

## REVIEW ARTICLE

# Current Practices of Sample Packaging, Sealing, Storage and Drying Techniques in a Medico-legal Case

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## Abstract:

Evidence is the basis of a medicolegal case. Forensic Pathologists collect biological evidence in cases of unnatural, violent, or unexpected deaths. The collection and preservation of biological evidence is one of the most crucial components of any forensic investigation. Even the slightest change or tampering can change the fate of a case. It can make a major impact in seeking justice and adhering to applicable laws. Although it may seem intuitive to place evidence in a bag or container for storage but it's critical to utilise specific evidence collection bags and containers for specific categories of evidence to preserve its integrity and efficacy in lab testing procedures. Proper evidence submission includes proper collection, drying, packaging, sealing and transportation etc. This paper aims to review all types of methods presently used to dry, pack, seal and preserve the integrity of biological evidences and recommend the necessary changes that should be made to make the process rapid and the biological evidences as tamper-proof.

**Keywords:** Biological evidence, Drying techniques, Tamper-proof packaging, Sealing, Preservation.

## Introduction:

A Forensic autopsy is a postmortem investigation performed to resolve medico-legal concerns. All unnatural deaths (homicides, suicides, and accidents etc), suspicious deaths, and unexpected deaths require a legal inquiry, which involves an autopsy as part of the evidence gathering procedure.<sup>1</sup> The samples collected during such autopsies are mostly arterial or venous, femoral and cardiac blood, urine, vitreous humour, stomach content, and organs (particularly the liver and lungs, always after dissection) and various other types of samples (e.g., blood clots, blood from the thoracic or abdominal cavities, cerebrospinal fluid, brain, spleen, bile, bone, synovial fluid, bone marrow, maggots, skeletal muscle) are collected in specific cases. These all samples are then submitted to respective Toxicology, Histopathology or Forensic Science laboratories for further examinations.<sup>2,3</sup> A proper analysis requires appropriate sample submission and as opposed to it, improper sample submission can jeopardize the procedure and leads to inaccurate results.<sup>4</sup> Proper evidence submission includes proper collection, drying, packaging, sealing and transportation. This study provides a global overview of sample collection, drying, packaging, sealing and transportation processes.

**Biological evidence:** Evidence is the basis of a medicolegal case. Forensic Pathologists collect biological evidence in cases of unnatural, violent, or unexpected deaths.<sup>5</sup> Biological evidence is a blanket term that encompasses anything that contains a

biological component or evidence that contains biological material.<sup>6</sup> Depending on the scenario, different types of biological samples such as blood, urine, vitreous humour, stomach content, hair, nail, oral fluid, gastric content and viscera, etc. are collected as evidence, packed and sent for analysis.<sup>7</sup> Likewise, evidences such as ligature, cloth with seminal or bloodstains recovered from cases of homicide, suicide or sexual abuse are packed and handed over to police personnel.<sup>6</sup> All these types of evidence would require a different collection method and accordingly the type of packaging material.

**Traditional methods of collection, packaging and sealing of biological evidence:** Although every mortuary and lab have its own protocols for gathering, packaging, and sealing biological evidence but there is no uniform process followed across mortuaries and labs. The samples are collected in either glass or plastic containers with screw caps.<sup>8,2</sup> These containers are packed using gauze or cloth and sealed with lac material which is heated over a flame and dropped over the gauze, following which a metallic impression of the sample collecting centre is placed. (Fig.1) Sometimes, this process is not smoothly followed, resulting in improper sealing and exposing the handlers to the risk of burn injuries and other health hazards.

The samples are kept unattended until they are handed over to the police. If samples like cloth or ligature soaked in blood, semen or water from drowning are received, they require air drying before packaging to avoid contamination. Even wet bloodstains on small objects should be dried, and objects should be preserved as it is. In case of larger objects, wet bloodstains should be transferred onto a clean cotton cloth which should be dried and packed. During packaging and transportation, it should also be dried to preserve the integrity of any bloodstain pattern.<sup>9</sup> However, this process is quite time-consuming. Due to lack of time, such samples are

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packed in plastic bags or paper envelopes before completely drying and handed over to the concerned authority. This creates a favorable environment for the microorganisms to flourish and destroy the biological evidences.

**Transport and storage of evidence:** Once evidence is collected in a paper bag or container, it should be sealed, labelled, and transported to ensure a proper chain of custody. While transportation and storage, evidence should be kept in a dry place and at room temperature as it could get destroyed and incompetent for further analysis. If the evidence is designed for DNA analysis, it should never be stored in plastic bags as it will retain moisture and destroy the evidence. All wet blood and body-fluid stained items should be air-dried and not subjected to any heat. All stained items, except for metal or glass (e.g., knives or bottles), post drying can be frozen if stored for a longer duration.

During transportation, it is advised to take samples in air-conditioned vehicles. Care should be taken that evidence collected from the suspect and victim are stored and transported separately or in separate packages to avoid cross-contamination.<sup>9</sup> But presently in most of the centres, attention is not paid on these aspect either due to ignorance or lack of resources so there are high chances of reduction in quality of evidence with time. Further the police transports the samples in most of the cases after a gap of keeping them in their storage rooms and that too in public transport in non-air conditioned vehicles so further the quality of samples is further degraded with chances of cross contamination by handling, storing and transporting samples from multiple cases together.

**Importance of proper drying, packaging and sealing of evidence :** In demonstrating the victim's case and the accused's innocence, medico-legal evidence of substantial quality is fundamental. Proper collection, drying, tamperproof packaging, sealing, and preservation of evidence significantly impact the quality of the evidence. All specimens of body fluids and tissues collected during autopsy are susceptible to contamination and degradation because of environmental conditions and microbial growth.<sup>10,11</sup> Therefore, when these samples are sent for biochemical and toxicological analysis, tamperproof packaging guarantees that damage/pilferage is avoided, the chain of custody is maintained and useful information is obtained through the analysis.

**Drying of Biological evidence:** Biological evidence can be submitted in two different physical states: wet and dry. Evidence such as blood samples and viscera must be submitted in liquid form, mostly collected from a mortuary, crime laboratory or medical facility. While other wet evidence, such as a bloodsoaked garment, should be dried so that it can be properly stored and tested in the future. Drying these wet samples should be the first thing done by the one handling them. There are two types of methods currently being utilized by a few countries for drying such wet samples- Low-Tech and High-Tech methods.

**Low tech drying methods:** Evidence is dried in a secure and secluded location, such as a room or locker. This area should have surfaces that allow easy decontamination, such as tiles. Stainless steel rods should be present for hanging the articles with traces of

biological evidence over it (Fig: 2). It is not recommended that the space allocated for drying biological evidence be exposed to direct sunlight. Furthermore, the temperature and humidity should be kept as consistent as possible, with temperature variations limited between 15.5 °C and 24 °C (60 °F and 75 °F) and relative humidity not exceeding 60%.<sup>12</sup> However at present mostly the labs and mortuary even don't have such a dedicated area for drying and the samples may be either lying in any corner of the mortuary or lab under ceiling fan for drying or packed without drying therefore making it susceptible for attack by microorganisms. Low tech procedures are used by organisations that do not have adequate funding or prerequisite for equipment specifically developed for drying evidence

**High-tech drying methods:** Commercially available high-tech evidence dryers are already manufactured in countries like the United States and the United Kingdom.<sup>13-15</sup> These cabinets use high-efficiency particulate air (HEPA) filter through which air is circulated, and any air-borne particles are drawn out through the filter. This also has a locking mechanism on the door handle that prohibits unauthorised access, thus preserving the evidence integrity (Fig: 3).

**Sample/Evidence Containers (packaging):** As evidence travels between locations for forensic examinations, it is packaged to safeguard it from the start of the inquiry. Some agencies use primary and secondary layers of protection for packaging recovered biological evidence. Primary packing protects the evidence, whereas secondary packaging preserves its continuity and integrity. Two considerations must be addressed when determining which packaging material is ideal for a specific type of biological evidence: degradation and contamination.<sup>11</sup> Although biological evidence collected from the mortuary is brought to a laboratory, immediate testing is unlikely.<sup>16</sup> Thus, packaging must be suitable for transit and storage. Deterioration and contamination may occur if improper packaging and sealing are employed during the preservation period.

It's critical that the sample container is suitable for the intended purpose and not jeopardize the analytical results. Unless the manufacturer indicates otherwise, use only new, distilled-water rinsed, and sterile containers. Samples need separate container and plastic, especially polypropylene, doesn't break when frozen. Volatile samples (such as solvent abuse or anaesthetic gas intoxication) should be collected as soon as feasible in glass containers sealed with Teflon® or aluminium foil-lined lids to reduce diffusion losses.<sup>7</sup> The size of the container should also be such that it is appropriate for the volume and weight of the sample leaving the least possible head-space.<sup>17</sup> Although plastic containers are routinely used to store samples, glass containers are the best materials for collecting and storing fluids or tissue specimens as glass is inert and does not contain plasticisers like phthalates found in some plastics, which could interfere with the analysis.<sup>5,2,8</sup> The only drawback with glass is that it is prone to breakage; thus, storing and transporting them in proper storage racks is recommended.<sup>1</sup> If plastic is to be used, it is recommended to use Nalgene, an inert plastic that lowers the chances of chemical interference and doesn't break on freezing.<sup>18</sup> Many commercially available containers are composed of



Figure 1(A-E). Method of packaging and sealing of biological evidence in a mortuary.



Figure 3. High-tech drying method. (Source: The Biological Evidence Handbook: Best Practices for Evidence Handlers).



Figure 2. Low-tech drying method. (Source: The Biological Evidence Handbook: Best Practices for Evidence Handlers).

polycarbonate, polyethene, or polypropylene with extremely low quantities of plasticisers appropriate for collecting tissue specimens.<sup>19</sup> To prevent samples from being tampered with, self-adhesive tamper-resistant stickers should be placed on container lids.<sup>17</sup> However at most of the places at present, the attention is not being paid on this aspect so either plastic or glass containers, locally available in the market are being used for the purpose. **Sealing of biological evidence:** The package or container should be sealed so that opening it results in noticeable damage or alteration to the container or its seal.<sup>6</sup> There are three common ways to seal any evidence heat seal, tape seal and lock seal. Lac sealing wax stick (Fig.4A) is the most commonly used heat seal method for sealing evidence.<sup>20</sup> Some laboratories, and even at the crime scene, heat sealers are used to seal plastic evidence bags. (Fig.4B) They are handy and can seal plastic bags and tubes in no time. Another most commonly used material for sealing is evidence security tape (Fig.4C). They are tamper-evident acetate tapes that tear if tried to remove physically, and if tampered with

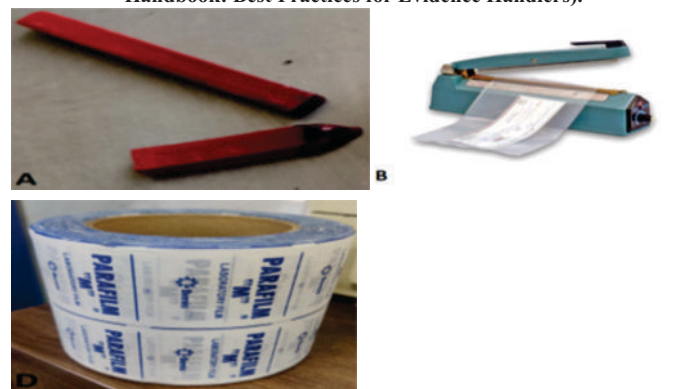


Figure 4 (A-D). Different types of evidence sealing materials.

using any chemical, the solvent sensitive dye dissolve and smears.<sup>21</sup> Parafilm is another tape seal material used for sealing screw top containers with evidence (Fig.4D).<sup>22</sup>

**Standard operating procedures being followed to avoid the risk of contamination:** When identifying, collecting, and preserving evidence, especially for DNA analysis, increased care for contamination issues is required. The following steps are being followed variedly and nonuniformly while handling any evidence or biological sample:<sup>9</sup>

- Wear gloves, use disposable/clean instruments, avoid coughing, talking or sneezing around biological evidence or stains.
- Avoid touching face, nose, and mouth.
- Avoid touching the place where DNA might be present.
- Allowing evidence to air dry completely before packaging.
- Not placing evidence in plastic bags and not using staples.
- Handle each stain independently.
- Use tweezers with smooth, easy-to-clean operating surfaces
- Separately packaging the "unstained control" from the evidence stain.
- Container- big enough for air to circulate the evidence item.
- Place the clean paper on (or in) bloodstained clothing and fold it such that the paper restricts contact between different



stains. Ensure that the staining pattern(s) are not altered or cross-contaminated with other wet stains while the objects are drying.

- Attaching a metal or glass evidence item to the bottom of the box with wire so that it doesn't pierce the edges of the box/container.
- Metal or glass evidence items with bloodstain or body fluids is not frozen.
- Samples submitted to the lab as soon as feasible.
- Tape seal, initial and date all samples

#### Discussion:

Until now, forensic expert testimony has helped the court in many cases. Medical evidence is vital in determining a person's time of death, cause of death, nature of injuries, the weapon used to inflict injuries, assailant's handedness, etc. Postmortem reports and autopsies can help determining the accused's guilt.<sup>23</sup> To maintain integrity, all evidence must be identified, inventoried, and secured from the mortuary to the trial. It's crucial to prove that the evidence presented in court is the same evidence gathered at the crime scene/mortuary and that access was regulated and documented. To ensure court admissibility, an investigator must observe chain-of-custody standards. Evidence preservation needs drying, tamper-proof packaging and sealing, safe storage, and transportation. The majority of "laboratory errors," according to laboratory medicine, come from the preanalytical phase (i.e., collection, packaging, sealing, storage and transport), not from difficulties with the analytical process.<sup>24,25</sup> Jansch<sup>5,26</sup> observed in 1922 that in cases of suspected poisoning, the use of improper containers and long-distance transit led to inaccurate findings. Also, there are no current best practice standards and guidelines to help forensic experts and pathologists. In response to an upsurge in evidence tampering cases in Himachal Pradesh, India, the High Court determined that the current standard of gathering, packing, and sealing is exceedingly low and that a tamperproof, scientific alternative to cloth packaging and wax sealing is needed.<sup>27</sup>

Moreover, several underlying factors influence law enforcement's ability to properly store evidence for optimum preservation, which includes limitations in the storage facility's management and capacity, insufficient packaging materials, inadequate or improper temporary storage, technological changes, and the intervals between evidence collection and transport to the evidence storage unit.<sup>28</sup> The ethical, legal and policy aspects of bio-specimen collection is also quite complex and even more than the technical matters.<sup>29</sup> A quality management system is also an essential element in managing biological evidences and key to this system is strict adherence to standard operating procedures which should guide through every step of biological evidence preservation.<sup>30</sup>

#### Conclusion:

Numerous procedures are available, and new approaches are being developed to improve the examination of biological evidences. However, no such universal standard protocols exist

in the way these samples should be packed, sealed, and stored in mortuaries and laboratories, which could significantly impact the testing quality and such practices vary from place to place for collection of evidences. Therefore, it is critical to standardize the drying, packaging and sealing techniques and materials used to maintain the integrity of the samples at every step from the moment it is collected through its final disposition. The demands of adequate storage space and staff personnel should be prioritized by authorities and some research initiatives on this aspect. It must also be ensured that institutions have adequate resources and the acceptable methods and procedures are being followed to ensure that biological evidence is suitable for future analysis. Until the samples are handed over to the concerned parties or police, there should be dedicated sample storage cabinets with limited access, effective sample's dryers, suitable containers and packaging materials in every mortuary and laboratory to safely store all biological evidences collected from medico-legal cases in a tamperproof manner to ensure sanctity and acceptability at the time of submission in the court of law.

#### Conflict of Interest: nil

**Ethical approval:** As this study is a part of extramural research project entitled "Developing a tamperproof sample packaging and sealing kit with an effective sample's dryer technique and a handy device to seal the samples in a medicolegal case "under Indian Council of Medical Research (ICMR), New Delhi there for the ethical approval was taken from Institutional Ethical committee of All India Institute of Medical Sciences Bhopal (AIIMS Bhopal) India( IHEC LOP/2020/ EF0180 dated 21/05/2020).

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