUM PRESSURE of 100kPa** (about 1 bar or 15psi) and often much less. The Iwata HP-C airbrush is rated for a maximum of 290kPa **BUT you should NEVER use this much pressure when applying makeup since it can cause injury!!!**
10. Press the regulator adjustment knob down to lock in the pressure.

11. As the compressor operates, water condenses inside the compressor and settles in the bowl under the regulator. You should drain the water during operation by lifting up the drain valve on the bottom of the bowl. Grasp this between your fingers (the water exits through the hole in the bottom) and lift. Some air will come out with the water and the compressor may cycle.

The Iwata HP-C airbrush is a independent double action, gravity fed airbrush. Pressing down on the trigger opens the air valve. Moving the trigger back increases the paint flow. It takes a bit of practice to use this type of airbrush. The distance of the airbrush to the object being painted determines the width of line being painted. Air pressure for makeup application is typically 8 psi but can be as low as 3 psi. Do not use a higher pressure than 15 psi. The higher the air pressure the more bounce back you'll get; the spray will bounce off the skin and you'll waste more makeup.

Shake the bottle to mix the paint, usually at least 2 minutes of shaking if the bottle has been sitting around for a while. You should hear the tiny ball bearing inside the bottle which helps to mix the paint. Makeup is added to the bowl on top of the airbrush by pulling off the lid; it requires very little makeup, just drops. Clean the skin with a cleaning pad and witch hazel before applying makeup. If you have to stop airbrushing for any longer than a couple of minutes, do a quick flush of your airbrush (see following) with the appropriate solvent to prevent clogging.

Quick Flush: Wipe the bowl with a lint-free tissue to remove most of the paint, squirt some solvent in the cup. Increase air pressure to 15psi (100kPa) and spray until all the solvent is gone. Repeat with a smaller quantity of solvent. For alcohol-activated paint the solvent is **99%** alcohol. Be careful with the 99% alcohol since the spray is flammable! **RESET YOUR AIR PRESSURE AFTER FLUSHING!!!**

Detailed Cleaning: Flush the airbrush as described above. Add solvent to the cup and GENTLY pinch the your thumb and index finger over the tip of airbrush then depress and pull back the trigger all of the way to force air back into the bowl through the nozzle. It should be bubbling and hissing inside the bowl. This helps to loosen and remove deposits of paint. Wipe the bowl with a lint-free tissue. Flat wooden toothpicks can be used to carefully remove deposits of built-up paint in the bowl. NEVER use metal tools to clean the airbrush. You can remove the needle from the airbrush for cleaning but the needle is very easily bent. To remove the needle, unscrew the rear housing of the airbrush. Inside you'll see a knurled knob. Turn this knob to loosen and carefully pull the needle straight out (see photo right). Deposits of paint on the tip can be removed with a lint free tissue dampened with solvent. Inspect the needle with a magnifying glass for any bends or other

deformities. Sometimes a bent needle can be straightened by carefully dragging it along a piece of glass at an shallow angle. Reinsert the needle straight into the airbrush using gentle pressure. The needle should seat gently against the nozzle. Reassemble the airbrush **HAND TIGHTENING** THE PARTS ONLY. **DO NOT USE** PLIERS TO REASSEMBLE. Make sure that all parts align before tightening.

For most casualty simulation work alcohol-activated paints such as Skin Illustrator are used in the airbrush. Shake the bottle to mix the paint before beginning. Most of the bottles have a small ball bearing inside to help mix the paint. These paints are available in squeeze bottles, ready-to-use from professional makeup suppliers.

The photo shows the parts of a typical airbrush nozzle disassembled with a Canadian dime included for scale. As you can see, the airbrush is a delicate, precision instrument which requires proper handling and ongoing maintenance to function properly.

Detailed instructions concerning the application of makeup by airbrush is beyond the scope of this article. For more information see your local distributor of airbrush makeup; there are books, videos and courses available.

3.1.4 Other Tools

You should also have several small, steel makeup spatulas. Spatulas are very useful in transferring small quantities of makeup from containers to your palette (to prevent cross-contamination from double dipping). You can apply items such as thick blood to wounds using a makeup spatula. Always clean and sanitize the spatula before using it on another casualty to prevent the transfer of germs. Wood tongue depressors are excellent for mixing and working silicones, effects gels and cabo (thickened Pros-Aide®). When sculpting with silicone or cabo on the skin, dip the tongue depressor in 99% alcohol before using to help reduce sticking.

You can get either polished stainless steel makeup palettes or white plastic makeup palettes. I prefer the white plastic palettes since the stainless steel palettes are small and tend to reflect the environment which can make colour matching and mixing more difficult. You should have several clean palettes available so you don't have to spend time cleaning the palettes while you are working; one palette for each casualty is perfect. Plastic muffin palettes are convenient for holding setting and character powders.

For cutting I like to use bandage scissors. These have an angled handle and a blunt end so it is easy and safe to use near the skin. The surgical stainless steel is highly polished and easy to clean and sanitize. The photo shows some of these items including the stainless steel palette, the white plastic palette, the plastic muffin palette for powders, two makeup spatulas and a pair of bandage scissors.

3.2 Creme Makeup

Creme makeup is available from most theatrical suppliers in a wide variety of colours. This makeup is oil based, most often castor oil, with pigment for colour and waxes in addition to other modifiers. High quality creme makeup has a pigment content approaching 50%. Although you might pay slightly more for high quality creme makeup it will last much longer due to the high pigment content and be much easier to use.

You can purchase creme makeup as a palette, several colours in one container, or as individual colours. Manufacturers such as Ben Nye and Kryolan offer palettes of colours grouped by use; wheel palettes, two are shown in the photo. These are very convenient for the casualty simulator.

The most versatile and useful products I've found are the burn, bruise and injury wheels available from various manufacturers. The wheel on the left is a Kryolan® Burn & Injury Wheel, the wheel on the right is a Ben Nye® Monster Wheel, excellent for frostbite and cold injury. These wheels group together commonly used colours needed to create the effects suggested by the name. You can use neutral set powder between layers of creme colour and makeup sealer to coat the finished effect. In many cases, all that is needed is a wheel, a brush, neutral set powder and a spray bottle of makeup sealer to create a realistic, long-lasting wound effect.

Creme makeup is formulated to apply and blend easily on clean skin. You can apply it with *clean* fingers, a brush, a makeup sponge or other applicator. Once you've got the effect you want, the makeup is set by using a translucent setting powder. This is dusted on using a powder brush and excess powder removed with a soft fan brush.

Do not confuse creme makeup with greasepaint in stick form. Greasepaint packaged as sticks has been around since the 1870's, The sticks are about the same size as an artist's pastel colour, consisting of pigment mixed with tallow or other grease. Greasepaint sticks should be avoided for casualty simulation. These tend to be difficult to apply and blend. Greasepaint sticks smear and transfer easily to clothing. I also find greasepaint sticks present a problem in maintaining a professional level of sanitation at my make-up station. Use creme colours or alcohol activated colours instead.

Sometimes in casualty simulation you will have to match a specific skin tone to hide the edges of a prosthetic appliance. In this situation you'll use a creme concealer, a theatrical foundation or alcohol-activated paints. Concealers and foundations are available in a wide variety of skin tones from light to dark. These products are divided by the undertone, which can be either neutral, red or yellow. I've found that the yellow undertone concealers and foundations are the most useful. The undertone of the skin is the bias of the skin away from a "neutral" skin tone. You will also need adjusters specifically made for the products you are using. Adjusters are mixed with the concealer or foundation, in small amounts, to tweak the colour to match the skin colour of a specific person. Coral, rose and olive are the most commonly used adjuster colours.

When blending to the skin, select one concealer slightly darker than the skin tone to be matched and another slightly lighter. Using an orange rubber stipple sponge, stipple on a layer of the darker tone then lighten the tone by stippling on the lighter tone. You should be able to closely match the skin tone by this method. After you are satisfied with your work, set the makeup with neutral set powder.

3.3 Powders

The most common powders you'll encounter in casualty simulation are setting powder and character powders. Setting powders are translucent powders, neutral or tinted, which are used to set creme makeup. These powders are available from various manufacturers and are inexpensive. Setting powders keep the creme makeup from smearing and transferring to wardrobe, increasing the longevity of your casualty's makeup. Apply with a powder brush and remove excess powder with a soft fan brush. These brushes are shown in the photo.

Character powders simulate charcoal, dirt and ash. Please note that the names given to these character powders describe the effect only. The actual pigments used in character powders are approved cosmetic colours. Don't substitute other substances for character powders.

Character powders should be used sparingly for greatest effect. Too much powder will look artificial and comical. Use a damp makeup sponge to control the powder during application. Be careful of your casualty's eyes and when working around the nose and mouth.

Character powders can be mixed with other products for different effects. Black grease can be made from charcoal character powder mixed with a water-based lubricant. Thin this mixture with a bit of glycerin for a more oily effect. A mud effect is made from ash character powder and hair gel. When applied thinly, this mud will dry and crack.

3.4 Makeup Sealers

Makeup sealers are used to protect the makeup, modify the surface of the makeup and to permit the artist to build multiple layers of colour. The most common sealers are alcohol based with a matte finish. Use these sealers to protect the makeup.

Some sealers are alcohol resistant when dry. These sealers can be used to layer alcohol-activated paints or to protect makeup. Choose the sealer based on the characteristics you require. Over sealing makeup can create problems when you try to remove the makeup.

3.5 Prosthetic Adhesives

Pros-Aide® is the industry standard adhesive for applying non-silicone prosthetics to the skin. To use, coat a thin layer on the prosthetic and allow to dry; it will remain tacky. Apply to clean skin.

For blending the edges of latex appliances or building up effects on the skin, Pros-Aide® adhesive can be thickened to a toothpaste-like consistency by adding Cab-o-sil®, an inert fumed silica thickening agent. This mixture is sometimes called bondo (**NOT** to be confused with the Bondo® used for auto body repair) or cabo.

Although it is inert from a chemical standpoint, inhalation of the dry Cab-o-sil® powder can cause pulmonary inflammation. The dry powder is also a mild skin irritant. Always wear a recommended respirator (use an N95 for nuisance levels of dust, see the product data sheet for more information) when using Cab-o-sil® in a dry powder state. Cab-o-sil® is approved by the U.S. FDA for use in food and cosmetics. Cab-O-Sil, a fumed, or pyrogenic, silica, should **not** be confused with crystalline silica which is classified as a human lung carcinogen and a cause of silicosis. Fumed silica **will** cause temporary irritation of the respiratory tract since it readily absorbs water. “Synthetic amorphous silica (SAS), in the form of pyrogenic (fumed), precipitated, gel or colloidal SAS, has been used in a wide variety of industrial and consumer applications including food, cosmetics and pharmaceutical products for many decades. Based on extensive physico-chemical, ecotoxicology, toxicology, safety and epidemiology data, no environmental or health risks have been associated with these materials if produced and used under current hygiene standards and use recommendations.” and “After inhalation, oral, intraperitoneal and intravenous exposures, SAS is eliminated from the lung tissues and other organs of experimental animals with no indication of accumulation, even after prolonged exposure to high doses or concentrations.” (preceding two quotations from Fruijtier-Pölloth C, “The toxicological mode of action and the safety of synthetic amorphous silica —A nanostructured material”, *Toxicology*, 2012-04-11, Volume 294, Issue 2, Pages 61-79)

This mixture can be tinted with coloured flocking and if a bit of care is used, painted with alcohol based paints. Use a wet makeup sponge for blending to get a smooth surface.

When using adhesives and makeup sealers try to avoid building up the products layer upon layer unless necessary. Doing so can cause problems in removal since one product may prevent remover from reaching a lower layer. Always have the proper remover for the adhesives/sealers you're using and enough to finish all of your casualties.

Thickened Pros-Aide® can be moulded into appliances using silicone moulds but this technique is beyond the scope of this article. If you wish to find out more about this technique, I highly recommend the book "*Special Makeup Effects for Stage and Screen: Making and Applying Prosthetics"* by Todd Debreceni. The technique of moulding Pros-Aide® into appliances was pioneered by makeup artist Christien Tinsley while working on the Mel Gibson film *"The Passion of the Christ"* (2004). Mr. Tinsley won an Academy Award (2007) in Technical Achievement *". . . for the creation of the transfer techniques for creating and applying 2D and 3D makeup known as "Tinsley Transfers.""* (preceding quote from http://www.oscars.org/). moulded Pros-Aide® appliances (forehead and under the eyes) were used to age actor Brad Pitt in the 2008 film *"The Curious Case of Benjamin Button".* Makeup artist Greg Cannom won an Academy Award, Achievement in Makeup, for his work on *Benjamin Button*.

3.6 Paints

Paints are used in casualty simulation to colour skin and appliances. Paints may contain:

- pigment/dye – gives the paint its colour. A pigment is a finely divided material which is insoluble in the vehicle used in the paint. A dye is a colourant which is soluble in the vehicle.
- vehicle or binder – the substance or body of the paint that binds the pigment or is coloured by the dye. Examples: gum arabic (watercolours, gouache), linseed oil (oil paint), acrylic, wax (encaustic).
- solvent – the liquid used thin the paint. Examples: water (watercolours, gouache, acrylic), alcohol (alcohol activated paints), mineral spirits, turpentine (oil paints).
- additive/modifier – an additive/modifier changes the characteristics of the paint. Examples: thickeners, dryers (speeds drying), retarders (slows drying), opacifiers (make the paint opaque), matting agents (reduce surface shine)

Danger! The components listed above are only examples and are not necessarily safe for use on humans. Use only approved cosmetic products on people.

Many **professional** artist's paints contain materials which are harmful to humans if not handled properly. For example, Flake White oil paint is made with the pigment lead carbonate. Other paints may contain compounds of cobalt or cadmium. Read all labels carefully. Do not use these paints/pigments in makeup or appliances.

Many odd things have been used as pigments in artist's paint. Beginning in the 16th century, a pigment known as mummy was made from pulverized Egyptian mummies. In 1881, after learning what his paint was made from, Pre-Raphaelite artist Edward Burne-Jones gave his tube of mummy paint a solemn burial in his garden. (source: *The Mummy Congress* by Heather Pringle, Penguin Books, 2002).

Stippling is the application of a paint or ink with a quick up/down motion at right angles to the surface rather than a brushing motion across the surface. Foundations are usually applied in a stippling motion using a sponge. Scumbling is the application of a paint or ink to a surface in a broken, irregular pattern. In makeup, scumbling is often used to recreate the slightly irregular texture of human skin. A torn makeup sponge can be used for scumbling. A wash is a diluted or thinly applied layer of paint, usually translucent or transparent.

3.6.1 Alcohol Activated Paints

Alcohol activated paints and inks are durable, waterproof makeup products that use 99% isopropyl alcohol as a solvent. Available in both cake and liquid, these paints/inks are concentrated colours with high coverage intended for professional use. I've found that cake colours in a palette are the easiest to work with when using brushes and can be replenished by adding liquid paint (same make and colour) to the palette and allowing it to dry. Liquids are best for using for airbrush application.

Since you're using 99% alcohol to activate these paints you can work directly from the paint palette to the skin. It is convenient to keep a disposable, lint-free towel handy to wipe off your brushes with so you don't end up with muddy colours. Clean the brushes with 99% alcohol and artist's brush soap.

Some of the brushes I use with alcohol-activated paints are shown in the following photo. I've found that the 1/4" angle brush, 2nd from the left in the photo, is a good overall brush to use. The pointed tip of this brush is good for fine detail work and the flat portion can be used for broad work. A fan brush is good for blending and softening hard edges. Dip the brush in 99% alcohol, wipe quickly on a clean towel so the brush is just damp and brush over the area you want to soften. The fan is also used for applying thin washes of colour over large areas.

A quick way to blend appliances to the skin colour with alcohol activated paints is to use a stiff brush to splatter paint in a random pattern in the area you wish to blend. This technique is often referred to as the poor man's airbrush. Use a chip brush with the bristles cut short (1cm), as in the photo above, or a toothbrush. Load the brush with thinned paint and splatter by drawing a makeup spatula across the bristles. With a bit of practise you'll find this technique is fast and effective for blending. You can use this technique with very diluted paint for making age spots (brown paint) or blotchy, irritated skin (red paint).

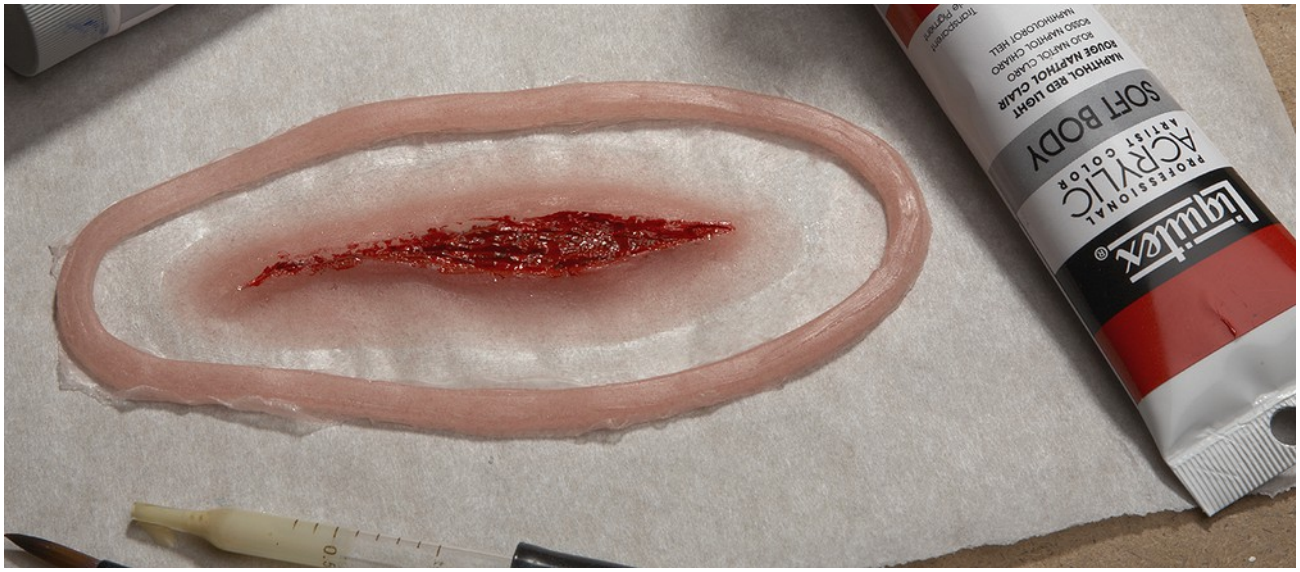
3.6.2 PAX Paint

PAX paint is a mixture of acrylic paint and Pros-Aide® in a 1:1 ratio. This paint is the standard paint used by makeup and special effects artists for painting appliances. PAX paint was originally developed by make-up artist Dick Smith; the name is from the components **P**ros-**A**ide® and Liquite**X**® paint. I use Liquitex® acrylic paints but other brands of acrylic paint can be used. PAX paint can be thinned with up to 25% water. If you need additional thinning for greater translucency add more Pros-Aide®. Use PAX ONLY for colouring appliances; DO NOT USE PAX DIRECTLY ON SKIN. For maximum durability allow PAX paints to cure for 3 days. A basic skin tone to start with is a mixture of 30 parts White, 10 parts Raw Sienna, 5 parts Burnt Umber and 2 parts Red Oxide. The amounts given are only approximate; you will need to adjust this to match your casualty's skin tone. This mix is a little bit reddish so you may want to use some blue or green as an adjuster to match olive skin tones. Darken basic mix this by adding more Raw Sienna and/or Burnt Umber. Parchment colour is a good starting point for bone and fascia. Subcutaneous fat can be coloured with a mix of Parchment and Yellow Oxide; remember that subcutaneous fat becomes more yellowish with increasing age. Naphthol Red Light is a good match for bright arterial blood, mix with Red Oxide for a darker scab congealed blood colour for wound edges.

I usually use a Cobalt Blue Hue in the deepest areas of the wound and under torn and avulsed skin to enhance the depth and to provide contrast and detail. Some sources say to use pure black to paint the deeper parts of the wound but I recommend against using black as black paint flattens the wound instead of making it

appear truly three dimensional. Experienced fine art painters rarely use pure black except as a key in small areas. If you look at the work of Rembrandt and Jean Siméon Chardin you'll notice the shadows are dark, not black, and contain detail even in the deep shadows. By colouring the wound slightly lighter than pure black you'll make it appear realistic. Vary the shading to add depth and detail; use the darkest, coolest blue at the deepest part of the wound and warm the blue with a touch of light red as you move toward the shallow areas. Highlight the upper parts of a bloody wound with small amounts of bright red mixed with deep yellow. Add transparent washes of your blood colours over the blue underpainting; the blue modulates the red.

The image is a gelatin appliance in the process of being painted with PAX paint. It is on silicone parchment and the gelatin is intrinsically coloured with flocking.



3.7 Flesh Effects Gel

Flesh Effects Gel is a gelatin-based product made by Ben Nye®; similar products are available from other manufacturers. Scar Effects Gel is a similar product only with colouring added to simulate flesh colour. Heat the container in a cup of hot water until it turns to a thick liquid. You can use a metal makeup spatula and wooden sculpting tools to shape the gel before it sets. Use this product to create small effects like lacerations, bullet and fragment wounds, blisters, pustules and lesions. Be sure you test the gel BEFORE you apply it to the casualty to make absolutely sure it is not too hot. For more durability apply Pros-Aide® to the skin before applying the effects gel and seal the finished effect with another thin layer of Pros-Aide® before colouring.

You can also make your own effects gel using the following formula. It can be adjusted to the materials you're using and to your personal preference.

- 14g Gelatin (food grade, 2 × 7g packets)
- 10mL Liquid foundation (dollar store, 20mL for $1)
- 30mL Glycerin
- 10mL Water

Mix components in a microwavable container. Heat in the microwave on high for 9 seconds and stir. Repeat until the gelatin is dissolved. Pour into individual containers and allow to set. Use the same way as the commercially made product.

You can make a clear effects gel by substituting 5mL of water for the liquid foundation (14g gelatin + 30mL glycerin + 15mL water). Mix and heat as described. You can add a *small* amount of red flocking (an inert coloured textile fibre) to this mixture to mimic capillaries. For more about flocking see the section "Making Gelatin Appliances."

3.8 Rigid Collodion

For small hits use Kryolan® Rigid Collodion, a solution of pyroxylin in ether and alcohol. This product dries quickly and you must work directly from the bottle. The alcohol in the solution will prevent cross contamination. You can also apply a thin layer of Pros-Aide® to the skin before applying the Rigid Collodion to help protect the skin. Stretch the skin with your fingers and apply a thin layer of collodion solution in the shape of the hit, usually a jagged shape. Allow to dry (usually about a minute) then quickly apply another thin layer over the top of the first and allow it to dry also. As the collodion solution dries, it contracts, pulls the skin and dimples the wound slightly for a dimensional effect. The photo shows collodion used to create a split lip. The bottom of the split was coloured with blue alcohol-activated paint to give depth and a small amount of thick blood applied.

Using collodion solution on the skin repeatedly in the same place can cause irritation. If you're using the same person as a casualty for several scenarios, use different areas for the hits to avoid skin irritation. The collodion solution tends to work best on the face, arms and legs. It doesn't work as well on the abdomen. Do not use collodion near the eyes.

3.9 Blood Effects

Stage blood is often darker, transparent and stickier than real blood; the basic ingredients in many brands are corn syrup and colouring. Usually this is advantageous since it sticks to the wound, stays in place and the dark colour adds depth. Some products, often labelled mouth blood, may have flavouring added. For more realistic splatter effects add a bit of yellow food colouring to the blood and thin it slightly. I sometimes add a very small amount of cheap, water-based makeup foundation (from the dollar store) to give the blood a realistic translucency. You can modify stage blood by adding other products to it. K-Y® Jelly or a similar water-based lubricant (suggested by MedFX at The FX Lab) can be added to stage blood to make it more slimy (let the blood-jelly mix sit overnight to thicken); use glycerin for a less sticky consistency.

Iron tablets can be used to give a realistic odour to the blood as suggested by Jackie Langford in Moulage Recipes. Ferrous gluconate is often used as an iron supplement and a colouring for ripe olives (listed in FDA *Color Additives Approved for Use in Human Food Part 73, Subpart A: Color additives exempt from batch certification*, § 73.160) Use in flow blood only for intermittent contact with the skin. The iron tablets I purchased were inexpensive (100 for $6.00) and contained 300mg of ferrous gluconate. I soaked the tablet in hot water to remove the coloured film then ground the tablet with the bowl of a spoon in a small amount of water. One or two of these tablets for every 2 litres of flow blood gave a realistic smell to the blood.

Blood used in quantity, often to indicate the severity of a wound, is called flow blood. Flow blood should be thin enough to be easily forced through small diameter plastic tubing with a hand pump but should have a bit of opacity and stickiness so that it looks realistic. Concentrated blood for making flow blood is available from several sources; my own experience has been with Laerdal Concentrated blood. This product is useful when you need large quantities of blood for arterial bleeds and similar situations. It is simple to make your own flow blood quite cheaply in quantity. Formula for a flow blood that flows and dries approximately like human blood is given below.

- 18g salt (NaCl)
- 113g KY Jelly, regular, tube
- 600mg Ferrous Gluconate (2 tablets)
- FD & C #40 Red food colour, adjust the amount to the depth of colour you require
- water to make 2L
- blue food colouring, liquid. Use a few drops to adjust colour.

Begin with about 1.8L of warm water. Dissolve the salt in the water, then add the KY Jelly. Soak the ferrous gluconate tablets in a few millilitres of hot water to loosen the coating that most of these tablets have. Discard the coating and add the tablet to your main mix. Stir until all the components are dissolved. Mix the red food

colouring with a small amount of water then add to the mixture. Stir until uniform. Let this mixture sit for at least 4 hours before using. Add blue food colouring drop-by-drop to adjust the colour as needed. This recipe will give you a blood which can be easily poured. It can be thinned with water for spraying.

Another formula for flow blood is below. This formula is methylcellulose based which is the primary ingredient of most water-based lubricants.

- 1900mL of water
- 10g methylcellulose (Monster Makers)
- 100mL glycerin
- 20mL starch
- 10mL FD & C #40 red food colour powder (Monster Makers)
- blue food colour, liquid

Methylcellulose is a thickener and an emulsifier used in a variety of products including food. It is soluble in water, although the solubility decreases as the temperature of the water increases. To get an even mixture of methylcellulose without lumps a special method of preparation should be used.

Stir the methylcellulose powder into 600mL of hot water (90ºC). This will disperse the powder in the water but it will not dissolve. Now add, while stirring, 1200mL of cold water (0ºC to 5ºC). Continue stirring for several minutes. Add the glycerin and continue stirring. Mix the starch and the food colour with 100mL of cool water and add to the methylcellulose mixture. Stir until uniform. You should leave this solution for at least 8 hours so the methylcellulose has time to absorb the water. The colour can be adjusted by adding blue food colouring a drop at a time while stirring. As with the previous formula, this formula will give you a blood that can be easily poured and it can be thinned with water for spraying.

Thick blood, sometimes called blood paste, is a thick gel type of product which can be applied to wounds with a makeup spatula for dimensional effects. Old or scab blood is like thick blood but with a brownish tint. Specially formulated blood is available for use with silicone.

Alcohol activated paints in blood colours can be used to create durable “bleeds”. Paint the bleed on the skin with appropriate colours then add water-based lubricant to the area for dimensionality and shine. Give the casualty a packet of lubricant to renew the bleed as necessary.

If you're concerned about staining try mixing red flocking (short red rayon fibres used to colour appliances) with a water-based lubricant (KY Jelly) to make a non-staining fake blood. Adjust the colour with small amounts of blue or black flocking. This mixture was used in the movie “Water for Elephants” (2011) to make up the elephants (elephant skin stains easily). Add glycerin/water to modify the viscosity of this fake blood. Be careful with this blood around the eyes as the flocking can cause irritation if you get it into your eyes.

For a non-pyro (no squib) blood hit effect from a bullet or fragment, try this simple effect used by Tom Savini in the movie “Dawn of the Dead” (1978). Take a condom and make a cut in it. Tape the cut closed then fill with blood and attach to the actor. Run a fishing line from the tape. For the effect, tug sharply on the fishing line to tear off the tape and cause a blood splatter. (source: the Tom Savini interview in “*Fantastic Flesh: The Art of Make-Up EFX*” DVD, directed by Kevin Vanhook, Starz Entertainment LLC, 2008).

3.10 Sculpting Appliances and Making Moulds

A prosthetic appliance (usually just appliance) in makeup and special effects, is a prosthetic made from silicone, latex, gelatin, wax or other material which is attached to the skin. The appliance modifies the shape and texture of the actor's features.

To make appliances you'll need a mould. You can create your own moulds or purchase ready-to-use plastic moulds online. In most casualty simulation work you'll be using plate moulds (also called flat moulds) to create generic appliances that can be used on anyone. To make your own mould, lay a piece of clear plastic on a flat surface and tape down along the edges. I use Dura-Lar™ clear polyester 0.005" sheets to keep the surface of my moulds smooth; other brands of polyester sheeting should work just as well. Using a non-sulphur professional plasteline (I use clay by Chavant, a brand popular with many professionals), sculpt your wounds on this surface. Using a non-sulphur pasteline makes your moulds silicone friendly (sulphur inhibits curing of most silicones) giving you more options with respect to materials. You can smooth the plasteline with a soft brush dipped in mineral spirits. Purchase sculpting tools from an art store or make your own from wood and metal. If

you're new to sculpting, use items you have around the house as sculpting tools to help you decide on what types of tools you need. Tool selection and use varies considerably among artists. Silicone coated parchment paper, used in baking, can be used as a non-stick surface to roll and form parts of your sculpture on before you add them to your sculpture. Gently taper the edges of your sculpture to help with blending the appliance to the skin. For large appliances surround with an overflow for easier handling. Keep the moulds small for easy handling and quick production. The edges of the sculpture should be irregular for easy blending (straight edges stand out). Keep the appliance thin, 5mm or under, you can make the wound appear deeper by applying colour and shading later. A thin appliance uses less gelatin, is easier to shape to the body and is easier to blend. Since gelatin, latex and silicone are flexible you can make wounds that are *slightly* undercut. The photographs which follow show the original sculpture with overflow on the left and the finished Ultracal® mould on the right.

When you're finished, surround the wound sculptures with a cardboard or foamcore dam about 2cm high. Stick it to the Dura-Lar™ with a hot glue gun. Spray the sculpture with a *thin* coat of Krylon® Crystal Clear Acrylic spray to seal the sculpture. Let the Crystal Clear dry for 8 hours or longer then spray the sculpture with a *thin* coat of Krylon® Dulling spray to give the sculpture a bit of tooth so the plaster will stick and help prevent bubbles from forming. Allow the dulling spray to dry for at least one hour. Over use of these sprays can cause loss of detail in your final appliance since the spray solvents can soften the plasteline. These sprays are available at many art/craft stores. You may be able to substitute other products; others have reported success in using Pledge® spray instead of the dulling spray but I have not tried this yet.

For most of your moulds use Ultracal® 30 gypsum cement, a product developed specifically for making moulds. This material, if properly used, give you a mould which is much harder and more durable than one made from regular plaster.

Fill the mould with Ultracal® 30 gypsum cement. Mix the cement in a ratio of 38 parts cool water to 100 parts Ultracal® 30 *by weight*. You can measure the water by volume since 1mL (1mL ≈ 1cm^3) of water is about 1 gram. The ratio is 2.63g of dry cement for each 1mL of water; round up to the nearest 10g after calculating the amount of dry cement needed. The final volume of your cement mix will be roughly 2 times the volume of water you start with. Measure your box and calculate the volume required (height × width × depth).

Example: The inner measurements of my box are 24cm × 12cm × 2cm = 576cm^3 or 576mL. The volume of water required is half of this amount or 288mL. The dry cement required is 288 × 2.63 = 757.44g rounded up to 760g of dry Ultracal® 30 gypsum cement.

Mix the cement in a flexible plastic bowl. Add the dry cement to the water and mix thoroughly. Let stand for about 5 minutes so the cement can fully absorb the water then mix again. When mixing do not whip the mixture; whipping the mix will add air bubbles which you do not want. Do not wash leftover cement down the drain as it will settle in the trap, set and plug your drain. Let any leftover cement harden in the bowl, then flex the bowl to break it up and dispose of the cement pieces in the garbage.

Use a very soft brush (I use a 1" chip brush) to apply the first layer of cement mix to the sculptures; this helps prevent air pockets, then carefully pour in the remainder. Gently tap the mould to help remove any remaining air bubbles. As the cement sets it will become quite warm to the touch. Allow to fully set and cool, then peel off the

plastic and remove the plasteline carefully. You can use a soft brush and mineral spirits if needed to remove small bits of plasteline. Small defects can be filled in or carved away with a sharp knife. If you need to patch a small defect, carefully scrape the area, soak with water for several minutes then apply freshly mixed Ultracal® 30 as needed.

Let the mould dry for 3 or 4 days then warm the mould (no more than 49°C/120°F or you'll risk surface calcination of the mould). *For slip casting (slush moulding) latex or Water-Melon™, do not seal or release the mould*. If you're using gelatin, coat the mould with a release agent such as Mann Ease Release™ 2831 (a wax based release). You can use a *very light* coating of petroleum jelly as a release agent instead. Heat the mould gently (keep below 49°C/120°F) before using so the gelatin mixture will remain liquid for a little while and flow into all areas and pick up detail.

3.11 Latex

Liquid latex used in casualty simulation should always be the cosmetic grade. Store liquid latex at a temperature above 10°C (50°F); below this temperature the latex can freeze, congeal and become useless. Be careful when using liquid latex around the eyes since the ammonia used in the latex can irritate the eyes. Heath care workers are at risk for latex allergies (see the Latex Alert at http://www.cdc.gov/niosh/docs/97-135/); Water-Melon™ (by Michael Davy http://www.michaeldavy.com/) is a substitute for liquid latex. If you or any of the people you work with have latex allergies, you might consider using this product in place of latex.

Latex can be intrinsically coloured with cosmetic colours available from suppliers. It will also accept creme colours. Before using creme colours on latex you should seal the latex with a thin application of castor sealer. Castor sealer prevents the creme colours from penetrating the latex and changing colour. Use a small amount of castor sealer on a makeup sponge and gently daub it onto the latex surface. Apply the creme colour and set with powder.

You can also use a product called Rubber Mask Grease Paint (usually abbreviated to RMGP or just RMG) directly on unsealed latex. It works just like regular creme colour and is set with setting powder.

3.11.1 Latex Build Ups

Latex is often used with facial tissue and cotton balls to create scars and wounds directly on the skin. This method has the advantage of being quick, flexible in the type and style of effects created and cheap. Makeup artist Jack Pierce used latex build ups on actor Boris Karloff to create the famous Frankenstein monster for the 1931 Universal Pictures film.

When doing latex build ups, work slowly one layer at a time. If you use too much latex, it will take a long time to dry. It takes very little latex to make a convincing wound. Use PAX paints to colour the latex wound ONLY; do not use PAX directly on the skin. As previously mentioned, use castor sealer to seal the latex before blending with creme colours.

Zombie skins are not really build ups but are sort of free-form prosthetics you can create ahead of time for use in casualty simulation. These skins can be used for burns, amputations, avulsions and skin conditions. The name comes from the use of these skins in some of the zombie movies from the early 1970s to quickly makeup the actors.

Use a makeup sponge to daub a thin layer of liquid latex on piece of clean glass. Let dry; you can speed up the process by using a hair dryer. Make small holes in the dried latex sheet by scraping the surface with a tongue depressor. Apply a second thin layer of liquid latex on top of the first.

Try to keep the edges of the latex thinner than the center. Build up a thin skin, peel from the glass, and powder with cornstarch baby powder. These skins can be stored. Before use, pull the latex skin with your fingers to create rents. You can also use scissors to make larger openings in the latex skin. To use, clean the skin with alcohol and and apply to the skin with Pros-Aide®.

If you are making Zombie Skin with Water-Melon™ (by Michael Davy http://www.michaeldavy.com/) use the same process as for the latex above.

3.11.2 Slip Casting Latex

Slip casting is a term borrowed from the pottery industry. It is the use of a plaster mould to absorb water from a liquid medium, usually a clay slurry, leaving a layer of solid material on the inside of the mold. The technique is used to mass produce ceramic items but the process can work equally well with liquid latex. Thick liquid latex, sold as mask latex, is poured into the plaster mould. The plaster absorbs water and forms a latex layer on the inside of the mould. Excess latex is poured out, the layer allowed to dry and then stripped out. This method of producing prosthetic appliances is low cost and with care each mould can be used many times. Slip casting latex is sometimes called slush casting.

Sculpt items to be slip cast in professional grade plasticine. Create a negative stone (gypsum) mould from the sculpture. I often use the Ultracal® 30 out of convenience but a better choice is USG No. 1 Pottery Plaster. Pottery Plaster has a greater absorption capacity than Ultracal® 30, speeds up the casting process and is cheaper. The ratios of Pottery Plaster are different from Ultracal® 30. Use 1.43g of Pottery Plaster per 1.0mL of water. To calculate the proper volume of water required multiply the volume of the mould by 0.80.

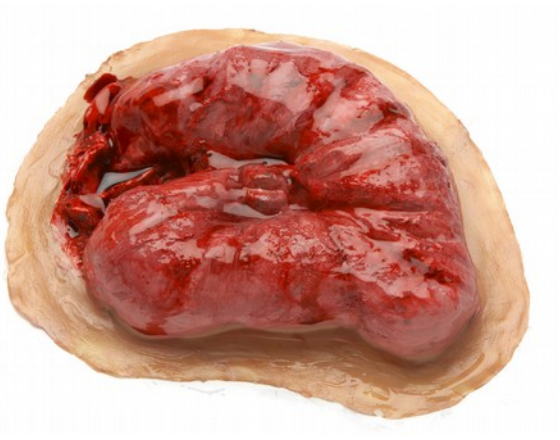
Example:
If your mould is to be 20cm × 20cm × 2.5cm deep = 1000cm3 or a total volume of 1000mL. The amount of water required for this volume will be 1000mL × 0.80 = 800mL and the amount of USG No. 1 Pottery Plaster required will be 800 × 1.43 = 1144g.

Follow the directions for mixing Pottery Plaster (see the MSDS and technical bulletin) and be aware that Pottery Plaster sets faster than Ultracal® 30. The photo shows finished latex appliances before painting.

Dry the mould thoroughly. **DO NOT RELEASE THE MOULD**. Make the appliance by slush moulding liquid latex. An alternative to latex is Water-Melon™; see the directions at the end of this section if slush moulding with this product. This process is similar to slip casting in clay. Take the dry mould and spray it lightly with clean water. This helps to reduce air bubbles in the casting by replacing air near the surface of the mould with water.

Set the mould on a level surface and fill with liquid latex. You can use either regular cosmetic liquid latex or the thicker mask latex. Mask latex sets faster than the cosmetic latex but due to the thickness it may be a problem to get fine detail in appliances which have deep parts. Use a wooden toothpick to carefully break up bubbles in the latex and move latex into the detailed parts of the mould. Allow the latex to sit for 15 to 30 minutes, you'll need to experiment to determine exact times, then pour it out. The mould will have absorbed some of the water, resulting in a latex coating on the sides of the mould. Let the latex dry, powder the interior with talc to prevent sticking and remove from the mould. If portions of the latex appliance are too thin, reinforce on the inside with a piece of gauze dipped in liquid latex. Paint the appliance with PAX paint. Add fine blood vessels as needed by dipping coloured thread or yarn in clear acrylic gel medium and applying to the surface.

The following image, left, shows a sculpt of an evisceration in NSP clay. It has been sprayed with Crystal Clear and Dulling spray. This sculpt was molded using Ultracal® 30. At the right is the finished latex evisceration appliance; in use the brown edge of the latex is coloured to match the skin of the casualty.



You can use Water-Melon™ (by Michael Davy http://www.michaeldavy.com/) instead of latex for slip casting. When using Water-Melon™ thinly coat the inside of the mould using a brush and allow to dry. Once dry add another layer of Water-Melon™ and repeat the process until you've built up enough layers that the prosthetic can maintain its shape. To apply the Water-Melon™ prosthetic, activate the base by applying a small amount of 99% isopropyl alcohol and press on the skin. When set blend the edges using a synthetic brush and 99% alcohol.

3.11.3 Applying Latex Appliances

To use, clean the skin with witch hazel and apply Telesis™ Top Guard® Skin Barrier to help protect against skin irritation from latex sensitivity. Attach the appliance to the casualty with Pros-Aide®. Blend the flashing to the casualty's skin colour with Rubber Mask Grease Paint (usually abbreviated RMGP) or PAX paint (use PAX paint only on the latex, never on the skin). RMGP contains a castor sealer to prevent the paint from changing colour when applied to the latex. Set the creme makeup or RMGP with powder. You can also seal the latex with castor sealer and use creme-based makeup. Use a water-based lubricant or stage blood to give the appliance a wet look. With care these appliances can be used several times.

The photo shows latex appliances available from commercial suppliers. These appliances represent lacerations and bullet wounds.

If you are using Water-Melon™ instead of latex you can adhere the appliance to the skin by reactivating the Water-Melon™ with 99% isopropyl alcohol. Adhesive is not required. Blend the edges of the appliance with 99% alcohol and a synthetic brush.

3.12 Wax

You'll often find a flesh coloured wax in casualty simulation kits. Although the wax (sometimes called nose & scar wax) is easy to shape and apply to the casualty, it does have shortcomings. Water-based colours will not stick to the wax. In cold climates, the wax becomes brittle and will fall off. It is difficult to apply to areas of the body that flex. The wax also deforms if a pressure bandage is applied over the wound, something which is common in casualty simulation. In most cases, I avoid using wax except for small effects over bony areas. It is good for creating deformations in limbs resulting from closed fractures. The image shows a simulated open fracture from a gunshot wound created with wax and latex. The entrance wound (left) and exit wound (right) were made first using skin safe silicone and alcohol-activated paints.

Wax can be made more durable by an application of Pros-Aide® or spirit gum on the skin before you apply the wax. Daub a cotton ball into the adhesive so the cotton fibres stick to the area. I keep a few cotton balls (absorbent puffs) in my kit to add fibres to Pros-Aide® to aid in the adhesion of wax. This provides additional grab for the wax to hold. Coating the wax with liquid latex improves the durability as well as the ability to accept certain kinds of makeup. Use a makeup sponge to apply a couple of thin layers of latex then seal with a castor sealer when dry, prior to applying any makeup. The sealer prevents the latex from absorbing the makeup and affecting the colour.

Wax can be modified in different ways. To make the wax softer and stickier, work petroleum jelly into it. Colour wax by kneading in coloured flocking.

3.13 Prosthetic Gelatin

In special effects makeup, a prosthetic appliance is a piece of shaped material applied to the face or body with adhesive. Various materials including wax, latex and silicone have been used to create appliances for the stage, television and motion picture. Gelatin is gaining in popularity since it is low cost, easy to work with, well tolerated by most individuals, flexible, tough, translucent and holds fine detail. Using gelatin instead of latex in casualty simulations may help reduce allergy risk. Gelatin appliance mix can be purchased ready to mould from special effects suppliers or you can make it yourself.

3.13.1 Making Gelatin Appliances

The gelatin used in makeup appliances is a high Bloom (usually 250-300 Bloom) type used specifically for make-up and available from special effects suppliers. Bloom is the measure of the rigidity or toughness of the gelatin; the higher the Bloom, the tougher the gelatin. The 70% (by weight) sorbitol solution is usually available from the same source as the gelatin. Both the glycerin and the sorbitol are plasticizers which increase the flexibility of the gelatin appliance. Sorbitol adds toughness to the finished appliance and also acts as an indirect plasticizer by incorporating water into the gel. I add a small amount of water and use slightly less sorbitol than other formulations to improve the blending and flexibility of the appliance. Glycerin interacts directly with the gelatin as a plasticizer and does not need additional water. You can purchase glycerin from your local pharmacy. The ingredients you use may vary in quality and consistency from source to source and even from batch to batch. You may have to make slight adjustments to the following formula.

- Gelatin (250-300 Bloom) 20g
- Glycerin 45mL
- Sorbitol 70% solution 40mL
- Water 5mL

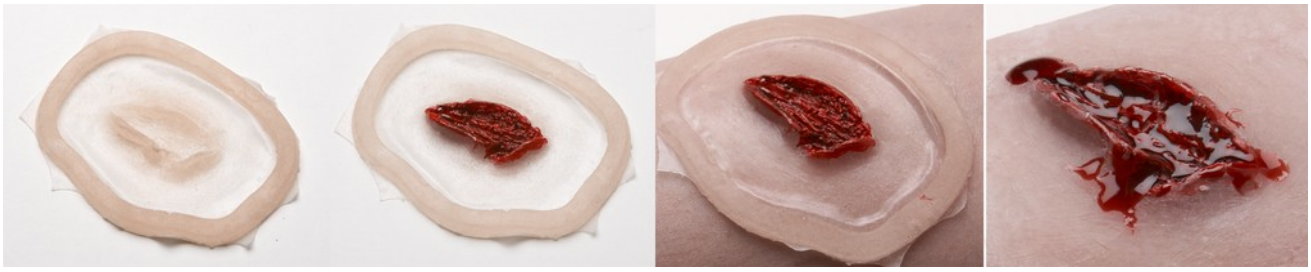
Mix the above ingredients thoroughly in a microwavable container. Allow the mix to sit for one hour. Place in the microwave and heat for 9 seconds on high. Stir. Repeat until the mixture is heated through and the gelatin is dissolved. You should not see any granules of gelatin in the mix when it is fully dissolved. DO NOT allow the mixture to boil. You can now stir in flocking in red and/or flesh colour if desired. Flocking is short pieces of thread, see photo. It mimics the tiny capillaries in the skin and gives the appliance a realistic colour. Use flocking to approximate the skin colour and reduce the amount of time you spend in blending the colour to match the casualty's skin tone. Flocking incorporated into a translucent or transparent medium like gelatin is called intrinsic colouring because the colour is distributed throughout the medium

rather than just painted on the surface. You don't need very much flocking; too much flocking will make it difficult to obtain a smooth surface. **Note:** Any colouring you use in the appliance should be approved for cosmetic use. Let the mixture set, peel out of the container and store in a sealed plastic bag in a refrigerator until you need it.

To make an appliance, place the gelatin mix in a microwavable container. Heat for 9 seconds on high. Stir. Repeat until the gelatin is liquid. DO NOT allow the mixture to boil. Carefully pour the mixture into a mould and scrap the top flat with a tongue depressor or plastic scraper. Don't use a metal scraper; I've found that metal conducts heat away from the gelatin mixture quickly causing a build-up on the metal and an uneven flashing on the appliance. Allow the gelatin to cool, then strip the appliance out of the mould. Powder with cornstarch baby powder and store in a plastic bag in the refrigerator if the appliance will not be used immediately.

3.13.2 Applying Gelatin Appliances

To apply a gelatin appliance, clean the appliance with 99% alcohol or with acetone (ensure proper ventilation) to remove powder and grease/release from the surface. Coat the flat side (to be adhered to the skin) with two light coats of Kryolan® sealer or Green Marble SeLr™ allowing each coat to dry. The application of the sealer protects the gelatin appliance from perspiration. You can paint the wound with PAX paint, see section on PAX for details. Do not paint the rest of the appliance; you'll need to leave the gelatin edges unsealed and unpainted so you can blend it during application. To adhere to the skin, coat the flat side which has been sealed, with Pros-Aide® and allow to dry until tacky. You don't need a thick layer of Pros-Aide®, a thin layer dries quickly and is easier to blend. Clean the skin with witch hazel then apply Telesis™ Top Guard® Skin Barrier to the skin. Place the appliance on the skin and gently press into place. If you're using a large appliance, leave on the overflow (thick) edge to help in handling and keep the flashing from flopping around and sticking to itself. Use a soft brush or sponge dipped in warm (40° C) witch hazel to blend (dissolve/melt) the edges of the appliance into the skin. Pull off the overflow as you blend. Now you can paint the entire appliance with a thin layer of plain, uncoloured Pros-Aide®. Extend this coating of Pros-Aide® onto the surrounding skin and allow to dry. Blend to the skin colour with thin washes of alcohol activated colour; you can spray with Green Marble SeLr™ to keep the alcohol from affecting the Pros-Aide® layer. Use a makeup sponge roughly torn in half to stipple the diluted colour on the appliance and skin. Splattering the appliance with alcohol activated paints is another quick way to blend. You can also use creme colours to blend the appliance to the skin. Fix with neutral set powder if desired.



The photos show a small gelatin appliance. At the far left is the powdered appliance after removal from the mould. The next image is the appliance after cleaning with alcohol and painting with PAX paints. The third image is the appliance being applied to the skin (you can see the transparency of the gelatin and how the closely the intrinsic colouring matches the skin colour). The far right is the appliance after blending with witch hazel and a small amount of stage blood applied. No colour was applied to blend to the skin, only neutral set powder was used to reduce the tack of the Pros-Aide®. You can use makeup sealer to reduce the tack of the Pros-Aide®.

3.14 Silicone for Special Effects Makeup

Silicone is often used in special effects for television and motion picture. It is available in a variety of densities, is hypoallergenic, skin safe, clear, is not affected by moisture or heat and can be intrinsically coloured. Silicone can be cast in moulds or modelled directly on the skin. There are, however, some technical points which should be understood before you work with silicone.

The hardness/softness of silicone is indicated by the shore scale. Shore hardness is given in one of twelve scales (A, B, C, D, DO, E, M, O, OO, OOO, OOO-S, R), with a value between 0 and 100; the higher the number the harder the material. For the most commonly used types of silicone the A and the OO scales are used. The scales overlap but the A is used for harder materials (mould making silicones). A rubber band has a shore

hardness of 30 on the A scale, chewing gum a shore hardness of 20 on the OO scale (much softer). The shore scale is most often used with silicones intended for mould making and casting.

Silicone changes from a liquid/gel to a solid by curing. The type of silicone used in special effects makeup is often referred to as Room Temperature Vulcanization (RTV) since it cures at room temperature without the application of heat. Single component RTV silicone, used in products such as caulking, cures when in contact with water (either liquid or vapour). Single component RTVs liberate acetic acid during curing, may take from 7-10 days to fully cure and should not be used directly on the skin. Two-part tin cured silicones release water and alcohol during curing and should not be used directly on the skin. Skin safe silicones are usually two-part platinum cured types. Platinum cured silicones can be heat accelerated and will fully cure in a matter of minutes. Always check with the product manufacturer beforehand to be sure that the product you have selected can be safely used for your application.

Pot life is the amount of time you have to mix and apply the silicone. Total cure time is the time it takes for the silicone to fully cure. Cure time may be affected by factors such as temperature and how thick a layer of silicone is applied. This is especially true of single component RTVs and tin cured silicones.

Materials containing sulphides or amine in contact with the silicone may inhibit proper curing (these compounds bind to the platinum catalyst and inhibit it). Don't use latex sponges or gloves when handling silicone and, if you're making clay originals, use non-sulphur clays like Chavant NSP. Materials suspected of containing sulphur can be sealed with a thin coat of Krylon® Crystal Clear prior to moulding.

As mentioned, some silicones can be applied directly to the skin to create wounds and other effects. Before you apply silicone to the skin make sure that it is skin safe and follow the manufacturer's instructions. I've had experience with two silicone products that can be used on the skin; 3rd Degree by Alcone and Skin Tite™ by Smooth-On.

Intrinsic colour can be added to silicone by adding flocking (fine coloured fibres) or with a suitable silicone pigment. The image is a close-up view of red flocking suspended in a translucent silicone appliance. You can also add ***very tiny*** amounts of Silc Pig® silicone colour pigments to colour the appliance. Begin with the amount of Silc Pig® silicone pigment that covers the tip of a toothpick, see photo.

3rd Degree is a two-part (A and B) platinum cure silicone that comes in a thick gel. It is easy to mix (you can eyeball the amounts of gel) in a 1:1 ratio, has a pot life of approximately 3 minutes and a cure time of 5 minutes. It takes alcohol based paints such as Skin Illustrator®. You can add a small amount of flocking while mixing for intrinsic colouring. When using 3rd Degree use separate tools to scoop out A and B gels; if you don't, cross-contamination between the two parts will make small lumps of silicone in your mix. Likewise, keep the lids labelled and on the proper containers. I have been able to use 3rd Degree with a dry latex “skin” for texture in wounds without any apparent problems (see previous caution regarding latex and silicone). If you wish to try this, experiment with small amount of latex “skin” and 3rd Degree to verify that this will work with your materials.

Skin Tite™ is a two-part (A and B) platinum cure silicone which is somewhat thinner than 3rd Degree. It is mixed by volume in a 1:1 ratio. You should measure it accurately according to the manufacturer's directions. Pot life is slightly longer than 3rd Degree, about 4 minutes, and the cure time is about 6 minutes. One of the things I like about Skin Tite™ is the ability to control the thickness/viscosity of the product by adding a thixotropic agent (Thi-Vex™). Thi-Vex™ is added to Part A in amounts between 0.5% and 2% of Part A; the more Thi-Vex™ you use the thicker the mix. Use a regular 1ml syringe or an insulin syringe to measure tiny amounts; the marking on the insulin syringe are usually in “units” of insulin (U-100 insulin). 1 unit of insulin is 1/100th of 1mL, 100 units = 1mL, 1 unit = 1% of 1mL. Don't use too much Thi-Vex™, as it is oily and the excess will migrate to the surface of the silicone and keep paints from adhering. Intrinsic colouring, such as flocking, can be added after mixing both parts. Like

3rd Degree silicone, Skin Tite™ works well with alcohol based paints. Skin Tite™ can also be cast in a mould to create appliances although Dragon Skin Pro FX is probably a better choice for casting. Skin Tite™ can also used as an adhesive to adhere silicone appliances to the skin. Label the lids of Skin Tite™ containers to prevent mix-ups and cross contamination. You can clean up mixing utensils containing unmixed parts A and B and Thi-Vex™ using mineral spirits.

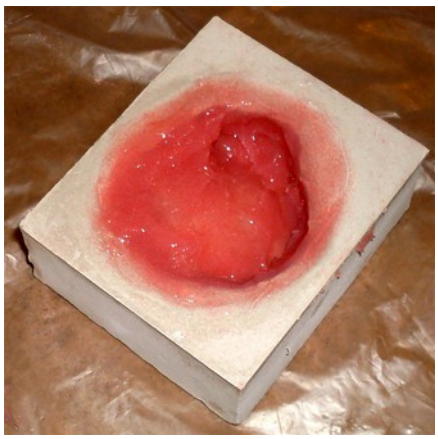
Both of the above products can be smoothed and blended with a brush, wooden stick or urethane makeup sponge and 99% isopropyl alcohol prior to curing. Remove by peeling off the skin; use baby oil or isopropyl alcohol as needed to help remove the appliance.

3.14.1 Casting Silicone Appliances

In many ways casting appliances in silicone is simpler than casting in gelatin. You do have to pay attention when measuring out the components but all steps in the casting are done at room temperature, unlike gelatin, no heating is required. I use Dragon Skin Pro FX by Smooth-On but there are several other similar products available from other manufacturers. Whichever product you choose, be sure that it is safe for the skin and follow the directions.

Make the mould from Ultracal 30 just like you would for a gelatin appliance but be very careful that no sulphur containing substances come in contact with your original sculpt or your mould. Seal/release the mould with Mann Ease Release™ 2831. I like to heat the mould so the release penetrates the stone and leaves a smooth surface. Allow the mould to cool to room temperature before casting. If you use a warm mould it will accelerate the curing of the silicone and the silicone may not flow into some of the detailed areas of the mould.

Mix your A and B parts of the silicone. In the case of Dragon Skin Pro FX use a 1:1 ratio by volume. After mixing thoroughly add Smooth-On Slacker, a silicone deadener which makes the appliance a bit softer and less rubbery, more like real flesh, and flocking or pigment to intrinsically colour the appliance. An amount of 20% to 50% Slacker by volume of your A/B mix seems to work well. Mix these additional components thoroughly with your A/B mix. Pour into your mould. Use a toothpick to remove large air bubbles and help the silicone flow into all areas of the mould. Scrape the top of the mould with a straightedge or the side of a tongue depressor to remove excess silicone and create thin blending edges. Allow the silicone to cure. Powder the back of the appliance with talc and then strip the appliance out of the mould. Powder the front of the appliance with talc. The talc keeps the thin edges of the appliance from sticking together. You only need to treat the mould once with the release since not very much transfers to the silicone. You can paint the finished appliances with alcohol activated paints. Store the finished appliances on a flat surface so they won't become misshapen or distorted.



3.14.2 Brush Up Silicone Appliances

The brush up technique is used to make large, hollow appliances by brushing thickened silicone on the inside of the mold. Appliances made this way are lighter in weight and use less material than would a solid silicone appliance. I use Dragon Skin Pro FX silicone by Smooth-On thickened with Thi-Vex™ to give me a uniform layer inside the mold. Make your sculpt from professional grade plasteline and cast in Ultracal® 30. **Release the mold. Please note that you <u>cannot</u> use molds previously used for casting latex since the sulphur from the latex will inhibit the curing of the silicone.** Colour the silicone with flocking or silicone pigments. Put the thickened silicone in the mold and use a tongue depressor or chip brush to coat the inside of the mold in an even thickness with the silicone. You may need to force the thickened silicone into some of the detailed areas. Use a tongue depressor dipped in 99% alcohol to scrape the top of the mold so the base of the silicone appliance will be flat and have a nice blending edge. The image to the right shows the mold coated with thickened silicone and the top scraped flat.

Paint your silicone appliance with a suitable paint. Adhere to clean skin with Skin-Tite™ or other skin safe silicone adhesive. Blend the edges to skin colour with Skin Illustrator® alcohol-activated paints. The image to the right shows the powdered silicone appliance removed from the mold prior to painting. Note the blending edge.

3.14.3 Applying Silicone Appliances

To apply the silicone prosthetic mix a small amount of Skin Tite™ but don't add any Thi-Vex™. Wipe off the talc from the back of the appliance with a pad dampened with 99% alcohol. Apply the Skin Tite™ to the skin then press the prosthetic into place. Smooth down and blend the edges with a tongue depressor dipped in 99% alcohol. After the Skin Tite™ has cured, wipe the appliance with a pad dampened with 99% alcohol. Blend with alcohol activated paints as necessary.

The slickness of the silicone may create problems with causing blood and makeup to adhere properly. Use thick blood on the silicone wound as a base for stage blood. You can apply a water-based lubricant to give water based blood something to cling to. A small amount of skin safe liquid hand soap applied to the silicone surface will help fake blood to stick. In some cases, alcohol activated paints will lift off when dampened with stage blood and then topped with a pressure dressing. If you anticipate rough treatment try stippling a thin layer of Skin Tite™ over the painted wound to help seal in your paint. You can use creme makeup of the appropriate colour to blend the silicone to the casualty or for additional effects such as bruising.

3.15 Other Materials

Glycerin is a hygroscopic liquid used to keep some effects such as thick blood wet looking. Mixed with water in a 1:1 ratio, it can be sprayed on the skin as a non-drying perspiration. Add a one or two drops of green food colouring per 100mL to make the glycerin/water perspiration stand out against the skin. In some situations a water-based lubricant such as Muko® can be used instead of glycerin. These water-based lubricants have a higher viscosity than the glycerin/water mixture and are less inclined to be absorbed by makeup.

Some casualty simulators have raised concerns about glycerin and the eyes. While it is true that glycerin in the eyes will cause stinging, pharmaceutical grade glycerin (USP) is a very safe substance. Glycerin is a component of many ophthalmic solutions including artificial tears. “Other than painful stinging, adverse effects to topically applied glycerin are rare.” (preceding quote from Duvall B, Kershner RM, *Ophthalmic Medications and Pharmacology,* Chapter 5: Use of Ocular Lubricants, Cyclosporine, and Osmotics, Slack Books, 2006, page 42) and “The separate use of both glycerol and sodium hyaluronate in the artificial tear preparations is known for a long time, and was shown to be safe.” (preceding quote from Kiss HJ, Németh J (2015) Isotonic Glycerol and Sodium Hyaluronate Containing Artificial Tear Decreases Conjunctivochalasis after One and Three Months: A Self-Controlled, Unmasked Study. PLoS ONE 10(7): e0132656. doi:10.1371/journal.pone.0132656) Glycerin is also a component of skin preparations intended for the face and body. In Canada, manufacturers using glycerin in oral and leave-on products are required to ensure that the glycerin is within the specifications of the accepted pharmacopoeia with respect to diethylene glycol (DEG) impurities. The glycerin you use in cosmetic applications should be USP glycerin. In the U.S. the Food and Drug Administration (FDA) classifies glycerin as generally recognized as safe (GRAS). If a solution containing glycerin does come into contact with the eyes, rinse the eyes with clean water.

Temporary tattoo transfer paper has many applications in simulation. Tattoos can be used to quickly create wounds or as a part of character makeup. You can make the tattoo using an imaging program to take a tattoo design and fade it a bit by reducing saturation, lighten the image and shift the colour to a greenish or bluish tinge. Use the imaging program to create a mirror image by flipping the image horizontally. Print out using a laser printer on a tattoo transfer sheet. Cut out the individual tattoo designs leaving a narrow border around each design. To apply stipple on a thin layer of Pros-Aide to the image. This layer will stick the image to the skin and will act as a barrier, isolating the toner image from the skin. When the Pros-Aide is dry, clean the skin where you want to apply and rub the tattoo, image side down onto the clean, dry skin. When the tattoo is fully adhered to the skin, release from the sheet by covering the back of the tattoo transfer sheet with a warm, wet washcloth. The water will penetrate the transfer sheet and soften the transfer layer releasing the sheet. Carefully peel off the sheet. Allow the transfer to dry for a couple of minutes then powder lightly with neutral setting powder. Carefully remove any excess setting powder with a soft fan brush. Any rippled edges can be carefully melted away with a soft brush loaded with 99% isopropyl alcohol. Small defects in the design can be fixed with alcohol-activated paints of the proper colour. To finish, spray lightly with a matte makeup sealer.

Temporary tattoos can also be used for minor wounds, especially when you have many to do in a short time span and all the wounds must look the same (think tests and competitions). Print out the wounds, prepare ahead of time and stick face down on silicone parchment paper (this paper will release from the Pros-Aide). Apply the temporary tattoo, seal with makeup sealer, and give the wounds a three-dimensional effect by applying drying paste blood with a makeup spatula.

3.16 Props

MedicAlert® bracelets are worn to indicate medical conditions which the casualty may be unable to tell medical personnel about in an emergency. Although official MedicAlert® bracelets are expensive for casualty simulation, you can make affordable substitutes with jewelry chain and jewelry findings available from a wide variety of suppliers. If you chose to do this, please respect the MedicAlert® emblem and do not use it on any faux bracelets. Information concerning medical conditions can be added to your jewelry with clear labels.

Concrete is one of the most commonly used construction materials in the world. Approximately 12 billion tonnes of concrete were used worldwide in 2012. (source: *Can Concrete Be Bendable?* by Victor C. Li, American Scientist, Volume 100, November-December 2012, pp. 484-493) Casualties are often injured or trapped by concrete chunks and wood. A slab of concrete falling from a 17 story building killed a woman in Montreal in 2009. Shoddy construction and an earthquake left thousands trapped under rubble in Haiti in January 2010. A worker in Toronto died after a concrete slab fell on him during sewer construction. Photos of real concrete structures are shown on the right. You can see the aggregate and rusting reinforcing bars (rebar) in the far right photo of a crumbling support pillar. Since concrete is such a common material, it is worth taking time to learn how to simulate it.

For obvious reasons you should never use pieces of real concrete in your scenarios. Instead you can easily make lightweight fake concrete chunks. In the movie industry, the props department uses expanded polystyrene to create realistic looking concrete chunks. These concrete props are lightweight; I've seen a person on a movie set easily pick up and carry a concrete prop the size of a small car. The photo shows finished polystyrene "concrete" pieces.

You can use the expanded polystyrene which is used to pack furniture and appliances. Use white glue (polyvinyl acetate) to make bigger pieces from smaller pieces. Apply a thin layer of glue and hold the pieces together with weights for an hour.

Use a drywall spatula to coat the polystyrene pieces with a mix of three parts ready-mixed Drywall Compound with one part white glue. This will cover the foam texture and make the pieces look a bit more like concrete. The glue makes the drywall compound flexible and helps it to stick to the polystyrene. Don't try to make the surface perfectly smooth, a bit of roughness looks more realistic. Let dry the pieces dry. Break or pick off edges and ends where you want crumbled parts on your concrete pieces.

Paint the pieces using non-toxic acrylic paint. Start with artist's acrylic gesso and tint two small batches slightly different light colours: a grey and a grey-brown with acrylic paints. Using a damp cellulose sponge, paint

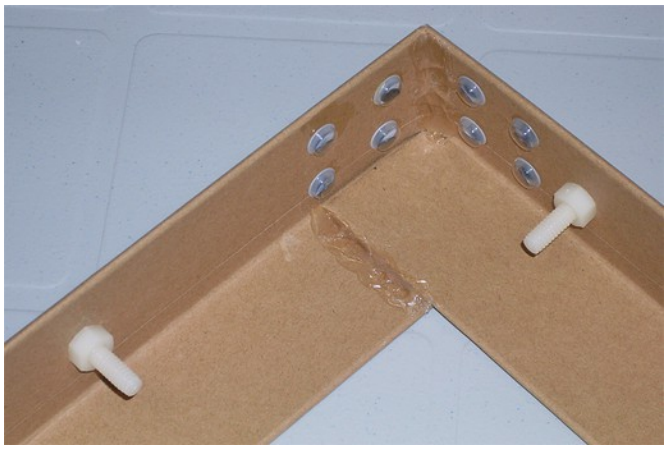
the pieces by stippling. Alternate the two colours. If you wish you can use dark acrylic greys and browns and a brush to add "aggregate" in the crumbled areas.

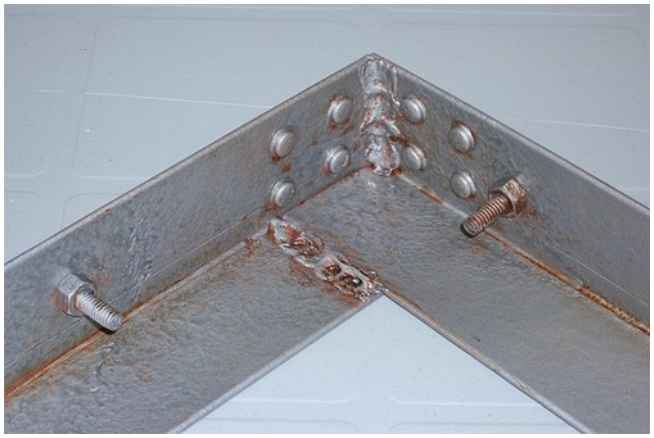
Expanded polystyrene comes in different cell sizes, the finest cell size is the type intended for home insulation. The smaller the cell size the greater the density of the material.

You can use some types of fast drying spray paints to melt the polystyrene and give interesting weathered effects. It requires a bit of experimentation and you have to be careful not to use too much spray or you will end up with a sticky, dripping mess.

Metal pieces can be made from bristol board, corrugated fibreboard (cardboard) and foamcore of suitable size and thickness. See the before and after photos. Plastic "googly" eyes can be glued on the card to simulate rivets and then painted. Welds can be simulated with glue from a hot glue gun. Use nylon nuts and bolts instead of metal and round any sharp ends. Paint with metallic paint. Matte acrylic paint in a burnt sienna or similar colour can be added in appropriate areas such as rivets, welds and seams for a rust effect.

Wooden beams can be fabricated from corrugated fibreboard (cardboard) and tape. Cover with self-adhesive woodgrain shelf covering.





3.16.1 Fragments and Embedded Objects

Fragments may be from a conventional munition such as an artillery shell, grenade or land mine. Two examples are the notched wire inside the M-67 grenade which breaks into small diamond shaped pieces and the steel shot embedded in a plastic matrix in the M18A1 Claymore Antipersonnel Mine. Nails, bolts, scrap metal and just about anything else that can be easily obtained are also used in fragmentation devices, especially in the case of an improvised explosive device (IED). In addition to fragments from the device itself, materials surrounding the blast site such as glass, concrete, dirt, rocks and vegetation may be picked up and propelled by the blast.

A note about the use of the word "shrapnel" to describe fragments from an explosive device. Shrapnel is a specific type of fragment from a specific type of artillery shell invented by Major-General Henry Shrapnel in 1800. Shrapnel shells have not been in widespread use since 1915 and have been replaced by high explosive shells. (source: *Improper use of the term "shrapnel"*, Rich NM and Burris DG, Letters to the Editor, Journal of Trauma, 2006 Oct;61(4):1024). "Fragment" is a more accurate and descriptive term.

When creating a fragment for casualty simulation you should try to keep it as lightweight as possible since it will be glued to the skin. It must also be non-toxic and without sharp edges.

Small fragments can be created from expanded polystyrene cups and packaging materials. Break the expanded polystyrene into suitable sizes. Use a brush to fully coat each piece with silver acrylic paint; I use Liquitex® Heavy Body Iridescent Rich Silver. Allow to dry. This acrylic coat prevents spray paints from dissolving the expanded polystyrene.

Use spray paints in various colours to give the fragments an authentic look. Flat black gives a burned look; red iron oxide primers and camouflage green are good choices for fragments produced by military ordinance. Apply the spray paint lightly and randomly for the most convincing effect.

For larger pieces resembling parts of military hardware use plastic poly plumbing connectors and nylon nuts and bolts, see your local big box building store for a selection. Cut into interesting shapes with a hacksaw. Sand any rough edges with 220 grit wet/dry sandpaper. You can use a propane torch, outside, away from combustible materials; be careful of hot melted plastic, to create realistic melted and distorted edges. Paint with spray paints, including aluminum for a metallic look.

To create natural materials such as small rocks, model from a lightweight synthetic modelling material; I've used Jovi PatWood® wood clay. Colour with matte acrylic paints in natural brown or grey shades, try Burnt Umber and Raw Sienna). Use flat black spray paint to give a burned or distressed look.

For embedded glass, use polycarbonate plastic sheeting at least 3mm thick to prevent injury. Cut into jagged shapes. Sand the edges with 320 grit sandpaper to remove any sharp edges. Colour the edges with a green marker such as Prismacolor® Emerald for a more glass-like appearance and better visibility in the wound.

Note: When dry the materials described will generally not cause any adverse reactions when stuck to human skin. If you are concerned about skin reactions with the materials, seal the items with a makeup sealer. The photograph shows finished fragments and glass made from safe, lightweight materials.

You can use rubber glass, sometimes called rubber ice, a clear silicone rubber, to simulate broken glass fragments such as the broken glass in an automobile accident. It looks like real broken glass but is soft and pliable. Rubber ice is a silicone rubber so you'll have to use either a fast setting skin-safe, platinum silicone such as Skin-Tite or a skin-safe silicone adhesive like Telesis 5 to stick it to the casualty's skin. These products are available from motion picture special effects suppliers.

3.17 Cleaning and Preparing the Skin

One of the primary skin cleansers I use is witch hazel, an astringent made from the leaves and bark of the *Hamamelis virginiana*, a shrub native to North America. It has a long history of safe use and is available from most pharmacies at a low cost and works well. You can also use isopropyl alcohol to clean the skin. Alcohol is especially good at removing grease and oils but may dry the skin if used repeatedly on the same area.

Cotton cosmetic pads are good for cleaning the skin. Purchase good quality woven pads; cheap pads tend to disintegrate and leave fibres on the skin.

3.18 Makeup Removal

Your choice of makeup removers will be based on the materials you wish to remove and where on the casualty the materials have been applied. Your first resource for makeup removal should always be the manufacturer's directions for the materials you've used. Keep instructions and data sheets in your make-up kit.

Removal of makeup before the casualty leaves is important. Aside from alarming uninformed bystanders, the casualty simulation makeup may delay treatment of a real condition if your simulated casualty becomes ill or is injured. During the filming of *First Blood* in 1981, actor Sylvester Stallone was taken to hospital for the treatment of injuries sustained in a fall. According to makeup artist Michael Westmore, doctors at the hospital insisted that they treat Stallone's "wounded" arm, actually makeup, before they treated his real injuries (source: *Canadian Movie Make-up Memories* by Michael Westmore, Make-up Magazine, Number 81, November/December 2009, page 84).

Be careful when you are creating the simulation. Building up layers of different products can make for a long and difficult removal process.

- **Creme makeup:** Use shaving cream and hot water for rapid removal of simple creme makeup. On the face try a makeup remover like Cetaphil Gentle Skin Cleanser. If you're not near a source of hot water use a product like Alcone Makeup Remover Cloths or NEUTROGENA® All-in-One Make-Up Removing Cleansing Wipes.
- **Latex and Wax, flesh effects gel:** Apply a towel soaked in water to the latex/wax buildup. The towel should be comfortably warm/hot and should be applied for about five minutes. This will soften the wax and loosen the latex allowing it to be peeled off.
- **Alcohol-Activated Paints:** Wipe with 99% alcohol on a cotton pad. Do this gently, do not scrub the area. Baby oil gel will remove some brands of alcohol-activated paints.
- **Prosthetic Adhesive:** Use a remover specific to the brand of prosthetic adhesive. Many brands can be removed with 99% alcohol.
- **Rigid Collodion:** Use a remover specific to the brand of collodion that you're using. Sometimes an acetone based nail polish remover can be used to remove collodion.
- **Silicone:** Carefully peel off skin, using a soft cloth and baby oil if necessary. If you have used a specialized silicone adhesive like Telesis 5, follow the manufacturer's directions for removal.

4. Specific Conditions

4.1 Blast Injuries

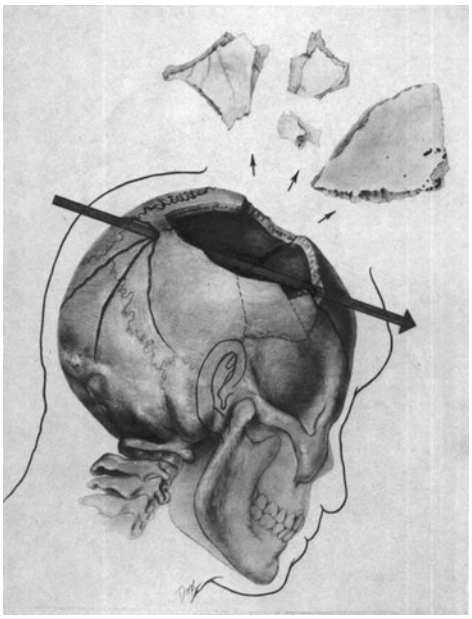
Blast injuries are most often found in warfare and terrorism scenarios. Sometimes industrial accidents (like this explosion at the Pacific Engineering Production Company of Nevada (PEPCON) plant in Henderson, Nevada, May 4, 1988, and the Sunrise Propane explosion in Toronto, Ontario, see video) can cause blast injuries as well. There are several mechanisms of injury at work in injuries caused by blasts.

Most fragments are aerodynamically unstable and cause irregular wounds. The fragment may bury itself fully in the casualty's body, it may be partially buried or it may bounce off the casualty causing only a small amount of

damage. Large, heavy pieces can travel a considerable distance. The famous WW2 "pineapple" grenade, the Mk 2, had a published lethal radius of under 10m. The fill plug of the Mk 2, which did not break up, was much heavier than the other fragments and was lethal at a distance of over 100m. Fragmentation injuries are secondary blast injuries; the blast propels the fragments. If the casualty is close enough to the blast to sustain many hits there will be other injuries as well; primary blast injuries caused by overpressure (tension pneumothorax and other barotrauma) and tertiary blast injuries such as broken bones caused by collision with other objects, including the ground, if the casualty is thrown by the blast. For a more complete description of blast injuries and treatment see *"Blast Injuries"*, Ralph G. DePalma et al, N Engl J Med 2005;352:1335-42.

To create hits, first determine how large the area will be. Clean the skin and make the hit with an application of rigid collodion. If the fragment is entirely embedded colour the centre of the hit with paint in a dark blue using alcohol activated colour; gently and quickly stipple the colour with a small brush for a realistic texture. Keep the brush fairly dry; too much alcohol may weaken the collodion. You can spray on a light coat of makeup sealer now if you wish. Apply a layer Ben Nye® Thick Blood, the blue base will make the centre of the hit darker and enhance the depth of the hit. To keep the hit from drying out coat with a thin layer of glycerin or water-based clear lubricant.

For medium size hits use scar effects gel, silicone or thickened Pros-Aide®. A spatula is used to shape the wound. Colour with blue paint and thick blood. Large hits can be made using gelatin appliances.



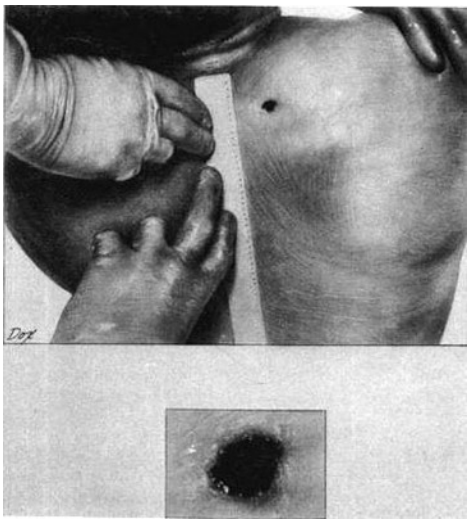
If the fragment is partially buried, use medical adhesive or Pros-Aide® to glue the fragment to the wound. It depends on the size of the fragment and what you're familiar with using. Apply a thin layer of thick blood to the wound and work up slightly around the base of the fragment.

For bounce hits use Ben Nye® Fresh Scab or create a small bruise (use a Kryolan® Six Color Burn & Injury wheel, Art.#1307 or a similar product). I'm assuming that bounce hits will only result in slight bleeding which will dry quickly, hence the use of fresh scab (brownish and scabby) rather than thick blood.

4.2 Impaled Objects

For small impaled objects, follow the instructions for a fragment hit. For larger objects, an appliance (silicone or gelatin) can be used. Use objects that are lightweight. Attach a thin base to the object then apply the appliance around it. Attach to the casualty using Pros-Aide® adhesive.

4.3 Gunshot Wounds



Gunshot wounds (usually abbreviated as GSW) are caused by the transfer of kinetic energy from the projectile to the body. Bullets in general can be called projectiles or missiles. These are different from fragments in that a projectile or missile is purpose built to be aerodynamically stable in flight. Bullets have a wide range of masses from a .22 cal. (2.6g) to a .50 cal. (59g) and speeds (330m/s for .22 cal. to 928m/s for .50 cal.)

Bullets transfer kinetic energy to the body, inflicting damage, in several ways. The bullet may strike a bone, damaging the bone and altering the trajectory of the bullet. After striking a bone the bullet may also become deformed, break-up or begin tumbling resulting in more damage. In soft tissue, inertial cavitation causes considerable damage when the energy from the bullet creates a cavity which collapses, producing a shock wave. Entrance wounds, in general, will be smaller and more sharply defined than exit wounds.

The two images from the Kennedy assassination show how the same type of bullet can cause dramatically different wounds. In the first illustration the bullet entering the President's back caused only a small entrance wound approximately 6mm by 4mm. It continued through the body, damaging the trachea and exiting from the neck. This exit wound was obliterated by an emergency tracheotomy.

The second illustration shows the path of a bullet through the head of President Kennedy. Skull fragments are not to scale. At the widest point the wound in the skull is approximately 13cm across. Illustrations are by medical illustrator Ida G. Dox, and published as (back wound) Figure 4 on page 85 of volume 7 and (head wound) Figure 29 on page 125 of volume 7 (Medical and Firearms Evidence) of the *Appendix to Hearings Before the Select Committee on Assassinations of the U.S. House of Representatives* (1979). Both are works of the U.S. Government and are in the public domain.

A Krönlein shot (after Rudolf Ulrich Krönlein 1847-1910, Swiss surgeon), is a shot though the brain (usually close to the base of the skull)in which the energy transferred to the brain tissue causes it to be expelled from the skull.

Gunshot wounds can be made with rigid collodion, effects gel, silicone, thickened Pros-Aide® or an appliance, depending upon the size and shape of the entrance or exit wound. See directions for fragment hits.

If the muzzle of the weapon is close to the casualty, residue from the cartridge can cause tattooing of the skin around the entrance wound. The hot gases will burn, bruise and discolour the skin in a mottled red.

4.4 Scrapes and Abrasions

An abrasion is an injury to the epidermis or dermis caused by contact with rough surface such as an asphalt road, in relative motion to the skin. Small pieces of glass, rock or other material may be embedded in the abrasion. Although it is not usually considered a serious injury by itself, it may indicate more serious occult injuries. For example, an abrasion on the forehead may indicate a blow to the head and a cervical spine injury. A Colles fracture, also known as a bayonet fracture, is often caused by falling on outstretched arm. An abraded palmar surface hints at this mechanism of injury.

Use a piece of stipple sponge to apply blood colour alcohol based paint to the area. Begin with dark blue and a small amount of black for the shadow base texture and finish with dark or blood red. Apply with a black stipple sponge. A fine brush can be used to add fine scratches. If you want to have small fragments embedded in or sticking to the abrasion you can be add those now with Pros-Aide® or other adhesive as required. A thin layer of latex can be added around the edges of the abrasion and pulled up with a wooden tongue depressor to simulate damaged skin at the edges of the wound. Next stipple a small amount of thick blood over the paint for a dimensional effect using a makeup spatula. The thick blood can be softened with stage

blood of the same type as needed. In the photos Fleet Street Blood Paste was used. This brand dries with a wet look and is long lasting. You can drag a stiff nylon or chip brush through the thick blood to make linear abrasions. Use glycerin or a water based lubricant to give the wound a fresh, moist look if desired. Dust on cosmetic dirt if the scenario calls for it. Seal with a makeup sealer if necessary for added durability. Apply stage blood at scene for oozing abrasions. The large photo shows the finished abrasion makeup and the sequence of applying the alcohol-activated paint, applying the latex and the blood paste.

4.5 Bruising

Bruising occurs in many types of trauma and can point to the mechanism of injury. In an automobile accident, bruising on the chest, along with appropriate symptoms, may indicate broken ribs or a flail chest. Quite often the bruises will have the pattern of the object which created them such as the steering wheel.

The edges of a fresh bruise are often well-defined. As the blood seeps into the tissues the bruise becomes darker and larger (this continues up to 24 hours after the injury). The blue/red colour of the bruise is from the hemoglobin in the red blood cells.

Over time the bruise fades as the hemoglobin breaks down. The colour changes from blue/red to green to yellow to golden brown and the edges of the bruise become less well defined. The photos illustrate bruising done with creme makeup and set with neutral set powder.

Use a torn makeup sponge and a bruise wheel (creme makeup) to create different types of bruises. Set with powder. Seal with a makeup sealer if desired.

4.6 Scars

Although a scar is a healed wound, it may give medical personnel valuable clues. For example, old scars on the wrists might indicate past suicide attempts, a surgical scar may help to fill in past medical history. You can make a scar by drawing it on clean skin with rigid collodion; see Section 3.8. When the solution dries it will contract and produce the scar. Raised scars (a hypertrophic scar or a keloid scar) can be made with thickened Pros-Aide®, silicone or with Flesh Effects Gel. For a recent scar or for a more pronounced effect, colour the scar a light rose (the colour should be a little blotchy). Seal with make-up sealer.

4.7 Shock

Shock is the lack of perfusion, the supply of oxygenated blood, to the tissue. Shock may be the result of pump failure (cardiogenic shock), vasodilation (vasogenic or high space shock), fluid loss (hypovolemic shock) or lack of oxygen (hypoxic shock). A myocardial infarction will result in cardiogenic shock. Uncontrolled internal or external bleeding, fluid loss from burns or severe dehydration can cause hypovolemic shock. Anaphylactic shock is caused by an abnormal reaction to a protein causing blood vessels dilate and bronchioles to constrict. Septic shock is caused by a toxin which dilates blood vessels and causes increased capillary permeability. Both anaphylactic and septic shock are types of vasogenic shock. In the first stage of shock, compensatory shock, the

body tries to compensate for the shock by shunting blood to the vital organs. The face and extremities become pale due to lack of blood. Untreated, shock progresses to decompensated shock when the body can no longer compensate for the shock. The face takes on a sunken look, the skin becomes diaphoretic and the lips cyanotic. Cyanosis usually occurs when the oxygen saturation drops below 90%. Unlike other types of shock, a casualty with shock from a spinal cord injury, a type of vasogenic shock, will have warm, dry extremities.

Apply Ben Nye® Color Cake Foundation in Blue Spirit (PC-82), Sallow Green (PC-83) and Death Flesh (PC-840). These shades are shown in the photo. Shades should be mixed to adjust for skin colour and effect desired. Green and blue tones in the foundation reduce the redness in the skin (from the blood) and give a better shock effect than pure white does. Pure white appears artificial and clown-like. I've found the Blue Spirit works well on lighter skin tones, the Sallow Green works well on darker skin tones. For intermediate skin tones, blend these colours with a bit of Death Flesh.

The foundation mentioned is a water activated foundation. For maximum durability, use Ben Nye® LiquiSet to activate the foundation. If you need to blend the foundation, activate with plain water. Apply lightly and evenly, stippling the colour on using a damp hydro sponge (see photo). The sponge should be quite damp but not dripping wet. You can blend the colours with a damp hydro sponge (shown in photo) unless you're using LiquiSet. When working around the eyes and mouth, pull the skin tight so any small wrinkles in the skin are coloured evenly. Apply shock makeup to the arms and hands as well. This product is a theatrical foundation and is a bit heavier than other foundations but I've found it easy to blend and get good results.

Begin by applying the colour to the forehead, high parts of the cheeks (apples) and the chin. Blend the colour smoothly out toward the sides of the face. You should not be able to tell where the colour begins or ends.

To create a sunken effect use gray creme colour under the eyes, the mentolabial furrow beneath the lower lip and in the nasolabial folds. Blend and seal with Final Seal or similar product. Lips should be coloured with a very light application of blue (I use Ben Nye® Creme Color Sky Blue CL-22, see photo). For a longer lasting blue use an alcohol activated colour instead of the creme colour. Apply in thin washes.

A mixture of glycerin and water (50% glycerin) can be applied to the face with a sprayer to mimic diaphoresis. Additional makeup sealer may need to be applied to prevent absorption of the glycerin spray. Water-based gel lubricants such as Muko® (the kind used for airway insertion) can also be used instead of the glycerin-water mix. Apply the gel to the skin drop by drop using a fine brush.

Shock casualties may also be nauseous and vomiting. Use the plastic "puke" from novelty/joke shops beside the casualty to indicate vomiting. This works well visually and is fast, cheap and more sanitary than using food products to make vomitus.

4.8 Lacerations

Langer's lines (after Austrian anatomist Karl Langer (1819-1887)) also known as stress or cleavage lines, are lines of stress in the resting body. Wounds parallel to Langer's lines will tend to remain closed and heal with less scarring. The lines are a result of the preferred orientation of the collagen fibres in the skin (source: *Characterization of the anisotropic mechanical properties of excised human skin* by Aisling Ní Annaidh, Karine Bruyère, Michel Destrade, Michael D. Gilchrist, Mélanie Otténio, Journal of the Mechanical Behavior of Biomedical Materials, Volume 5, Issue 1, January 2012, pg. 139-148) Wounds which cut at right angles to the lines will present as more open as the stresses pull the wound open and the wound will heal with more scarring. You can find Langer's line charts online and in medical texts. In living, active individuals stresses in the skin caused by the position of the body (extension or flexion) can sometimes work counter to Langer's lines. For example the skin on the dorsal surface of the hand is not bound to the underlying fascia as it is on the palmar surface and is loose so the fingers can move easily. When creating lacerations be aware of how the wound would actually present in an actual casualty. Lacerations are classified as linear (smooth edges), usually caused by a knife or other sharp object, and as stellate lacerations (jagged edges) caused by blunt objects which tear rather than cut the skin.

Lacerations usually begin to swell around the edges. The injury triggers the cellular and humoral immune systems. Blood flow increases in the area of the wound causing edema (swelling) and erythema (a reddening of the skin). This reaction actually makes it simpler for the casualty simulator to create realistic looking lacerations. Our work is done on the surface of the skin so the additional thickness of the material we use to make the wound is realistic if we shape it properly. Pay attention to blending the edges of the material.

Create tiny lacerations by applying fresh scab directly on the skin; in areas of loose skin you can use collodion solution to add depth and texture to the laceration. A shallow laceration can be painted on the skin with alcohol activated paints then a makeup sponge dampened with alcohol can be used to spread some of the red paint around the wound to simulate erythema. Add depth to the wound with a small amount of blue paint and add a bit of thick blood for dimensionality. Try flesh effects gel for small lacerations. Spread on a thin, smooth layer of gel on the skin. Make the laceration with a wooden modelling tool or make-up spatula after the gel has set enough to become workable. Fold the gel back on itself and allow to fully set. A gel wound can be made more durable by stippling on a couple of layers of latex with a makeup sponge. Another technique is to brush one ply of a facial tissue with cosmetic grade liquid latex and apply to the skin. This method is good for stellate lacerations since the tissue can be pushed into position to give the effect of skin subjected to a tearing force. Before applying the tissue tear it in a shape with a ragged edge to make it easier to blend. Brush some more liquid latex on top to blend. Allow it to dry slightly then create the laceration as described for the flesh effects gel. You can also use Pros-Aide® thickened with Cab-O-Sil® to build the laceration or use silicone. Whichever method you use don't build up too much thickness; it makes blending more difficult and increases drying time for the medium. Colour the deepest parts of the laceration blue using an alcohol activated paint then use thick blood to colour and texture the wound (the red and blue give the illusion of depth, see the section on PAX paints for more about this technique). Colour the area as needed to match the surrounding skin. When the casualty is in position, add liquid blood. For large lacerations, use gelatin or silicone appliances.

4.9 Bleeding

An arterial bleed is usually considered a serious condition which the first responder must take care of quickly. When creating a casualty with an arterial bleed consider which artery is affected. Most arteries are deep and run along bones, usually on the flexor aspect, which offers protection for the artery. An arterial bleed can be made with concentrated blood colour (used to make fake blood by mixing with water), a 500ml or 1litre IV bag of 0.9% normal saline and a fluid administration set. You can use out-of-date IV solution since it is not being injected. Cut the luer lock off the end of the fluid administration set. Puncture the IV bag with the spike on the top of the drip chamber then *carefully* withdraw it (it is plastic but it is still sharp). Use an eye dropper or catheter syringe to add concentrated blood colour to the IV bag then reinsert the spike. Shake to mix. Embed the end of the fluid administration set tube in your wound. Squeeze the IV bag to squirt blood from the wound.

A blood pressure unit for simulated bleeding can be made from an IV bag (1000mL), a primary line and a blood pressure cuff. First, make sure the primary line is clamped. Spike the bag with the primary line, remove the spike and add concentrated blood colour to the bag with a syringe. Carefully reinsert the spike. Wrap the blood pressure cuff around the bag. Cut the Luer lock fitting off the end of the primary line and route to the place you

want the bleed. To get the blood to flow inflate the blood pressure cuff to a suitable presure. Now all the casualty has to do is to release the clamp on the line and the pressure in the cuff will force the blood out of the bag.

4.10 Avulsions

An avulsion is the tearing away of a part or structure of the body. In many cases it refers to a wound with flap of loose skin. A limb, eye or tooth may also be avulsed. Skin avulsions are often caused by a force that is at an oblique angle to the surface of the skin. Hair may be caught in a rotating shaft and part of the scalp torn off. Degloving injuries are a type of avulsion in which the skin is pulled off an extremity such as a finger, hand or foot. You can make a prosthetic avulsion or create one out-of-kit with a latex and tissue buildup.

Here is another method. Begin by making a variety of latex skin flaps well ahead of time. On a clean piece of glass, use a soft brush or makeup sponge to create the skin flap by brushing/stippling on a thin layer of latex. When dry add more layers on the free edge to increase thickness. The edges that are to be bonded to the skin should be as thin as possible. When finished, peel off the glass and, if you're storing the latex skin, powder it. Apply Pros-aide® to the edges of the flap that are to be bonded to the skin. Allow to dry, position and press into place. Colour to blend with the surrounding skin then add thick blood under the flap.

4.11 Fractures

Fractures of the long bones, whether open or closed, can be accurately described using standard terminology. This will give the casualty simulator a guide to creating a realistic fracture for the scenario.

Level: Where the fracture is along the length of the bone. The part of the bone closest to the centre of the body is the proximal segment, the central portion of the bone is the diaphyseal segment, and the part farthest away from the centre of the body is the distal portion of the bone. The level of the fracture can also be described by dividing the bone into thirds, for example a fracture in the distal third of the humerus.

Displacement: When a bone is fractured, the parts of the bone are often displaced with respect to one another. If the bones remain in normal alignment at the fracture, this is the anatomical position. The displacement can be given by the percentage that the bone ends remain in alignment. If the bone ends are overlapping by half, this is 50% bony apposition. When the bone ends do not meet at all there is no bony apposition.

Angulation: The position of the point of the angle of the two bone ends, usually given as pointing in a particular direction such as medial, lateral, anterior, or posterior.

(source: *Practical Fracture Treatment, 5th Edition* by Ronald McRae, FRCS(Eng, Glas), AIMBI and Max Esser, FRCS(Ed), FRCS(Ed)(Orth), FRACS(Orth), published by Churchill Livingstone, 2008)

4.11.1 Closed Fracture

Clean the area where the swelling/deformation caused by the fracture will be with witch hazel or alcohol then coat with a thin layer of Pros-Aide® or spirit gum. Daub the adhesive with a cotton ball so that fibres adhere to the adhesive base. These fibres will help bond the wax to the skin. Build up the area with wax (nose and scar wax). The wax should be smooth and blend into the skin. Coat with a thin layer of latex and allow to dry. Seal latex with Green Marble® or castor sealer (the sealer prevents makeup from changing colour due to absorption by the latex). Colour with the Bruise wheel, set and seal with makeup sealer. You can also use RMGP instead of the sealer/creme makeup combination. A wax and latex buildup was used to create the swelling on the finger in the photo.

4.11.2 Open Fracture

An open fracture, also called a compound fracture, is a fracture in which the broken bone is exposed through a wound in the skin. The wound may come from outside, such as a bullet or axe, which produces a wound as

well as breaking the bone. A wound may be created by the broken bone ends puncturing the skin from the inside.

The severity of an open fracture is often rated according to the Gustilo Open Fracture Classification which lists six classes of open fractures (I, II, III, IIIA, IIIB, IIIC).

Open fractures are common in the long bones; for example the tibia in the middle third of the bone length (source: Iran Red Crescent Med J. 2011 December; 13(12): 868–872). Fractures of the distal radius are some of the most common open fractures in adults (source: Hand (N Y). 2011 June; 6(2): 185–189). Pelvic fractures can be open.

Open fractures are usually the result of high energy mechanisms of injury. In civilians, open fractures are often associated with automobiles (automobile vs. pedestrian/cyclist/automobile). Blast waves often cause open fractures in warfare. (source: Blast-related fracture patterns: a forensic biomechanical approach, J. R. Soc. Interface (2011) 8, 689–698, doi:10.1098/rsif.2010.0476, Published online 1 December 2010)

There are many images (radiographs) of broken bones available on the Internet to provide a starting point for your casualty simulation.

You should have a selection of previously created broken bones made with Sculpey or a similar modelling material. See the examples in the photos. Sculpey is a synthetic, non-toxic modelling clay available in a wide variety of colours that can be cured in your kitchen oven at 130°C/275°F for 15-45 minutes (time depends on thickness of sculpture). Clean the area of the break and attach the bone with a suitable adhesive. Cover the area where the bone exits the body with a latex skin flap attached with Pros-Aide®. Colour the open wound area with alcohol activated blue paint to give depth then apply thick blood with a makeup spatula. Blend the skin flap as necessary. Create additional damage as necessary depending upon the bone broken and the mechanism of injury. Seal with makeup sealer. A silicone or gelatin appliance can also be used for an open fracture. The photo shows a broken bone made with Sculpey attached to the arm with Pros-Aide®. The wound was created quickly using only thick blood applied with a makeup spatula, liquid latex and stage blood.

4.12 Amputations

When creating amputations always consider the mechanism of injury. For example, an amputation caused by a sharp object such as a machete or industrial machine may be quite clean. The limb may be mangled by construction or farm equipment. In the case of a blast injury from a land mine or IED, the stump may be torn and burned. Traumatic amputations in civilians (without protective gear) resulting from blast injuries have a high fatality rate (see "*Medical Consequences of Terrorism: The Conventional Weapon Threat"*, Michael Stein, Asher Hirshberg, Surg Clin North Am,1999 Dec;79(6):1537-52). The end of the bone may or may not be showing. Muscles may retract leaving loose skin and fascia hanging from the stump.

To create a simulated amputation g*ently* fold the arm or leg back to create the "stump". Secure the limb in position with a wide triangular bandage if necessary. Clothing may be cut, the folded limb inserted and safety pins used to hold the cut clothing together. If you can, build your amputation in such as way, using flexible materials, so that your casualty can straighten his/her limb when not role playing (this helps to prevent discomfort). You can use a variety of materials for the stump. Latex "skins" held on with Pros-Aide® are good for

a start then colour with alcohol based paints and add thick blood. Other methods you can use are gelatin or silicone appliances or wax (follow directions in "Closed Fracture" for using wax). For fingers or thumb, bend the finger/thumb under and *gently* secure with tape. Build up the stump with either wax or effects gel, colour with blue ink and thick blood. A Sculpey bone can be used (you'll have to plan this ahead of time). Amputated parts such as an arm or leg can be created with boots, gloves, bits of clothing and some silicone or latex.

4.13 Burns

First degree (superficial) burns involve only the epidermis, the outermost layer of skin. This type of burn will be pink or red without any blistering. The skin will be dry and possibly slightly swollen. Apply red from a burn wheel evenly over the area using a wide, soft brush or a makeup sponge. A first degree burn caused by a sudden burst of heat is called a flash burn and will have sharply delineated borders.

Second degree (partial thickness) burns involve both the epidermis and the dermis. Damage to the blood vessels in this layer of skin will cause blistering. Depending upon the burn site, the individual and the heat source a second degree burn may range from white to bright red, be moist, mottled and blistered. Clean the area with witch hazel and apply Telesis™ Top Guard® Skin Barrier. Create the blisters using beads of transparent effects gel (see photo). Position your casualty so the area you're applying the effects gel is level to keep the gel from forming drip shaped blisters. Let the gel set and coat with liquid latex applied with a makeup sponge. Apply a white/tan colour to the blistered area and blend with the darker surrounding area. Where the second degree burn blends into a third degree burn (see following paragraph) carefully pull up the edges of the latex film with a wooden tool and tear to rough and random borders. Seal the latex with castor sealer then use the burn wheel to colour the area.

Third degree (full thickness) burns involve the subcutaneous tissue and can extend into the fat and muscle of the body. The destroyed skin layers form a tough, dry layer called eschar. The burn may range in colour from white to red or brown. Portions of the burn may be carbonized, sooty or dirty. Fresh third degree burns are usually dry. Begin by applying colour from the burn wheel to the area of the burn. Then apply a very *light* coating of petroleum jelly in random spots to the skin where you want the 3rd degree burns. Using a makeup sponge, stipple on one or two layers of liquid latex (depends upon the consistency the latex you're using) beyond the area where you've applied the petroleum jelly. Use neutral set powder on the wet latex. The petroleum jelly prevents the latex from sticking to the skin and the powder dries and weakens the latex slightly. Now use the edge of a tongue depressor to *carefully* scrape and lift the latex eschar you've created away from the skin and break it into rough sections. If you use Water-Melon™ (by Michael Davy http://www.michaeldavy.com/) instead of latex you can weaken the eschar with a bit of 99% alcohol before using the tongue depressor. Thick eschar for deep burns can be made using a single ply of facial tissue and latex.

Instead of the direct on skin method described above, you can create latex or Water-Melon™ eschar (zombie) "skins" ahead of time. See Section 3.11.1 for directions on making latex or Water-Melon™ Zombie skins. Make blisters from flesh effects gel Section 3.7. Drip the liquid flesh effects gel onto silicone baking parchment and allow to set. Powder with baby powder and store in a plastic bag until use (see photo).

To use the Zombie Skin and blister method, clean the area of the skin where you want the burn. Apply a thin coat of Pros-Aide® and allow to dry. Peel the blisters from the parchment and apply where desired. Press the Zombie Skin into the areas where you want 3rd degree burns, forming pockets where the "skin" is pulling away. Once you're satisfied, lightly powder the area. Stipple one or two layers of latex over the blisters and around the edges of the Zombie Skin to blend. The photos show the Zombie Skin blister method.

Whichever method you use to create the burns, seal ***latex*** with castor sealer (you don't need to seal Water-Melon™), and apply appropriate colour from a burn and injury wheel. Fix with neutral set transparent powder. If the burn is bleeding add old/scab blood or thick blood (spread and soften using a brush loaded with glycerin or a water-based lubricant to prevent the blood from drying out) in the exposed areas. Use cosmetic charcoal powder (a black powder made from cosmetic grade pigments, specifically produced and sold for cosmetic use) to mimic charred areas.

Smoke inhalation is the leading cause of death in fires and often goes unrecognized on scene. Injuries from smoke inhalation include thermal injury to the upper airway, carbon monoxide toxicity, and injury from toxic gases such as hydrogen cyanide (burning plastics). Common signs include facial burns, singed/burned hair and soot around the nose and mouth. Singed and missing eyebrows can be simulated using Nose & Scar wax, worked into the brows. Smooth using a bit of water-based lubricant to prevent the wax from sticking to your fingers. For larger areas of burned hair use Gafquat® to protect the hair; see section 4.14 for details. Use burn makeup over the singed area. Simulate soot on the face by using cosmetic charcoal powder under the nose and around the nostrils. Apply the cosmetic charcoal powder by picking it up with a moist makeup sponge. Be very careful not to get any of this powder in the eyes. Have your casualty close their eyes and hold their breath while you fix the powder in place by spraying with makeup sealer. You can spray a small amount of liquid smoke, available from grocery stores, on the casualty's clothing to give a burned odour.

Do not use wood ash on casualty's skin or clothing. Wood ash has a high pH value and can cause skin irritation. (source: *"Use caution with wood ash on your lawn and garden"*, author Peg Herring, source Dan Smith (Soil Science), Oregon State University Extension Service, January 1, 2011).

More realistic blisters can be achieved by stippling a thin layer of latex on a piece of glass. With a small amount of gel effects create a blister on the latex. Stipple a thin layer of latex over this gel and onto the base

layer of latex on all sides. Inject the blister using a fine needle (20-24gauge) and syringe filled with the appropriate fluid. Lubricate the needle with a small amount of water-based lubricant before inserting to prevent tearing the latex skin when withdrawing the needle. Carefully pull out the needle, wipe off any fluid and coat with a small amount of latex to seal the hole.

4.14 Head and Scalp Trauma

The scalp is a highly vascular area and even a small laceration will bleed profusely. To protect the hair use Gafquat® (the trademark name, owned by International Specialty Products, for Polyquaternium-11), a thick, water-soluble solution which is used in many hair products. Use Gafquat® to hold down, seal and protect the hair in the area you're going to build the wound. Build the wound on top of the Gafquat®. The photo shows a gelatin prosthetic affixed with Pros-Aide®. Gafquat® has been used to protect the hair. The "brain matter" around the wound is left over pieces of prosthetic gelatin mixed with water-based lubricant and stage blood.

Two external signs of basilar skull fracture are raccoon sign (sometimes raccoon eyes) and Battle sign (also Battle's sign, after William Henry Battle (1855-1936), an English surgeon). Raccoon sign is bruising which blackens the eyes. Battle sign is a sign of basilar skull fracture at the posterior portion of the skull and appears as bruising over the mastoid process, behind the ear. Both are late signs of fracture since it takes blood time to accumulate and the bruising to appear.

Deformations and lacerations of the head are indicators of possible brain injuries. Deformations can be created with a wax/latex build. You may be able to cover the build by combing over hair. You can also create a laceration in the deformation and bloody up the area eliminating the need for hair on the wound. The hair in this case would be covered and matted by the blood.

4.15 Facial Trauma

4.15.1 Mouth Injury

Injuries to the mouth are often bruising and bleeding. Use the bruise wheel and fresh scab applied with a small makeup spatula OUTSIDE the mouth. Lost teeth can be painted out with black tooth paint which is available from a number of suppliers. BEFORE using tooth paint ask the casualty if he/she has dental veneers or cosmetic bonding. If the casualty does have veneers or bonding, then DO NOT use tooth paint on that casualty. Dry the tooth with a piece of clean gauze before applying the paint. Alcohol activated inks such as Skin Illustrator® can be used to paint out the teeth; follow the same rules as for black tooth paint. You can purchase synthetic teeth as a stand-in for the missing teeth. Look for teeth from a typodont, a model of the oral cavity used by dental students for training. Alternatively you can make teeth from a modelling material like Sculpey. Synthetic teeth should **NOT** be placed in the mouth since they might be swallowed by accident. The casualty should hold them in a piece of blood stained gauze instead. Use stage blood, sometimes listed as "mouth blood" and made with food grade materials, in and around the mouth.

Prosthetic teeth can be molded from real human teeth. Extracted teeth obtained from a dental clinic (cleaned and autoclaved) were sprayed with two coats of Krylon® Crystal Clear. The two-part mold was made from Mold Max 30 by Smooth-On. I partially embedded the teeth in non-sulphur plastiline to hold the teeth in position during

the molding process. I also added keys to the plastiline to help in aligning the two parts of the mold later. The teeth were cast using dental polymer/monomer from Monster Makers. This product is very forgiving with respect to proportions of the polymer/monomer. I found that a ratio that gave a thick syrup consistency worked well. The mixed product sets very quickly.

After casting, remove the prosthetic teeth from the mold and remove any flashing with sharp knife or fine sandpaper. Small voids can be filled with thick dental polymer/monomer. A clear coating for the finished teeth is available from the polymer/monomer supplier. Discolouration can be added with alcohol-activated paints. The finished teeth in the photo have been daubed with Ben Nye Stage Blood and latex to simulate blood and tissue from pulled teeth.

4.15.2 Nose Injury

A nosebleed, also called epistaxis, is commonly caused by blunt trauma to the nose, foreign bodies inserted in the nose or by an inflammatory reaction such as an allergy. Epistaxis can be a sign of a basilar skull fracture and a contraindication for the insertion of a nasopharyngeal airway (NPA). A few drops of stage blood below one or both nostrils will indicate epistaxis. You can use thick blood with a thin coating of glycerin to indicate a heavier blood flow.

Breaks and bruising of the nose are common and can be simulated with bruising makeup and a wax/latex buildup. A broken nose often results in bruising and swelling of one or both orbits. The nose will be displaced right or left. A high energy mechanism of injury such as motor vehicle accident, a broken nose may indicate and injury to the cervical spine. The broken nose may interfere with breathing.

4.15.3 Eye Injury

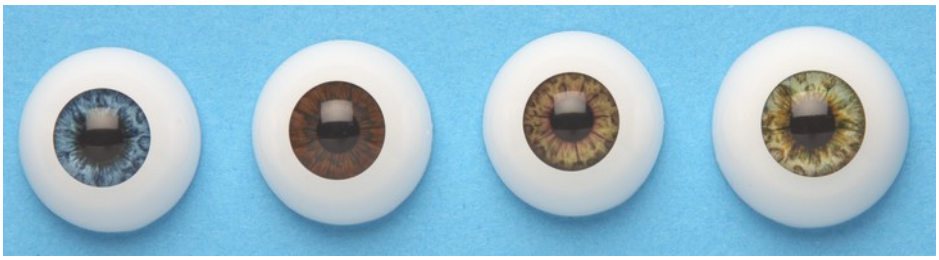
Eye injuries are serious and must be treated promptly. As many as 28% of blast casualties may have eye injuries(source: *“Maxillofacial injuries caused by terrorist bomb attack in Nairobi, Kenya”*, Odhiambo WA et al, Int J Oral Maxillofac Surg 2002;31:374-7).

The adult eye socket has an average volume of 35ml. As small a change as 10% in the volume can result in the globe of the eye being displaced from the normal position.

A blowout orbital fracture (fracture of the bones which form the eye socket) can cause entrapment of muscle and soft tissue structures surrounding the eye resulting in enophthalmos and diplopia (double vision, in this case resulting from the restricted movement of one eye due to entrapment). Blowout fractures are usually the result of a high energy blow to the eye.

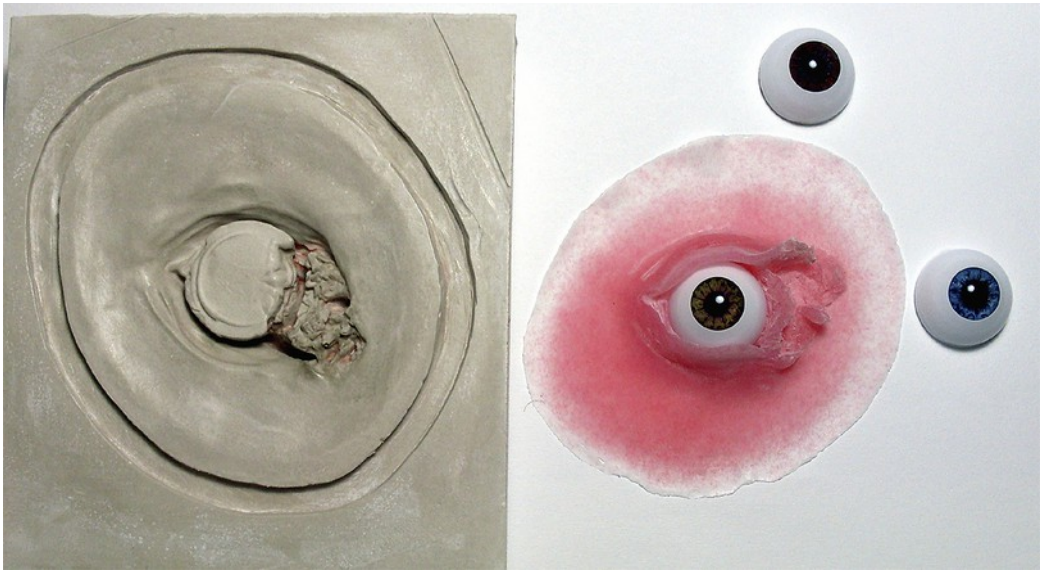
In many blowout fractures (80% in adults) periorbital edema (swelling of the tissue surrounding the eye) was so severe that ophthalmological examination was not possible immediately following the injury (source: *“The Differences of Blowout Fracture of the Inferior Orbital Wall Between Children and Adults”* Jae Hwan Kwon, MD; Jung Hwan Moon, MD; et al, *Arch Otolaryngol Head Neck Surg.* 2005;131:723-727, http://archotol.ama-assn.org/cgi/content/full/131/8/723). Severe swelling can mask the actual position of the globe.

The adult human eye is approximately 25mm in diameter. You can purchase fake eyes of this diameter from various suppliers (the eyes in the photograph are Real Eyes Brand Doll Eyes by the Secrist Doll Company, 24mm and a 26mm diameter at the far right). Frayed red threads can be added to the fake eyes (NEVER your casualty's real eyes!) to give realistic blood vessels.



The photo shows an example of an eye injury prosthetic for the right eye made using the doll eyes with a generic silicone prosthetic cast in the stone mould on the left. This type of prosthetic can be applied and blended to the skin rapidly. Note the thin edges of the silicone which make blending easy and the different colours of eye

which can be inserted. I usually attach this prosthetic with Telesis 5 Silicone Adhesive (easier on the delicate skin around the eye) and colour blend with Skin Illustrator. With a bit of care it can be reused one or two times. A fragment can be glued to the wound area depending upon the scenario.



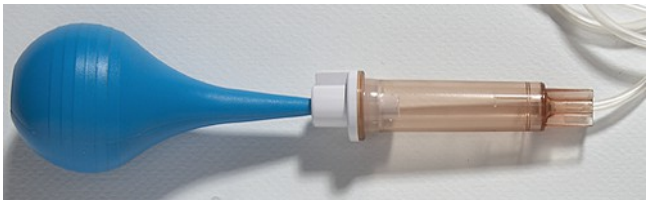
When working around the eyes be aware that the skin is more delicate than the skin on the rest of the face. Avoid using strong adhesives on the area just under the eye and the eyelid. Appliances should extend from the cheek to the eyebrow. You can seal the eyebrows with Gafquat® (see **Head and Scalp Trauma**).

4.16 Chest Trauma

4.16.1 Open Pneumothorax

An open pneumothorax is a opening between the chest and the chest cavity (pleural space) often caused by a penetrating chest wound (bullet, fragment, stabbing). This is a serious medical condition which, if not treated, will result in death. As the casualty breathes, the chest cavity (pleural space) fills with air and fluid compressing the lung. An open pneumothorax, also called a sucking chest wound, is easily recognizable with a mixture of blood and other fluids bubbling out of the wound as the casualty breathes. Proper treatment involves the application of an Ascherman Chest Seal (a one-way valve) or something similar to drain the chest of air and fluids and keep the lung from collapsing. In some cases, a needle decompression may need to be performed.

Creating a realistic open pneumothorax makes use of a specially created gelatin or silicone appliance (see silicone or gelatin appliances section) with a 14g IV catheter embedded in it (just the plastic part, NOT the steel needle) with the opening hidden in the wound and the luer portion available. You'll also need a fluid administration set, a 20ml or larger syringe, an 18g or 20g needle and a soft rubber ear bulb syringe (usually about 30ml or 1 oz.)



MacGyver the ear syringe to the tubing to form an air tight seal. What I've done is to cut off the plastic spike on the drip chamber and drill out the opening to fit the ear syringe. When drilling hold the drip chamber above the drill so the plastic particles fall away from the drip chamber and don't end up inside the chamber and tubing. Use medical tape to hold the ear syringe in place. If you're using a gelatin appliance, place on a flat surface and *carefully* push the IV catheter through the gelatin so the tip is in the “wound” then withdraw and properly dispose of the sharp, leaving the Teflon® catheter in place. Keep your fingers behind the sharp end of the needle. A bit of petroleum jelly on the catheter will make it easier to push through the gelatin. For a silicone appliance embed the catheter when you're moulding the appliance. Position the appliance in the proper area and apply. Seal the gelatin appliances thoroughly to prevent the blood solution from destroying the appliance. Blend the appliance with makeup to match the skin and apply thick blood as required taking care not to block the end

of the 14g catheter embedded in the appliance. Using the luer lock on the catheter, attach the fluid administration set. With medical tape or Tegaderm™ secure the tubing of the fluid administration set to the casualty running it in a 360° loop with a 5cm radius.

Fill the 20ml syringe with stage blood, thinned with water and with a drop of liquid dish washing detergent added (mix well before filling the syringe). Attach the needle to the 20ml syringe and insert the needle in the lower injection port on the fluid administration set. Squeeze the ear syringe bulb and release while injecting some of the blood solution into the port. The ear syringe will draw the mix into the loop. Withdraw the needle and dispose of properly or store safely.

You can now create bubbling, frothy blood by compressing the bulb of the ear syringe. The ear syringe will force the "blood", along with air, out of the wound. For the best effect have the casualty squeeze the bulb at the same rate as his/her breathing. Inject more "blood" into the line as necessary.

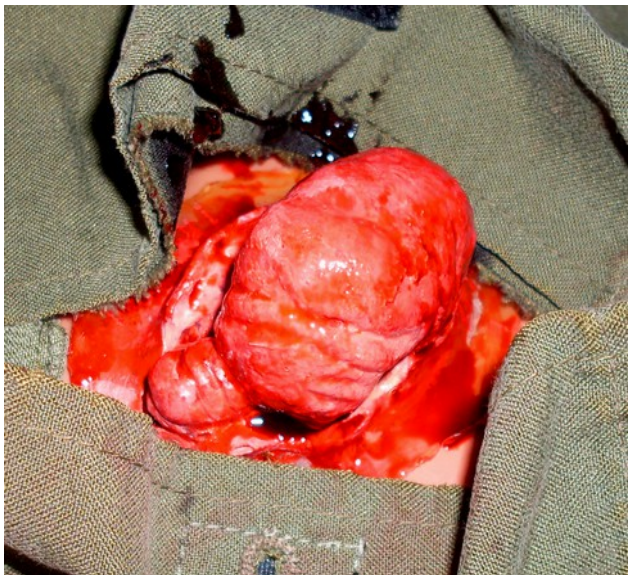
4.16.2 Tension Pneumothorax

A tension pneumothorax is caused by air leaking from the lungs into the pleural space causing the lung(s) to collapse. If not treated promptly the casualty will die. A violent blow to the chest, such as the impact of the chest against the steering wheel in an automobile accident, can cause a tension pneumothorax. The shock wave from an explosion can cause a tension pneumothorax by spalling; as the blast wave travels through the body it moves from the tissue into the less dense, air filled, alveolar spaces. Bits of tissue are blown off the surface creating defects which allow the air to enter the pleural space. Protective equipment such as body armour can potentiate primary blast effects increasing the severity of the injuries. Overpressure from the blast, especially in enclosed spaces such as a vehicle, will cause small tears in the lung parenchyma resulting in a tension pneumothorax and noncardiogenic pulmonary edema. Proper treatment for tension pneumothorax is needle decompression at the scene with rapid transport to a medical facility.

For a blow to the chest, create appropriate bruising using creme makeup and sealer. A tension pneumothorax caused by a blast may not have any obvious injury to the chest (external) but should be apparent by mechanism of injury and other injuries. Coach the casualty to cough and wheeze, and to have trouble answering questions in more than one or two words. Pulmonary edema can be simulated with mouth blood; casualties usually have a pink froth at the mouth.

4.17 Abdominal Trauma

4.17.1 Eviscerations



Most abdominal organs are well anchored internally and will not be eviscerated except in extremely violent situations and, in those cases, the casualty will be dead. An exception is the small intestine, which can extrude through an opening into the skin or through an internal opening to another area of the body (a hernia). The image on the right shows an evisceration slip-cast from latex attached with Pros-Aide® and colour blended. A water-based lubricant gives the prosthetic a wet look along with an application of stage blood. The original sculpture for this prosthetic was made using a reference photograph of an actual evisceration.

4.17.2 Pregnancy

Trauma occurs in 6-7% of all pregnancies (source: *Trauma and pregnancy*, Am J Perinatol., 1997 Jul;14(6):331-6). During pregnancy, trauma is the most frequent cause of maternal death in the U.S., often as a result of motor vehicle accidents (MVA). Silicone pregnancy bellies can be purchased from a number of companies or you can make your own from fabric and a suitable stuffing. Proper acting technique can increase realism; the Moonbump website points out that bending the knees and arching the back more than normal will help sell the pregnancy.

4.18 Pelvic Trauma

The pelvis contains major organs and blood vessels. A fractured pelvis can lose up to 500ml per fracture. Seat belt bruising and abrasions in automobile collisions, the "seat belt mark", (also the seat belt sign) are associated with a internal injuries in approximately 25% of cases (source: *International Trauma Life Support for Emergency Care Providers* by John Campbell, MD, published by Pearson Education, Inc., 2012, pg. 240) The seat belt mark is a straightforward application of makeup; see Bruising and Abrasions. Increasing numbers of genital injuries are being seen in warfare, as a result of blast injuries and as a form of terrorism toward civilian populations. (see: *"The War within the War: Sexual Violence Against Women and Girls in the Eastern Congo"*, Human Rights Watch, 2002).

Aside from any squeamishness, the inappropriateness, and the discomfort, makeup should never be applied directly to the genitals. Makeup is not designed for application to mucous membranes. The genitals are covered with a thin, loose skin which can be easily injured during the removal of adhesives. Instead of working directly on the body, build genital trauma simulations on latex or silicone sheets and attach to the abdomen and the medial aspect of each thigh using an appropriate adhesive. Blend as for other prosthetics.

4.19 Medical Conditions

Diabetes, myocardial infarction, stroke, allergic reactions are medical conditions which the first responder might encounter and can be simulated. In many cases, the application of shock makeup along with prompting by the casualty will be sufficient. For stroke you can use a product like Steri-Stripes™ to mimic facial paralysis. Pull the skin gently into position and anchor using the stripes. Blend the stripes to the skin using cabo and appropriate colours.

4.20 Environmental Injury

4.20.1 Heat Injury

Heatstroke is a serious medical condition that occurs when the body can no longer handle the stress imposed by a hot environment. Sweating stops and the core temperature of the body rises out of control. Unless treated immediately, death will result. Characteristics of heatstroke include: dry red (flushed) skin with a rapid pulse and difficulty breathing. Neurological signs include confusion, agitation, seizures and coma.

When creating a heat injury casualty the makeup should give the first responder appropriate clues. If the casualty has been exposed to a hot environment, he/she may have sunburn and be dehydrated. Use the Burn and Injury wheel to make a first degree sunburn in the appropriate areas. Powder the face with a neutral set powder to dry the skin. Apply a thin latex skin with Pros-Aide® on stretched lips. When the lips return to the normal position they will wrinkle. You can pull up parts of the latex to show peeling lips. Colour the lips as appropriate with a burn and injury wheel.

4.20.2 Cold Injury

Frostbite is damage to the skin and underlying tissue caused by extreme cold. Areas of greatest risk for frostbite are the hands, feet, ears and nose. Risk factors include exposure to extreme cold, prior cold injury, moisture in the skin, wind, altitude, medical conditions such as diabetes which involve poor circulation, and tobacco use. Nicotine is a vasoconstrictor which reduces blood flow to the extremities.

The frostbitten area becomes hard, pale, and waxy white. Well-defined grey or yellowish blisters may form even in the early stages of frostbite. When thawed, frostbite becomes red sometimes progressing to blistering with shades of white, dark red, grayish blue and black. Frostbite can be approximated by using a Ben Nye® Monster Wheel, mixing and blending the colours to give a pale, waxy effect. The creme colour can be mixed with a small amount of Smashbox Artificial Light or a similar product to give a more realistic waxy appearance. Apply a small amount of Ben Nye® Sparklers Glitter Opal Ice MD-1 on top of the colour with a soft brush to mimic tiny ice crystals then seal with a matte sealer. Create the blisters with flesh effects gel and colour with the monster wheel. You can use pre-made gelatin blisters for these blisters. Colour the blisters with blood colour if desired. These blisters often form at the border between the frostbitten and non-frostbitten areas as a result of freeze/thaw cycles. Colour lips with a burn and injury wheel (purple, red, black), apply thin latex to simulate peeling skin on the lips. When applying the latex to the lips ask the casualty to tighten his/her lips; this will create a more natural wrinkled appearance when the lips are relaxed. For windburn apply the red from a burn wheel in a fine stipple with a stipple sponge.

For ice effects, mix a small amount of Ben Nye® Sparklers Glitter Opal Ice MD-1 with a water-based lubricant such as KY Jelly. Apply to face and hair but keep away from the eyes. You can thicken this mixture with a bit of Cab-O-Sil® if needed. There are kits available for ice effects from motion picture and special effects shops. The problem with these kits is that many of the ice effects shown in the instructions are fanciful rather than realistic.

When working in a cold environment, you don't want to expose your casualty to the cold. Make latex sheets by pouring latex out on a flat surface and letting it dry. Build your wound on the latex. Leave a wide border (10cm or more) around the wound. Cut or tear an opening in the casualty's outermost layer of clothing where the wound is located and position your wound below/inside this. It can sit on top of the casualty's skin or on top of inner layers of clothing. If you're careful you can reuse these wounds several times.

4.21 Bioterrorism

The most likely scenarios, based on the availability of suitable toxins and dispersal methods, are:

- anthrax
- botulism
- plague
- smallpox

See *Bioterrorism Preparedness Training and Assessment Exercises for Local Public Health Agencies*, by David J. Dausey, Nicole Lurie et al, prepared for the Department of Health and Human Services by RAND Health, a unit of the RAND Corporation, Santa Monica, CA, U.S.A., 2005 http://www.rand.org/

4.21.1 Anthrax

Anthrax is caused by the bacterium *Bacillus anthracis* and has two variants, cutaneous and inhaled. Cutaneous anthrax starts as a boil-like skin lesion eventually forming a painless necrotic ulcer with a shiny black eschar. Approximately 20% of cutaneous anthrax cases result in death.

Inhaled anthrax results in flu-like symptoms for several days followed by respiratory collapse. If treated early mortality for this form of anthrax is approximately 45%.

Cutaneous anthrax images are from the CDC, upper image by James H. Steele, 1962, lower image dated 1953 creator unknown. As a work created by an agency of the U.S. Federal Government it is in the public domain.

The anthrax attacks of September 2001 in which the spores were delivered in the mail, 11 cases were inhaled anthrax and 11 cases were cutaneous anthrax. For more about anthrax as a weapon see “Anthrax as a Biological Weapon, 2002, Updated Recommendations for Management”, JAMA. 2002;287:2236-2252, http://jama.ama-assn.org/cgi/content/full/287/17/2236

Cutaneous anthrax lesions may be simulated by a number of materials including latex and facial tissue. Take a single ply of facial tissue the approximate size and shape of the lesion you wish to make and saturate with cosmetic grade latex. Apply to clean skin. Shape with a makeup spatula and brush handle to approximate the shape of the lesion. Allow to dry

and colour with creme or alcohol activated paint. For the shine of the eschar, coat with glossy makeup sealer or a very thin coat of baby oil gel. You can also create lesions with cabo (thickened Pros-Aide®) or silicone. Colour and blend with alcohol activated paints.

4.21.2 Botulism

Botulism is caused by the neurotoxin botulin, produced under anaerobic conditions by the bacteria *Clostridium botulinum*is. Signs of botulism include drooping of both eyelids and loss of facial expression. The muscles controlling facial expression are inserted into the face and controlled by the cranial nerves which are affected by the toxin. If untreated respiratory failure can follow leading to coma and death. Death from botulism is approximately 2% when treated, 60% if left untreated.

The drooping of the eyelids and facial paralysis can be simulated by using adhesive medical dressing like Steri-Strips™ to tension parts of the face. Apply the strips to clean skin. You can use cabo to blend the edges of the strips. Colour blend with alcohol activated paints. Be very careful when placing adhesive strips near the eyes since the skin in this area tends to be thin, delicate and easily injured.

4.21.3 Plague

Plague (pneumonic plague) is a bacterial infection caused by *Yersinia pestis* which affects the lungs. Unlike bubonic plague which is caused by the same bacterium, pneumonic plague can be spread by an initial aerosol attack and then from person to person by coughing or sneezing. Signs and symptoms include fever, weakness, and rapidly developing pneumonia with shortness of breath, chest pain, and cough. Sometimes a watery or bloody sputum is present. Simulate bloody sputum with a fake blood product designed for use in the mouth. Without treatment respiratory failure, shock and death follow. For more information about plague as a weapon see Plague Information at the Centers for Disease Control and Prevention at http://www.bt.cdc.gov/agent/plague/.

4.21.4 Smallpox

Smallpox is caused by the variola virus and comes in two forms, variola major and variola minor. Most cases, approximately 90%, of smallpox are of the ordinary variola major type which has a fatality rate of about 30%.

After exposure to the virus there is an incubation period lasting 7 to 17 days. During this time no signs or symptoms are present. The Prodrome phase follows the incubation period and lasts from 2 to 4 days. Symptoms are fever, malaise, body aches and sometimes vomiting.

The next phase is an early rash starting with small red spots on the tongue and mouth. It is during this phase, the seven days following the onset of the rash, in which the person is most contagious. They will remain contagious until the end of the resolution phase. The spots develop into sores that break open spreading large amounts of the smallpox virus into the mouth. At the same time a rash spreads over the entire body usually within 24 hours and the fever goes down. By the third day the early rash forms raised bumps. On the fourth day these bumps fill with a thick opaque fluid and may have a depressed centre. This is a distinguishing characteristic of smallpox. At this point the fever may rise. Smallpox photos from the CDC, first photo by Dr. John Noble Jr. 1968, second photo by Dr. Robinson, 1962.

During the next 5 days the raised bumps become pustules, sharply raised and firm to the touch. At the end of this time the pustules form a crust and then scab over. This phase lasts about 5 days also, then a resolution phase lasting about 6 days begins during which the scabs begin to fall off. The person remains contagious until all the scabs have fallen off. For more information about smallpox as a weapon see Smallpox Information at the Centers for Disease Control and Prevention at http://emergency.cdc.gov/agent/smallpox/

Smallpox can be simulated using the latex/tissue method (see cutaneous anthrax description for this method), cabo or silicone. Colour using appropriate materials.

4.22 Character Creation

A casualty simulator may be asked to create a character for a specific scenario. The following are examples only, you should be able to come up with your own characters as required.

To make a person appear older, dress in outdated styles of clothing and have the person wear glasses. You can grey the temples by using a light application of white, water-activated cake mascara applied to the hair with a synthetic fan brush. Ask the casualty to wrinkle their face and use a light application of alcohol-activated paint one or two shades darker than their skin tone, applied in each wrinkle line with a fine brush. This will accentuate the wrinkles and make them appear older. Age spots and broken capillaries can be painted on the face. Apply foundation with a sea sponge, one shade darker than the actual skin tone, to age the face. The sea sponge gives an uneven, dry look.

To create a homeless person, start by considering how that person might live. They will be exposed to the elements and show the effects. Dress in old clothes, suitable for the environment but well-worn and dirty. You can use sandpaper to abrade and age the clothing and character powders to dirty it. Apply a bit of alcohol-activated red colour to the nose and cheeks with a black nylon stipple sponge for broken capillaries. Bronzer applied unevenly with a sea sponge to the face and hands will give a weathered look. An unshaven look can be created with a creme makeup called beard stubble (usually a reddish black and available from theatrical makeup suppliers), applied with a black nylon stipple sponge. Use latex on the lips for a chapped, weathered look. If consistent with the scenario, consider bruising on the hands and face from fights and falls. Hair can be given a stiff, unkempt look by applying a heavy coating of hairspray along with a dusting of character powder. Teeth can be aged using suitable tooth paints available from theatrical suppliers.

The smell of stale sweat (Bromhidrosis or bromidrosis) can be approximated using cumin spice. Extract the smell by soaking cumin seeds in water for a couple of days. Filter the mix. Do not use this mixture directly on the skin to avoid irritation and possible allergic reactions. Instead, slightly moisten a piece of gauze with this mixture and hide in the clothing.

Build up the inside of one shoe heel to create a limp (source: Inside Camp X by Lynn-Philip Hodgson, Blake Book Distribution, 2000).

For fast application of dirt to a large number of people, create a dirtbag by filling the end of a sock with cosmetic character powder (source: *Creating dirt effects for film and TV* by Steve LaPorte, Make-Up Artist Magazine, posted: Thursday July 07, 2011). To apply shake the bag over (do not touch the bag to the skin) the area you wish to dirty. If you're working near the face have the casualty hold their breath and close their eyes.

5. Appendices

5.1 Casualty Simulation Resources

Makeup Manufacturers

Graftobian Makeup Company http://www.graftobian.com/
Ben Nye® http://www.bennye.com/
Temptu Cosmetics http://www.temptu.com/
Kryolan® Professional Make-Up http://www.kryolan.com/
Reel Creations http://www.reelcreations.com/
Pros-Aide®, a division of ADM Tronics Unlimited, Inc. http://www.pros-aide.com/
Obsessive Compulsive Cosmetics http://www.occmakeup.com/
Kett Cosmetics http://kettcosmetics.com/
Michael Davy Film & TV Makeup http://www.michaeldavy.com/
Premiere Products - Makeup Products http://www.ppi.cc/makeup_sp_efx.htm

Art and Specialty Supplies

Liquitex® Artist Acrylic Paints http://www.liquitex.com/
Trengove Studios (special effects) http://www.trengovestudios.com/
Sculpey http://www.sculpey.com/
Burman Industries http://www.burmanfoam.com/
Kilgore International Inc. (typodont) http://www.kilgoreinternational.com/
Ice Fx Makeup http://www.icefxmakeup.com/
3M Tegaderm™ Dressings http://solutions.3m.com/wps/portal/3M/en_US/SH/SkinHealth/brands/tegaderm/
Chavant non-drying clay http://www.chavant.com/
Crown Brush (Cosmetic Brushes) http://www.crownbrush.us/
Smooth-On Liquid Rubbers and Plastics (silicone molding supplies) http://www.smooth-on.com/
Krylon Spray Paints (Crystal Clear and Dulling Sprays) http://www.krylon.com/
Industrial Products Division of United States Gypsum Company (Ultracal® 30) http://gypsumsolutions.com/
Mann Mold Release Agents http://www.mann-release.com/
Monster Makers http://www.monstermakers.com/

Makeup Safety and Regulation

Cosmetic Information & Safety http://www.cosmeticsinfo.org/
Cosmetics, U.S. Food and Drug Administration (FDA) http://www.fda.gov/Cosmetics/default.htm

Special Effects and Makeup Forums

The Effects Lab http://www.theeffectslab.com/
Indy Mogul - DIY Filmmaking http://www.indymogul.com/

Researching Trauma and Medical Conditions

PubMed, a service of the U.S. National Library of Medicine, http://www.pubmed.gov/
Trauma.org - Trauma care, http://www.trauma.org/
Pathology Index, University of Utah, http://library.med.utah.edu/WebPath/FORHTML/FORIDX.html
Instructor's Guide for Casualty Simulation, U.S. Army, 1964, http://www.archive.org/details/CasSimKit

5.2 Bibliography

Special Makeup Effects for Stage and Screen: Making and Applying Prosthetics *by Todd Debreceni, Focal Press, Burlington, MA, 2009*
The best introduction I've seen to special effects makeup. Everything from simple to advanced techniques explained in enough detail that you can try it out for yourself. Covers intermediate and advanced work in gelatin, silicone, foam latex and other materials. Clearly written and well illustrated, showing the latest techniques in special makeup effects. Every casualty simulator should have a copy of this book. Well worth the modest price.
Update: *2nd edition published* January 5, 2013

A Complete Guide to Special Effects Makeup: Conceptual Creations by Japanese Makeup Artists *by Tokyo SFX Makeup Workshop, Graphic-sha Publishing Co. Ltd., Tokyo, Japan, 2008*
This book is a good choice for the beginner with a couple of caveats. First, the book seems to be targeted at cosplay enthusiasts which somewhat limits its usefulness in casualty simulation. Secondly, the book shows many techniques but does not provide, in my opinion, sufficient detail to easily recreate the effects. Otherwise this book is a good source of inspiration for the casualty simulator. Well illustrated with colour photos.

Grande Illusions a learn-by-example guide to the art and technique of special make-up effects *by Tom Savini, Imagine Inc., Pittsburgh, PA, 1994*
Grande Illusions Book II *by Tom Savini, Morris Costumes, Charlotte, NC, 1996*
Although these books are now somewhat dated (Grande Illusions was first published in 1983) both are an excellent introduction to the type of thinking and skills necessary to create convincing special make-up effects. Well illustrated with photos and drawings showing the techniques in detail. Easy to read and very entertaining.

DVD
Fantastic Flesh: The Art of Make-Up EFX*, directed by Kevin Vanhook, produced by Andrea Kaufman, Starz Entertainment LLC, 2008*
Interviews with directors, actors and make-up artists about special effects make-up in motion pictures. Includes excerpts from well-known films such as “Dawn of the Dead”, “Planet of the Apes”, “Death Proof” and many others. Although this is not an instructional video, you will find some useful tips and you'll be introduced to the way that working make-up artists think and solve problems. 58 minutes.

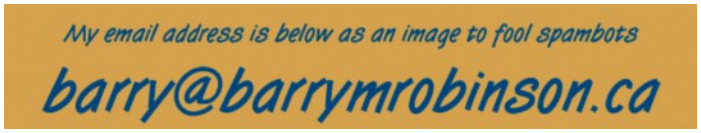
5.3 Casualty Simulation Basic Kit List

The quantity will vary according to the number and type of simulations you're doing. Using the materials in this list takes a moderate amount of technical skill. This list includes materials necessary for prosthetics application and removal but not the prosthetics (make these yourself or purchase). For clarity I've included examples in the product column (greyed out) where applicable; choose products based on performance, availability and price. Print out the list, fill it in (**#** = quantity, Product/Size) and take it to your local supplier. Keep your kit clean and organized. Check the contents on a regular basis for leaks and changes in colour or consistency. Some materials, such as silicone, have a limited shelf life.

#	Product/Size	Description
	Ben Nye® Stage Blood	Blood, stage
	Fleet Street Bloodworks, Drying Pastes, Blood	Blood, thick
	Fleet Street Bloodworks, Drying Pastes, Scab	Blood, old/scab
	Laerdal® Concentrated Blood	Blood, concentrated
	Kryolan® Burn & Injury Wheel and Bruise Wheel	Burn/Bruise Wheel
	Ben Nye® Monster Wheel	Creature Effects Wheel
	Green Marble SeLr™ or Ben Nye® Final Seal	Sealer, makeup spray
	Ben Nye® Neutral Set Powder	Powder, translucent set
		Powder, charcoal/black makeup
		Powder, dirt makeup
	Ben Nye® Color Cake Foundation	Foundation, theatrical, pale colours
	Ben Nye® creme Color Sky Blue	Creme base, light blue makeup
	alternative to latex: Water-Melon™ by Michael Davy	Latex, cosmetic grade liquid
	Seals latex when using creme makeup	Castor Sealer
	Kroylan® Dermacolor Camouflage Cream	Creme Foundation Palette, fair to dark
	Graftobian Modeling Wax, Bone	Wax, nose and scar
		Effects Gel, transparent
		Pros-Aide® adhesive
		Rigid Collodion
		Cabo, premixed Pros-Aide® + Cab-o-sil®
		Gafquat®
	3rd Degree or Skin Tite™ and Thi-Vex™	Silicone, skin safe prosthetic grade
		Flocking, red
		Flocking, beige
		Flocking, brown

#	Product/Size	Description
		Flocking, black
		Flocking, green
		Flocking, yellow
		Mixing cups, disposable
	Skin Illustrator® FX Palette	Paint, alcohol-activated, wound effects
		Witch Hazel
	MUST BE 99%	Alcohol, isopropyl **99%**
		Glycerin
	K-Y® Jelly or Muko®	Lubricant, water-based
		Mineral oil
	Collodacolor™ remover or acetone (cosmetic grade)	Collodion remover
	Telesis™ Super Solv®	Makeup remover
	Telesis™ Top Guard®	Barrier, skin
		Cotton tipped swabs
		Cotton balls
		Pads, quilted cotton
		Sponges, makeup
		Sponges, stipple
		Tongue depressors, wood
		Brush, powder
		Brush, round sable fine point
		Brush, angle, 1cm
		Brush, flat, various widths
		Brush, chip, 2.5cm
		Spatula, stainless steel, makeup
		Palette, stainless steel, makeup
		Eye droppers
		Scissors, bandage

6. License



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