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Postmortem Impression Recovery: Guidance and Best Practices for Disaster Victim Identification

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Foreword

Friction ridge analysis (to include fingerprints, palm prints, and footprints) is a rapid, reliable, and cost-effective means to identify unknown deceased individuals and human remains [1]. Friction ridge impressions obtained from a decedent are generally termed postmortem (PM) prints and can be difficult to obtain due to circumstances surrounding the condition of the decedent/remains as a result of the deadly event. Postmortem impressions can be used to verify or establish the identity of a decedent by comparing them to a known antemortem (AM) fingerprint, palm print, or footprint record, or by searching them through an automated fingerprint identification system (AFIS). While not all jurisdictions utilize an AFIS system that also allows for palm print searching, many databases have expanded to include palm prints and supplemental prints. The medicolegal authority should adhere to the best practices identified in this text to the extent possible, practical, and appropriate. These practices are specifically designed to address postmortem friction ridge recovery associated with mass fatality incidents (MFI). The retention of these postmortem impression records is crucial to the successful use as a means of victim identification. In the absence of specific guidance, the principle, spirit, and intent of this document should be met.

The objective of Disaster Victim Identification (DVI) is to match acquired PM data from the recovered remains with AM data obtained from the victim's next of kin or other external sources to help establish a positive forensic identification. If the remains have reliable primary identifiers, such as Odontology, Friction Ridge Prints, or DNA and the identifiers have met approved standards without inexplicable discrepancies, the information can be presented to an identification board for reconciliation. These scientific means of identification are the basis for DVI.

This document was revised, prepared, and finalized as a standard by the Disaster Victim Identification Consensus Body of the AAFS Standards Board. The draft of this standard was developed by the Disaster Victim Identification Subcommittee of the Organization of Scientific Area Committees (OSAC) for Forensic Science.

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the term **'should'** indicates that a provision is not mandatory, but recommended as good practice.

All hyperlinks and web addresses shown in this document are current as of the publication date of this standard.

Keywords: *forensic identification, postmortem identification, automated fingerprint identification system (AFIS), postmortem fingerprint, postmortem impression, disaster victim identification, fingerprint submission strategy, mass fatality, friction ridge*

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Postmortem Impression Recovery: Guidance and Best Practices for Disaster Victim Identification

1 Scope

This document provides guidance on, and highlights challenges associated with, obtaining postmortem prints from decedents and/or human remains in morgue operations associated with mass fatality disaster incidents.

2 Normative References

There are no normative reference documents. Annex A, Bibliography, contains informative references.

3 Terms and Definitions

For purposes of this document, the following definitions apply.

3.1
antemortem and postmortem records
Antemortem (AM) records are records collected from live subjects, and can come from any part of friction ridge skin. Friction ridge skin is present on the palmar and plantar surfaces of the hands and feet. As such, impressions from the fingers and palms of the hands as well as the toes and soles of the feet can all be used for personal identification purposes. During antemortem friction ridge print recovery, the living subject is usually manipulated against the recording medium.

Postmortem (PM) records are records collected from deceased subjects or remains. During postmortem friction ridge recovery, the recording medium is usually manipulated against the deceased subject in the same manner as the antemortem records. Unless a manual comparison is available, an AFIS search of an unidentified postmortem impression is used as a tool to find antemortem records in order to establish or verify the deceased subject's identity [4,9].

3.2
Automated Fingerprint Identification System
AFIS
Biometric computer system that allows forensic examiners to encode, digitize, and search recovered fingerprint impressions against known fingerprint record databases for identification purposes. Many newer systems also allow for palm print and lower joint searching.

3.3
friction ridge analysis
Fingerprints, palm prints, and footprints have friction ridge skin that has been used for personal identification purposes for well over a century. Collectively, the analysis of friction ridge prints from any of these areas of skin is known as friction ridge analysis.

4 Postmortem Impression Collection

4.1 Setup and Equipment

DVI settings are unique in that morgues are not always a stationary setup. Often times, a mobile mortuary is required to handle the quantity of decedents, or a permanent mortuary is reconfigured to be used for high throughput processing. In these scenarios, location is not important, but essential tools and setup procedures will ensure ease of collection and processing of remains [5,6].

- "Clean" station:
  - administrative designated work area;
  - setup of administrative equipment such as computers, scanners, and comparison equipment;
  - personal protective equipment (PPE).
- "Dirty" station:
  - mortuary friction ridge print collection station;
  - tools/equipment for reconditioning the remains;
  - medium(s) to record the friction ridge prints;
  - personal protective equipment (PPE).

4.2 Preliminary Information

Before examining the remains, it is advised that the technicians or practitioners familiarize themselves about the incident to determine best possible methods of friction ridge print recovery. This information may consist of the following.

- Circumstances surrounding the death (e.g., natural versus accidental versus man-made event).
- Circumstances surrounding the recovery of the remains (e.g., found under rubble, recovered from water, highly fragmented, remains removal facilitated by implements, or machinery, etc.).
- Determine if there are AM friction ridge impression records available elsewhere, such as decedent's residence, place of employment, etc.
- In addition to familiarization of the event it is important that the practitioner understands the local laws and jurisdictions pertaining to the removal or modification of human remain tissue. Any anticipated removal of skin or digits should be done with the prior approval and permission of the chief medicolegal authority residing over the case.
- It is important to have an agreement amongst all practitioners that will be processing the deceased on protocols, labeling methods, and intended workflows.

4.3 Postmortem Friction Ridge Print Recovery Process

4.3.1 Locate, Clean, and Inspect Friction Ridge Skin

Once work begins to process the remains, following a systematic approach of locating any remains, cleaning them if necessary, and inspecting them for damage or postmortem changes will ensure the best possible outcome for obtaining best-quality postmortem friction ridge impressions.

a) When initially inspecting the remains, it is important to account for all available friction ridge skin. It may be necessary to sort through more damaged or highly decomposed remains to ensure all friction ridge skin present is located.

b) Cleaning the remains can be done using soap and warm water, or mild cleaners with care to not disturb or damage the skin on fragile remains. In the place of soap and water acetone or isopropyl alcohol can be very effective for both cleaning and drying the skin.

c) Inspect the remains to see what is the condition of the skin, and note any damage. This initial assessment will help to determine the methods used (if any) to recondition the skin.

d) In cases where the digits may not be accessible due to extreme rigor, thermal modification or desiccation, the rehydration process may require either the severing of the flexor tendons (Siwek slice) [2] or removal of the fingers or hands. All care should be taken to avoid the removal of fingers if at all possible, but in certain cases this may be necessary to obtain high quality friction ridge impressions. It is important to verify that jurisdictionally the practitioner is legally allowed to do so and has permission of the medicolegal authority in advance.

e) If at any time during the examination of friction ridge skin the intended methodology may destroy or negatively effect the ability to capture a quality postmortem impression, the remains should be photographed prior to any reconditioning or attempted recording of the skin. This photographical documentation should be done with the least amount of manipulation of the skin and with the goal of producing a high quality reproduction of the friction ridge arrangement.

f) See Annex A: Postmortem Recovery Workflow for additional information [6].

4.3.2 Recondition Damaged Friction Ridge Skin

Damaged or deteriorated friction skin often requires the use of advanced techniques to recondition the skin in an effort to return it to as natural a state as possible for recording quality postmortem impressions. The below methodologies pertain to the indicated conditions of the remains. While they are not explicitly applicable to only one type of postmortem change, not all of the processes listed are universally suitable.

a) Maceration and Decomposition (water exposure/damage)

    1) *Injection Method*
    A viscous liquid used that can be injected into the fingertips in an effort to restore firmness in the tissue. Solutions such as tissue builder, alcohol, or other viscous liquids are injected into the end of the finger by passing the needle through the first joint or medial phalange, resulting in the elevation of depressed areas in the fingertip, thus removing any wrinkles that are present [1].

2) *Epidermal Gloving*
The initial stages of decomposition may result in a phenomenon known as "gloving," in which the epidermal layer of skin separates from the dermal layer of skin. In this situation, the epidermal skin can be cut from the dermis, dried, and placed over the protected finger of an examiner for recording purposes. If the epidermal skin is too fragile to manipulate, it can be documented photographically with appropriate lighting for retention purposes. If the epidermal layer is completely separated from the dermal layer, recordings of the epidermis and dermis should be taken to ensure that they match and are not from different individuals. This is especially important in disaster situations where a commingling of remains often occurs [1].

3) *Boiling Technique*
Friction ridge prints can be recovered from a variety of remains by using the boiling technique, a method that uses boiling water to visualize or elevate ridge detail on the dermis through osmotic rehydration. This technique is very effective on dermal skin, but may not yield higher quality prints if the epidermis remains intact. This process involves bringing water to a boil in a hot pot and then after removing the water from the heat source, submerging the hand from the body into the water for 5 to 10 seconds. The hand is then removed from the water and examined for friction ridge detail, which will be visible on the surface of the dermis if it has been successfully reconditioned. If no detail is present, the hand can be placed back into the water for another 5 to 10 seconds. After drying, the friction ridges should be printable at this time using standard techniques. If there is any visible damage to the skin the boiling water can cause adverse effects. The use of a sponge soaked in the heated water placed on the skin can have the same effect without inducing damage. It is important that the friction ridge skin is not left in actively boiling water for any extended period of time as it can cause tearing of the skin and permanent contraction of the muscles. Friction ridge skin that has been boiled will lose definition gained through the technique after 3 to 5 minutes. The practitioner should be prepared to record the impression prior to boiling the skin [3].

b) Thermal Modification (charred/burned skin)

1) *Sever flexor tendons if hands are clenched (Siwek Slice)*
Clenched hands are usually exhibited on decedents that burn to death. While the fingers of the hand can be forced open, there is a risk of damaging the brittle skin resulting from thermal modification of the tissue. One way to minimize any additional damage to the friction skin is to relax or fully extend the hand by cutting the flexor tendons of the fingers. An incision placed at the crease of the wrist (Siwek Slice) will sever the flexor tendons in all the fingers allowing access to the palmar surface of the hand to recondition the friction skin and record postmortem impressions [4].

2) Break or twist off the outer skin at the tips of fingers, attempt to print the dermal skin.

3) It is possible to attempt the boiling technique as a last resort to rehydrate the skin.

c) Desiccation (mummification)

1) *Ammonium Hydroxide Rehydration*
A solution of ammonium hydroxide (2%) and sodium bicarbonate (25 g/L) in water can be used to rehydrate friction ridge skin in 6 to 12 hours. Whole hands or extremely mummified

tissue will increase the duration required. This process utilizes the sodium bicarbonate as a buffer and is less destructive than the sodium hydroxide rehydration method. It also allows the remains to be printed using traditional means as it does not leave an oily residue behind [8]. Extended soaking using this technique will typically not dissolve the skin. The effectiveness of this technique however decreases under refrigeration and may require additional time.

2) *Sodium Hydroxide Rehydration*
A solution of sodium hydroxide dissolved in water can be used to rehydrate the hands and/or digits of mummified remains [5]. This process utilizes a 3% to 5% sodium hydroxide solution and generally works within a matter of hours, however, frequent monitoring is advised as the tissue may start to disintegrate rendering the skin unprintable.[6] There is no required stopping point for hydration, rather the remains can continue to soak until they are reasonably rehydrated. An oily film may appear on the epidermal skin and can be gently rinsed away with water and light scrubbing. As a safety precaution this process should not be started unless the progress can be constantly monitored by an attended technician. The effectiveness of this technique however decreases under refrigeration and may require additional time, but the remains must still be frequently monitored.

3) *Detergent Rehydration Techniques *very lengthy process**
A number of different chemical methods can be used to rehydrate desiccated skin, such as soaking the fingers in the leather conditioner Lexol®[ab] (Summit Industries, Inc., Marietta, Georgia), Palmolive®[ac] or equivalent. The rehydration of the fingers may take hours or days, depending on the extent of desiccation. Accordingly, the examiner should regularly check for skin pliability. When the skin has softened, the fingers are removed from the jars and washed clean. The examiner should try to stretch the skin to remove any creases and then use tissue builder to remove any remaining wrinkles, returning the fingers to a near natural appearance.[1]

4.3.3 Record Quality Postmortem Impressions

Examination quality postmortem impression records should be recorded from human remains using various recording strategies. Techniques used and conditions of the skin observed should be documented on the record to assist in properly searching and comparing the prints. The recording strategies below are listed in order of best suggested practice to yield the highest quality impressions in the most efficient manner.

a) *Biometric Scanning Device*
Biometric scanner devices are becoming increasingly more available in their use to capture prints of both living and deceased individuals. These devices differ greatly in quality, capability, speed, and ease of use [9]. Many of the scanners require electrostatic connectivity produced by a living individual and therefore do not work well with deceased individuals. It is important to know how to use particular devices prior to deploying them in a DVI setting, and know their limitations in printing decedents. Some devices also have the capability to directly transmit the images to an AFIS system, but ensure that a copy of the record is retained for the Medicolegal

[a] This term is used as an example only, and does not constitute an endorsement of this product by the AAFS Standards Board.
[b] https://www.lexol.com/
[c] https://www.palmolive.com/en-us

Authority and Identification Review Committee, or to be used for further comparisons. Typically the devices are comprised of a scanner platform that can be manipulated against the decedent's fingers until a sufficient impression is recorded. This is repeated for all available fingers, as available. The resulting card is printed or transmitted as necessary.

b) *Powder and Adhesive Lifter Technique*
The recommended recording strategy for recovering postmortem impressions from deceased individuals involves the use of black powder and white adhesive lifters. This technique is quick and easy to use, resulting in clear prints compared with those obtained through inking. The first step in the procedure is to lightly coat the fingers or other friction ridge skin with black powder, covering the entire area, using a traditional camel or squirrel hair fingerprint brush (stiff bristle) or sponge-type disposable paintbrush. Each area is lightly powdered and separately placed on an adhesive lifter, (such as Handiprint[de], Quickprint[df], or equivalent), that is pre-cut to the approximate size of the finger blocks on a standard fingerprint card or free form card for palms and feet. For fingerprints, the lifter is placed just below the first joint and then wrapped around the finger nail to nail to record the powder impression. If debris or skin from the finger is being lifted along with the powder and obscures ridge detail, a less adhesive lifter such as an adhesive mailing label should be used. The recorded impression is then affixed to the back of an acetate fingerprint card. This type of clear plastic card can be produced by photocopying a standard fingerprint card onto transparency film. The same process applies for lower joints, unknown portions of skin, palms, and feet [2].

c) *Photography*
When recommended recording techniques have failed to produce quality postmortem impressions, or the skin is too fragile to handle effectively, images of the friction ridge detail present on the skin can be captured with digital photography. The proper selection of direct, oblique, reflected, or transmitted lighting schemes will enhance the appearance of ridge detail often resulting in high-quality images that can be used for identification purposes. It is also important to capture 1:1 images, at a 90˚ angle to the plane of the friction skin because the photographs will be compared against antemortem impressions of natural size. If the capture is not taken at 90˚, or 1:1, the print will undoubtedly be distorted and may miss in an automated database search. If a 1:1 capture cannot be accomplished, a scale or object of a known measurable size should be included in the photograph so that image dimensions can be corrected through the use of digital imaging software to a minimum of 500 ppi in a lossless file format. Photographs taken directly of friction ridge skin will be in reverse position, and many photographs may require advanced digital processing before use [1]. Adding a very thin layer of fingerprint powder or ink may assist the photographer with creating a better contrast, if the use of oblique lighting is insufficient.

d) *Casting Techniques*
Friction ridge print casting works well on desiccated remains containing wrinkles in the friction skin. This technique can be used after the skin has been rehydrated or at a disaster scene when rehydration is not an option and prints need to be recovered from the remains without delay. Lightly coat the fingers with black powder, followed by the application of the casting material,

[d] This term is used as an example only, and does not constitute an endorsement of this product by the AAFS Standards Board.
[e] https://www.csiforensic.com/10.html
[f] https://www.arrowheadforensics.com/catalogsearch/result/?q=quickprints

(i.e., AccuTrans®[gh], Mikrosil™[gi], or equivalent), that is white in color, to the fingers. Mikrosil[g] must first be mixed and then applied to the fingers with a spatula, whereas AccuTrans[g] comes with an auto-mixing gun option that allows direct application to the fingers. The casting material must be allowed to dry on the fingers before being peeled off to capture the print. Recovered prints will be in correct position and color when compared to an antemortem standard [4].

e) *Ink/Paper Technique (limited in DVI setting - use only if necessary)*
The standard method for recording fingerprints has been the application of a thin layer of black printer's ink to the fingers and then recording the friction ridge impressions onto a fingerprint card from nail to nail. A full palm or foot print can be captured the same way. Although this technique works well with the living, it is more difficult in its application for printing the dead. The examination of a body usually takes place with the deceased positioned on his or her back for eventual autopsy. This position makes it difficult or nearly impossible for the examiner to apply ink to the fingers using an inking plate and thus requires that ink be directly rolled or added onto a spatula and applied to the fingers. The common application of too much ink may result in distorting/smudging of the recorded prints. It is also not feasible to roll the finger impressions onto a fingerprint card, especially when rigor mortis has set in the body. The recording of inked impressions is thus accomplished using a tool called a spoon that can be placed on the end of the finger. Fingerprint blocks are held in the spoon and are used to capture friction ridge detail and create a complete fingerprint record.

Remains should be thoroughly examined as soon as possible, before ongoing decomposition deteriorates the friction ridge skin and limits the ability to recover quality postmortem impressions. (1) It is assumed that the remains have been rendered safe from any hazards and that appropriate personal protective equipment (PPE) is worn. (2) Trained friction ridge print practitioners[j] should be utilized for the recovery of examination quality postmortem impressions from the deceased. Qualified friction ridge print examiners will be necessary for the subsequent comparison or search/submission of recovered postmortem records through appropriate AFIS databases, but may also prove useful in the collection process.

5 Use of Postmortem Records

5.1 General

The end goal of recording postmortem impressions from disaster victims is to help establish the scientific identity of those victims. The impressions taken can be manually compared, or searched through an AFIS system to verify or establish identity. It is imperative that the quality of recovered postmortem prints be sufficient for both of these tasks.

[g] This term is used as an example only, and does not constitute an endorsement of this product by the AAFS Standards Board.
[h] https://www.accutransusa.com/
[i] https://www.shopevident.com/category/casting-footwear/mikrosil-forensic-silicone-casting-material
[j] The term *trained friction ridge print practitioner* indicates that individuals recording or approving the postmortem impression records must be able to discern the prints' value for comparison purposes as a quality measure. This term does not encompass/include the training recommended for PM print recovery techniques.

5.2 Manual Comparisons

Refer to the policies of the Forensic Service Provider (FSP) for further guidance on the examination of friction ridge impressions.

5.3 AFIS Searches

Refer to Postmortem Impression Submission Strategy for Comprehensive Searches of Essential Automated Fingerprint Identification System Databases, ANSI/ASB Best Practice Recommendation 007, *Postmortem Impression Submission Strategy for Comprehensive Searches of Essential Automated Fingerprint Identification System Databases* current edition, for effective searching of postmortem impressions.

5.4 Collection and Use of Postmortem Footprints

Especially in the case of high energy crashes and in fire scenes, the most protected friction ridge skin is often on the feet. While the availability of AM databases containing fingerprints and palm prints make collecting PM fingerprints and palm prints a priority, footprint collection should not be ignored. Most often AM footprint records are not readily available, if they exist. Unless the person was printed as a military pilot, or as part of a specific collection program, the only AM footprints will be those which are collected by processing items of evidence or the floors of the person's residence or domicile. These "purported knowns" are still a viable means of identifying the person, especially in cases where AM Dental records are not found and no familial DNA reference exists. It is common from the stress related to morgue operations for a managerial decision to be made for footprints to not be taken in an effort to save time. This should only be considered for whole bodies or when the hands are at least intact and still attached to the body. If there is gross fragmentation or severe degradation to the quality of the hands and fingers, then footprints should be taken for all remains as that may be the only primary modality of identification available. The same principals listed above apply for taking footprints, however automated searching of footprints is typically unavailable.

6 Record Retention

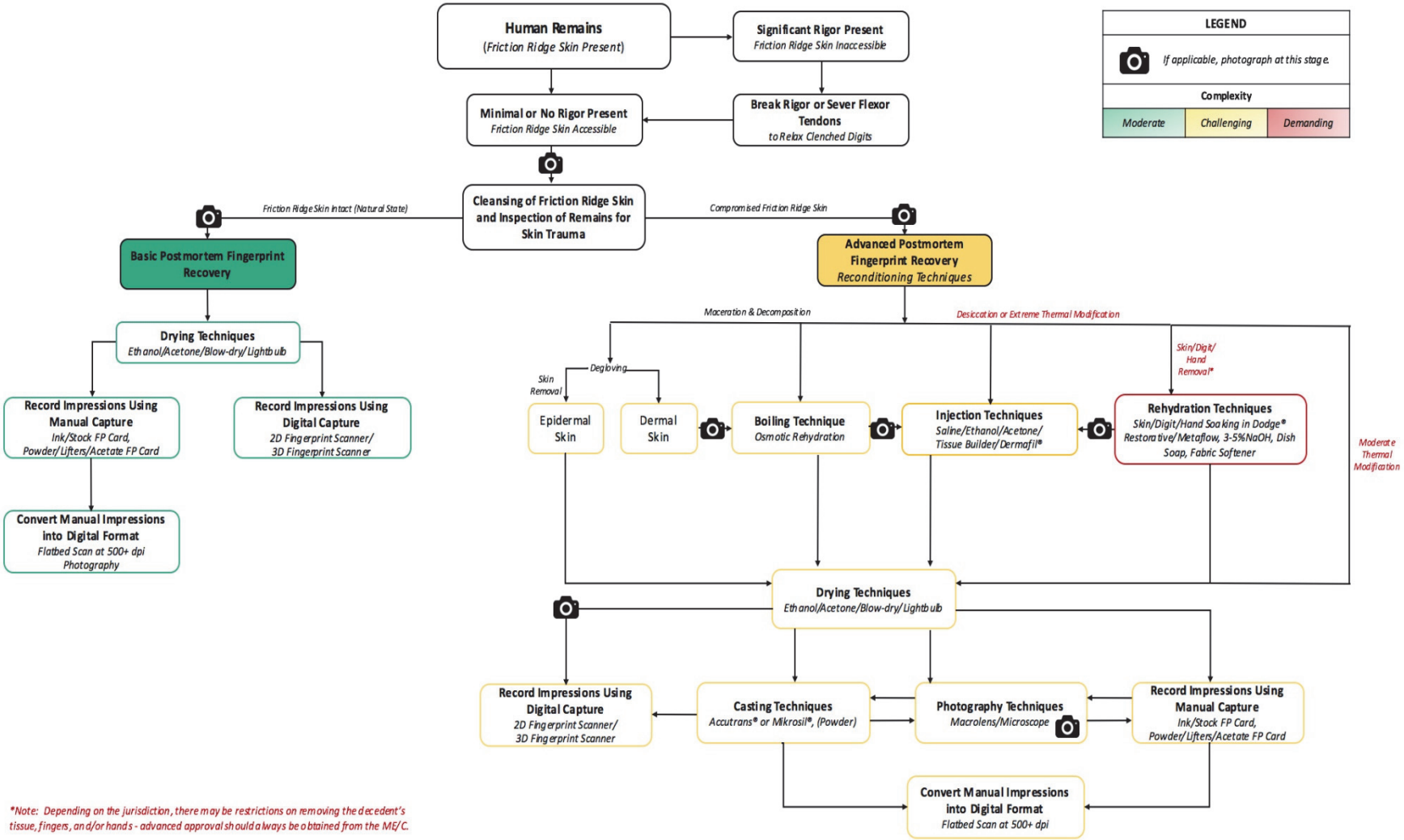
All hardcopies taken of postmortem impressions should ultimately go to medicolegal authority that is designated as being in charge of the scene as they are considered evidence.

— It is best practice to retain a digital/scanned copy of any prints taken, for further comparison and documentation as needed. This record should be a minimum of 500 ppi in a lossless file format.

— Depending on the capture capabilities or transmission capabilities on scene, it may be possible to digitally transmit records to AFIS systems or forensic laboratories for additional searches and image processing.

Annex A
(informative)

Postmortem Recovery Workflow



Annex B
(informative)

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[k] http://europepmc.org/article/PAT/MX2010011682

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