Use of Alternate Light Sources & Negative-Invert Filters to Improve Visibility of Injuries Under the Skin

End Violence Against Women International

A few housekeeping items before we begin:

• Warning: explicit pictures of injuries will be shown

• Power Point handouts will be provided without images

End Violence Against Women International

EVAWI offers:

– Training assistance
– On Line Training Institute (OLTI) Free
– Webinars
– Conferences
– Website with additional information, facts and resources
– Join the EVAWI list serve for notifications!
A very special thank you to SPEX Forensics for sponsoring this webinar!

SPEX Forensics is a world leader in forensic light sources and the manufacturer of the CrimeScope series. These high-power versatile light sources are highly effective in finding many different types of evidence and injuries on victims both living and deceased. The CrimeScope is an invaluable tool in finding evidence not normally seen with the naked eye.

Contact them for a no obligation, onsite demonstration at questions@mail.crimescope.com.

**Webinar Speakers**

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**Objectives**

- List 3 external physical symptoms observed in strangulation cases
- Describe 3 differences between the alternate light source (ALS) and negative-invert filter technologies
- Describe the application of ALS and negative-invert filters to patients/victims reporting strangulation or other injury
- List 3 challenges in ALS photodocumentation
- Explain how using a tool to enhance visualization of an injury is different than diagnosing an injury
IPV, SA and Strangulation Injuries

- Strangulation is used as a means of power and control
- Strangulation is used to subdue a victim
  – May result in physical injury, emotional injury and death

Choking vs. Strangulation

- Choke (verb):
  – To keep from breathing in a normal way by compressing or obstructing the windpipe; no air exchange; or to entirely block the windpipe (e.g. hard candy or food)

- Strangulation (verb):
  – To seriously or fatally obstruct the normal breathing of a person
  – Excessive external pressure placed on the neck causing compression on the blood vessels and/or air passages (Gwinn et al., 2001)
  – Force most commonly used to gain control (Wilbur et al., 2001)
Carotid Artery: Transports blood to the brain. If blocked, petechial hemorrhages might not be observed in the eyes or surrounding tissue.

Jugular Vein: Transports blood back out of the brain. When the blood cannot escape, there is increased negative pressure which causes capillaries to burst, creating petechial hemorrhages to eyes as well as facial tissue (under eyes, forehead, scalp or inside the mouth).

Vessel Occlusion

- Carotid Artery Occlusion
  - Anterior Neck
  - 11 lbs. of pressure for 10 seconds

- Jugular Vein Occlusion
  - Lateral Neck
  - 4.4 lbs. of pressure for 10 seconds

Leads to Unconsciousness
Examples of Applied Pressure

- Handgun trigger pull: 6 psi
- Opening of soda can: 20 psi
- Adult male hand shake: 80-100 psi
- Maximum adult male hand shake: 160-180 psi

Source: Dr. Bill Smock, Louisville Metro Police Department

THE BRAIN

THE MOST OXYGEN SENSITIVE ORGAN IN THE BODY!

The brain must be bathed in a continuous circulation of oxygen rich blood or a progressive decrease in consciousness occurs within seconds. Cell death happens within 4 minutes. (Progresses to Anoxic Encephalopathy)

Signs and Symptoms

- Symptoms most commonly associated:
  - 71.7% neck pain
  - 54.2% headaches
  - 39.3% painful swallowing
  - 30.3% difficulty swallowing
  - 22.9% difficulty breathing

- Physical signs most commonly seen:
  - 33.6% ecchymosis of neck
  - 26.4% ecchymosis of chest and shoulder
  - 35.9% eye findings (petechiae, sclera hemorrhage)
  - 19% scratches on face

Petechial Hemorrhages

- With complete obstruction of mouth and nose by suffocation petechiae become generalized throughout the body rather than being isolated to the head.
- Complete and sustained obstruction of both jugular veins for 20-30 seconds causes petechiae above the point of constriction.

(Dr. Dean Hawley 2012)

Petechial Hemorrhages

- Multiple, pinpoint hemorrhages under the skin or sub mucosal tissue
- < 2mm
- Can be caused by blunt force injury

Other causes include:
- Consensual oral copulation
- Suction
- Strangulation


Are there other causes for subconjunctival hemorrhages?

- Strenuous labor
- Scuba diving
- Severe coughing or vomiting
- What else?
Documentation

Strangulation Cases

Photographing patients eyes
(Sclera)
- Have patient pull down on lower canthus to reveal sclera.
- Have patient pull up the upper eyelid to reveal the sclera.
- Have patient look from side to side to reveal the sclera.
- Photograph each angle as appropriate.

Simulation of strangulation
- Have patient demonstrate how they were strangled and photograph.
- A mannequin head or wig head can be used to help simulate the act.

Manual strangulation

- Ask patient/victim to demonstrate how he/she was strangled & look for injuries at those pressure points.
- Key Points:
  - Swab
  - Take photos of injuries or lack of injuries
Negative-Invert Filters

• Digital software filters for enhancing visualization
• Digital images are based on red, green and blue color values (RGB)
• The negative invert filter is 2 filters applied sequentially
  – A negative filter
  – An invert filter

Negative-Invert Filter

• Negative Filter
  – Creates a digital negative of the image
  – Converts the color value from positive to a negative
Negative-Invert Filter

- Real world analogies
  - Bright sunny day on the water or beach
  - Glare off of a mirrored building

- Clinical analogies
  - Alternate light sources
  - Toluidine blue dye
  - Fluorescein dye

- Common thread of all...
  - Used or applied to enhance visualization

Negative-Invert Filter

- Global Change
  - The change is globally applied to the image
  - The filter effects every single pixel of the image
  - Lightening or darkening an image

- Spot Change
  - Manipulation of an image that is NOT a uniform change to the entire image
  - A change made to a single area
  - This includes adding, subtracting, and obscuring
  - YES! This includes red-eye correction
Negative-Invert Filter

- Always show the filtered image side-by-side with the unfiltered image
  - Showing the filtered image without the unfiltered image can be grossly misleading!

- Best practice: raw files
  - The original data captured by your camera
  - JPEG/JPGs are NOT originals

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Alternate Light Sources

- Alternate light source (ALS) - Equipment used to produce visible and invisible light at various wavelengths to enhance or visualize certain items such as injuries, evidentiary items, and biological fluids. Visualization is made possible due to luminescence of the subject when specific wavelengths of light are applied.

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What happens?

• When light from the ALS is shined onto a subject, the radiation will be:
  – Reflected (specular reflection)
  – Transmitted (glass, water)
  – Absorbed (luminescence - fluorescence)
  – Or a combination of the three

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What can we see?

• Biologic fluids
  – semen, saliva, vaginal secretions, urine, sweat, decomposition fluids
  – Note: blood will absorb the near UV and blue-violet and appears black
• Gunshot residue
• Fibers
• Pigments and inks
• Powders/dyes for fingerprint development
• Petroleum products

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Electromagnetic Spectrum

Red  620 – 700 nm
Orange 590 – 620 nm
Yellow 575 – 590 nm
Green 490 – 575 nm
Blue  430 – 490 nm
Violet 400 – 430 nm

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Alternate Light Sources

Illumacam

Fox Fury Rook ALS Kit

Alternate Light Sources

- DSLR cameras are the preferred camera for use with any ALS
  - Adjustable settings from fully automatic to fully manual
  - Variety of lenses and filters available
  - Several file formats to choose from
- The key functional component is the sensor
  - Hot mirror: filter between sensor and lens

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Alternate Light Sources

• Purpose of hot mirrors
  – Protection for the sensor
  – Block certain wavelengths considered “undesirable”
    • 350nm and below (varies sensor to sensor)
    • 750nm and above (varies sensor to sensor)
• Removal of hot mirror allows for full spectrum photography
  – No full spectrum camera is commercially available off the shelf

Alternate Light Sources

• What to look for in a DSLR camera
  – Capable of generating a live preview on LCD
    • Especially for IR photodocumentation where subjects cannot be viewed through the viewfinder
    • Also allows for needed adjustments secondary to focus shift that occurs
  – Option for aperture priority mode
  – RAW, TIFF and JPEG file format options (not just JPEG!)

Alternate Light Sources

Courtesy of SPEX Forensics
Alternate Light Sources
The perfect camera system wish list…

• Full spectrum converted DSLR camera (commercial grade – hot mirror removed)
• Multiple multi-gig memory cards
• Macro lenses (especially for clinical use)
• Wide angle zoom lenses (crime scene/physical evidence, non clinical use)
• Tripod or stand with ball-head attachment and quick release plate on camera body
• Remote shutter release cables (hand/foot)
• Ring flash (for non-ALS photodocumentation)
• UV filters
• IR filters
• Full spectrum filters
• Color barrier filters
• Multiple scales (ABFO, linear, L)
• Camera battery charger and extra battery
• Batteries for flash unit

Alternate Light Sources
Additional items…

• Alternate light sources
• Goggles
• Education
  – Use of various wavelengths for different scenarios
  – Goggle and light combinations
  – Equipment

Alternate Light Sources
Quality does matter
  – Sensitivity and specificity
  – Illumination intensity
  – Diffuser
  – Hot spots
  – LED lights
  – Impact resistance
Alternate Light Sources

Considerations

• Negative-invert filter
  – The negative-invert filter is a software filter applied after the images are loaded into a computer with imaging software.
  – For use AFTER the exam.
• Alternate Light Source
  – An ALS is used at the time of the examination for locating samples to collect for analysis and for visualizing injuries.
  – For use DURING the exam.

In our practices...

• Diana
  – SDFI Telemedicine system with forensic imaging software
• Debra
  – SPEX Forensics alternate light source system
• Rachell
  – SDFI Telemedicine system with forensic imaging software plus various ALS solutions
Baltimore City ALS Strangulation Project

- Fewer arrests – no injury visible
- Bench training
- District and Circuit Court State’s Attorneys
- Detectives
- Academy

Reported Symptoms

- Dizziness
- Vision Changes
- Loss of Consciousness
- Ringing in Ears (tinnitus)
- Coughing
- Nausea/Vomiting
- Incontinence
- Muscle Spasms
- 2 or more = 90% ALS + (Holbrook, D., Jackson, M. 2013)
Physical Assessment Findings

• Bruising to the head and neck
  – Especially behind the ears
• Petechial Hemorrhages
• Abrasions
• Voice Changes - Hoarseness or Raspy
• Breathing Difficulties
• Dysphagia
• Point Tenderness
• Neck Pain and/or Edema
• 2 or more = 90% ALS + (Holbrook, D., Jackson, M. 2013)

When

• Fortunate enough to see injury
• Abrasions
• Bruising
• Petechial Hemorrhage

The Forensic Assessment
Reported Symptoms

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- Nausea/Vomiting
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Physical Assessment Findings

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When:

- Fortunate enough to see injury
- Abrasions
- Bruising
- Petechial Hemorrhage
The Research

Strangulation Injuries

• 97% of strangulations are manual
  – 90% of these will not show any visible markings to naked eye

• 3% of strangulations are ligature
  – 90% of these will show visible markings
  (Straek, McClane & Hawley, 2001)

Severity Assessment

• Loss of consciousness or incontinence cannot depict severity of assault.

• Increasing intensity and duration of assault = increased threat to life.
Physical Findings

• Approximately 80% of strangulation victims do not present with visible injuries to the neck.
• About 35% of victims present with minor injuries post assault.
• Petechial hemorrhages were most commonly found on or around the eyes.

(Holbrook, D., Jackson, M. 2013)

Physical Findings

• Swelling to the neck presents 24 to 48 hours after the strangulation attack. (Measure the neck)
• Imperative that the victim be assessed medically even though there may be no injury present
• Forensic medical exam guides medical intervention

Alternate Light Sources (ALS) Documentation

• This is NOT a camera
• Photographic documentation as available
  – Diagrams required as true and accurate representation
Alternate Light Sources Defined

• An Alternate light source is made up of a powerful light containing one or all of the ultraviolet, visible, and infrared components of the Electromagnetic Spectrum.

• It then filters down or selects the light by individual color bands (wavelengths) that enhance the visualization of evidence by light interaction techniques.

• The more power (energy) the better results

• The main way to visualize evidence is by:
  – Fluorescence (evidence glows)
  – Absorption (evidence darkens)
  – Oblique lighting (small particle evidence revealed).
How it Works

- When light strikes a surface or compound, it will either be absorbed, reflected, transmitted, or a combination of all 3.
- The actual interaction is between the photon of light and electrons bound to the atoms of the surface.

Equipment you will need

Nurse using the ALS light
Bruises

The Benefits

- Enhance identification of additional injury and evidence
- Complete documentation of injury for patients
- Locate and collect foreign material/debris evidence not visual to the naked eye.
FORENSIC NURSES USE ALTERNATE LIGHT SOURCES

- To visualize injuries and bruising not seen with naked eye
- Inform law enforcement that injury does exist
- Counsel physicians to severity of injury – that they couldn’t otherwise diagnose
  - CT, MRI, Soft tissue films
Closing Points

- Most patients are manually strangled.
- This mechanism rarely leaves visible marks.
- Patients generally do not fully “pass out”.
- Vast majority show positive ALS injury with absorption under the skin requiring prompt medical intervention.

(Holbrook, D., Jackson, M., 2013)

Will this Help in the Courtroom?

- Successful Frye Reed Hearing
  - May 2013
  - State of MD vs Nelson Clifford
  - Upheld as respected technology used by Forensic Medical Professionals

A Few Final Thoughts on Implications
Enhancing the Visibility of Injuries with Narrow-Banded Beams of Light within the Light Spectrum

- Crime-lites, especially violet and blue, improve the visibility of injuries that are barely visible to the naked eye.

- Study Conclusion: Narrow banded beams of light within the visible light spectrum enhance visualization of injuries, including contours, size, and pattern. The technique is quick, noninvasive and easily performed.

R. Limmen et Al. AAFS Journal March 2013

Key Points

- Legal reliance on standard photography to document the severity of bruising injuries is unsupported by scientific evidence.

- Victims of color are systemically disadvantaged by visual assessment of bruising and are at greater risk of having their injuries ignored or under-prosecuted.

- Strangulation is highly correlated to lethality for victims but often leaves little to no bruising, making it difficult to prosecute. This problem is compounded for victims of color.


Key Points

- Improved methods of documentation are needed to increase effective prosecution and remedy racial inequities. Methods include alternate light source photodocumentation and negative-invert filter software.

- Attorneys can effectively advocate for victims using expert testimony, scientific understanding of bruising, and improved evidence-gathering techniques.

Man sentenced to 15 years in prison for sexually assaulting co-worker

Alex Carreon was convicted of assault with the intent to rape and assault and penetration by a foreign object in the April 4, 2008, attack on "Molly Doe." Superior Court Judge Stephen Gallon denied a defense bid to drop a sentence enhancement for causing great bodily harm.

Defense attorney said the defendant was just trying to keep her quiet.

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**Improve The Response**

- Educate, Educate, Educate
- Training, Training, Training
- Document, Document, Document
- Photograph, Photograph, Photograph
- Offer Rx, note symptoms and refer, collect specimens for analysis
- Collect, Collect, Collect.....

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**References**

- Tactical MAX Forensic Light Kit. Catalog No. TMX 100. Sirche product manual Lot # 02/13
- Spectrophotometric evaluation of the age of bruises in children: measuring changes in bruise color as an indicator of child physical abuse. Mimasaka S, Ohtani M, Kuroda N, Tsunenari S.
References


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