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Autopsy vis-à-vis defective preservation and dispatch: a retrospective audit of medicolegal histopathology

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Background: Histopathology can strengthen medico-legal opinions, but its yield depends on pre-analytical steps: what is sampled at autopsy, how tissue is preserved/packaged, and how it is dispatched/received. We audited these steps to quantify where the diagnostic value is lost.

Methods: We did retrospective audit of medico-legal histopathology submissions during calendar year 2022 at the Himalayan Institute of Medical Sciences (SRHU), Dehradun, Uttarakhand, India. We analysed all attempted submissions (parcels + paperwork), integrating pre-receipt intake rejections (leakage; labelling/document discrepancies) with cases received and accessioned. Defects were classified as: (i) autopsy-side sampling; (ii) preservation/dispatch; and (iii) packaging/labelling.

Results: Of 82 attempted submissions, 22/82 (26.8%; 95% CI 17.1–36.5) were returned before receipt (leakage 4/82, 4.9%; labelling/document discrepancies 18/82, 22.0%). The laboratory received 60/82 (73.2%); among these, 32/60 (53.3%) were diagnostic/informative and 28/60 (46.7%) were non-diagnostic. Within received cases, preservation/dispatch defects were present in 30/60 (50.0%; 37.3–62.7), autopsy-side sampling defects in 7/60 (11.7%; 3.5–19.8), and packaging/labelling defects in 2/60 (3.3%; 0.0–7.9). Viewed end-to-end, only 32/82 (39.0%; 28.3–49.7) attempts yielded a diagnostic report; 28/82 (34.1%) failed after receipt and 22/82 (26.8%) were rejected pre-receipt. Geography showed modest, imprecise differences (preservation/dispatch: hills 36.4% vs plains 53.1%). By IPC group (received cases), preservation/dispatch defects were most frequent in 306 (71.4%) and 302 (58.3%), and lowest in 304B (14.3%). Sentinel issues included "LAD/LCx not submitted" (n=7) and single-jar multi-organ (n=2).

Conclusions: Most diagnostic loss arises after sampling but before processing, dominated by preservation/dispatch failures; a smaller, fully preventable share reflects autopsy-side omissions. A focused bundle—send the whole heart intact, ensure ≥10:1 fixative:tissue in separate jars, UN3373-style triple packaging with leak-testing and two-person label checks, plus intake triage with rapid re-submission—should improve yield and reduce avoidable loss of evidentiary value.

Keywords: Medicolegal; Histopathology; Pre-Analytical Error; Autopsy; Quality Improvement.

Introduction

During medico-legal autopsies we frequently rely on histopathology to corroborate or refine the cause of death especially when the gross findings are subtle or equivocal. However, the diagnostic yield of histopathology is highly vulnerable to pre-analytical factors that occur before a slide is cut. What is sampled at the autopsy table, how the tissues are preserved and packaged, and how they are dispatched and received all affect the outcome. In forensic workflows, these upstream steps often sit outside the direct control of the histopathology laboratory but are decisive for whether sections are even possible and whether microscopy can contribute to the legal questions at hand. [1–3]

Two broad sources of pre-analytical failure are commonly conflated.

1. Autopsy sampling: failure to submit key structures (e.g., both coronary arteries, septum, valve rings), use of non-representative fragments (e.g., tiny slivers), or ambiguous labelling. [4,5]

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2. Preservation/dispatch: inadequate fixative, leakage in transit, single-jar multi-organ packing, delays or temperature excursions, missing seals or paperwork, and other chain-of-custody breaks. [1,3,6–8]

In routine reporting, these distinct problems are frequently summarized under a single rubric, "autolysis," or "sections not possible," which obscures responsibility and blunts quality-improvement (QI) efforts. Clearer attribution is essential: sampling lapses require changes at the post-mortem room, whereas preservation/dispatch defects call for packaging standards (e.g., separate jars, adequate fixative), transport controls (including UN3373-compliant triple packaging), and intake triage at the laboratory. [1,3,8]

In our institute the cases originate from both plains districts (e.g., Haridwar, Dehradun) and hill districts (e.g., Pauri Garhwal, Chamoli, Uttarkashi), with varying transport distances, facility types, and human resources. Case mix spans IPC sections 302 (homicide), 304B (dowry death), and 306 (abetment to suicide), each with different investigative pathways and expectations from courts and police. Courts and investigating officers care less about where the failure occurred than about whether an informative histopathology opinion can be produced at all, and how to prevent recurrent loss of evidentiary value. Against this backdrop, we present a retrospective audit of medico-legal histopathology in 2022 using a practical classification that distinguishes autopsy-side sampling from preservation/dispatch and packaging/labelling defects, and that incorporates pre-receipt intake outcomes. Our objectives were to quantify the frequency of each class and propose a targeted quality improvement bundle to improve yield and reduce recurrent pre-analytical loss. By disaggregating where and how the process fails, this audit aims to align corrective actions with the point of failure, shorten the path to an informative histopathology report, and, ultimately, better serve the evidentiary needs of the justice system.

Aims and Objectives

Primary aim

- To quantify pre-analytical defects in medico-legal histopathology.

Secondary objectives

- Compare defect rates between hill and plains districts.
- Describe reasons for pre-receipt returns (leakage vs labelling/document discrepancies).
- Identify sentinel markers that are directly actionable (e.g., "LAD/LCx not submitted," "no sample solution attached," single-jar multi-organ).
- Assess submission completeness for mandatory cardiac elements (LAD, LCx, RCA, septum, valve ring).
- Screen for clusters by police station/facility indicating process bottlenecks.

Methods

We performed a retrospective audit of medico-legal histopathology submissions during calendar year 2022, in Himalayan Institute of Medical Sciences, SRHU, Jolly Grant, Dehradun, Uttarakhand, India. Cases originated from plains districts (Haridwar, Dehradun) and hill districts (Pauri Garhwal, Chamoli, Uttarkashi, Tehri Garhwal).

Pre-receipt intake rejections: samples returned before acceptance because of leakage (n=4) or label/document discrepancies (n=18). These were included only for the end-to-end denominators.

We extracted data in an excel sheet after applying pre-specified text markers (regular expressions) and verified ambiguous entries by reviewing manually. This study used de-identified medico-legal records and met criteria for waiver of consent. Reporting follows STROBE guidelines. [9]

Inclusion criteria

1. Medico-legal autopsy submissions accessioned in 2022 that physically reached the histopathology laboratory and for which a report text was issued.
2. Any organ set (heart-only or multi-organ) and all ages/sexes.
3. Submissions logged in 2022 but returned before accession due to Leakage, or Labelling/document discrepancies.

Exclusion criteria

1. Duplicates/resubmissions of the same case: if both an intake rejection and a later accepted submission occurred, they were linked and represented as a single attempted submission in end-to-end totals.
2. Cases not accessioned in 2022.

Results

During the calendar year 2022 there were 82 attempted submissions (parcels + paperwork) relevant to the audit. Of these, 22/82 (26.8%; 95% CI 17.1–36.5) were returned before receipt at the laboratory (pre-receipt/intake rejections). Of these 4/82 (4.9%; 0.2–9.5) were marked for leakage and 18/82 (22.0%; 13.0–30.9) for returned for labelling/document discrepancies. The remaining 60/82 (73.2%) were received and accessioned and form the primary analytic cohort.

Among the 60 received cases (Figure 1), 32 (53.3%) produced a diagnostic/informative histopathology opinion, while 28 (46.7%) were non-diagnostic (e.g., sections not possible or "no opinion possible,"). Within received cases (Figure 2), preservation/dispatch defects were present in 30/60 (50.0%; 37.3–62.7), autopsy-side sampling defects in 7/60 (11.7%; 3.5–19.8), and packaging/labelling defects in 2/60 (3.3%; 0.0–7.9).

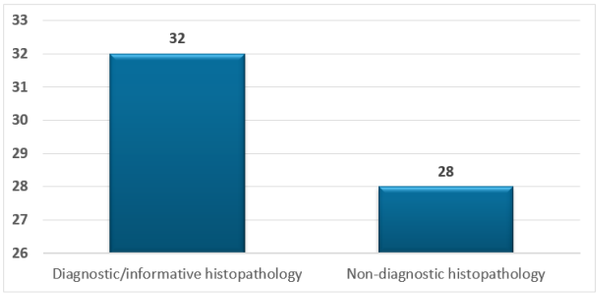

Figure 1: Distribution of cases on the basis of outcome.

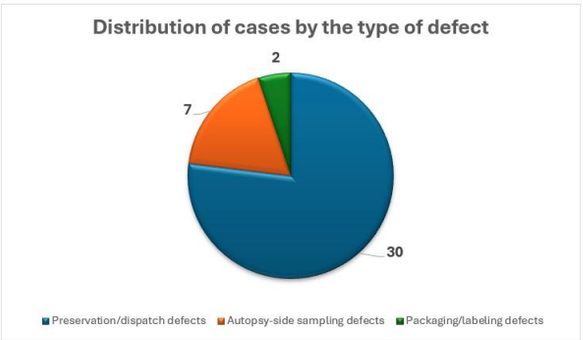

Figure 2: Distribution of cases by the type of defect.

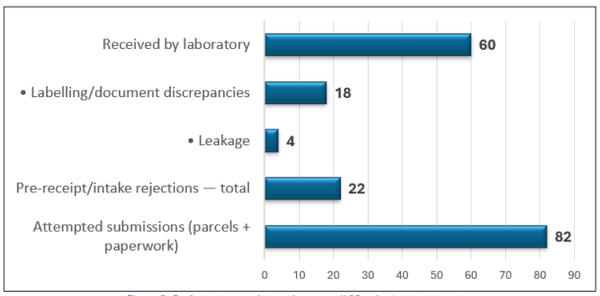

Figure 3: Performance end to end across all 82 submission attempts.

Viewing performance end-to-end across all 82 attempts (Figure 3), 32 (39.0%; 28.3–49.7) yielded a diagnostic report, 28 (34.1%; 23.7–44.5) failed after receipt, and 22 (26.8%) were rejected pre-receipt.

Geography (Figure 4) showed modest, imprecise differences: preservation/dispatch defects were 36.4% in hill districts (4/11) versus 53.1% in plains (26/49), odds ratio 0.51 (95% CI 0.13–1.95); autopsy-side sampling defects were 9.1% vs 12.2% (OR 0.72). Packaging/labelling defects appeared only in hill submissions (2 cases).

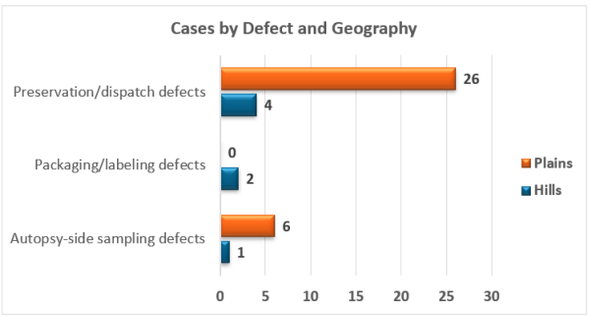

Figure 4: Distribution of cases based on Defect and Geography.

By IPC group (received cases, Figure 5), preservation/dispatch defects were most frequent in 306 (71.4%) and 302 (58.3%), intermediate in Other/None (50.0%), and lowest in 304B (14.3%).

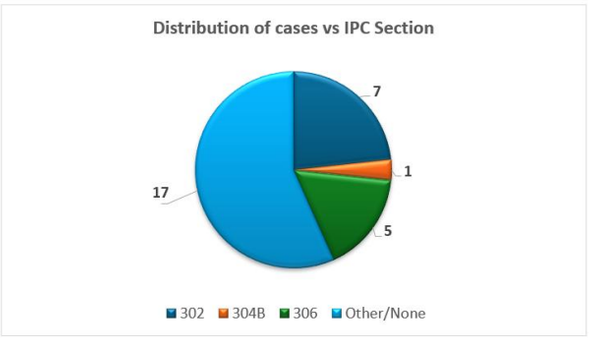

Figure 5: Distribution of cases vs IPC Section.

Sentinel markers (Figure 6) included "LAD/LCx not submitted" (7 cases), and single-jar multi-organ (2).

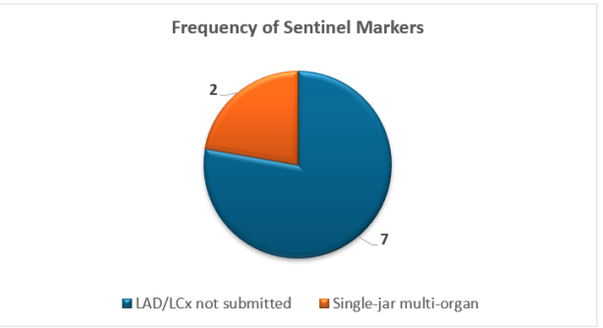

Figure 6: Frequency of Sentinel Markers.

Discussion

This audit shows that much loss of diagnostic value in medico-legal histopathology occurs either during sampling, after sampling, but before processing. Among received cases, half (30/60; 50.0%) carried preservation/dispatch defects, while autopsy-side sampling defects were less common (7/60; 11.7%) and packaging/labelling defects were rare (2/60; 3.3%). When the entire pathway is considered, only 32 of 82 attempted submissions (39.0%) produced an informative report; 28/82 (34.1%) failed after receipt and 22/82 (26.8%) were rejected at intake for leakage or labelling/document discrepancies. This end-to-end perspective is critical: it reflects how investigators and courts experience the service and identify where remedial effort will have the greatest impact.

Preservation/dispatch failures were characterized by language such as "autolysed," "sections not possible," or "no preservative solution," indicating inadequate fixation, leakage, single-jar multi-organ packing, or transport delays/temperature excursions. These defects eliminate the possibility of meaningful microscopy, even when sampling at the post-mortem table was otherwise appropriate. The concentration of such findings along specific routes suggests operational bottlenecks that are amenable to targeted training and packaging/transport controls. [1,3,6–8]

Autopsy-side sampling defects were fewer but fully preventable. The most frequent sentinel was "LAD/LCx not submitted" (seven cases), indicating that heart had not been received intact and was missing some parts. In each instance, this was attributable to errors during autopsy, wherein the Medical Officer did not remove and dispatch the whole heart intact, and the necessary coronary segments were not included for histology. Such omissions limit interpretation of coronary disease or myocarditis despite adequate preservation. [4,5]

Packaging/labelling issues within the received cohort were uncommon but high consequence. Two submissions (both from hill districts) arrived as single-jar multi-organ parcels. In several instances, oversized tissue was forced into undersized containers, for example, a large heart packed in a small jar or multiple organs placed in a single small jar, producing pressure artefacts and gross deformation of viscera, further compromising interpretability. Most label/document problems were intercepted at intake (18 pre-receipt rejections), underlining the value of strict accessioning criteria. Nonetheless, zero-tolerance rules for single-jar multi-organ, missing fixative, and mismatched identifiers should be enforced at both dispatch and intake. [8]

Geographical differences were modest and imprecise in this series: preservation/dispatch defects were 36.4% in hill submissions versus 53.1% in plains (OR 0.51; 95% CI 0.13–1.95), and autopsy-side sampling defects were similar (9.1% vs 12.2%). These estimates are limited by small denominators (11 hill, 49 plains). By IPC group, preservation/dispatch defects were highest in 306 (71.4%) and 302 (58.3%) cases and lowest in 304B (14.3%). The higher defect burden in IPC 306 (abetment to suicide) and IPC 302 (murder) is concerning because these are the most serious medico-legal categories. This suggests gaps in protocol adherence and/or training of Medical Officers working in peripheral hospitals, compounded by operational pressures (after-hours autopsies, longer or more complex chain-of-custody, heavier/large-organ parcels, and longer transport times). In contrast, the lower rate in IPC 304B (dowry death) may reflect tighter oversight and faster routing in these cases. These remain hypotheses and targeted audits of pre-dispatch checklists, fixative volumes, packaging, and transport intervals are warranted.

The findings support a simple quality-improvement bundle aligned to the observed failure points:

1. Sampling: remove and dispatch the entire heart en bloc, with ≥ 2–3 cm of aorta and pulmonary artery attached; do not send partial hearts or small fragments.
2. Fixation/packaging/dispatch: minimum 10:1 fixative:tissue ratio, separate jar per organ, UN3373-style triple packaging with leak-proof secondary containment and absorbent material, 10-second inversion test before dispatch, and two-person label/document verification with barcoding.
3. Intake triage and feedback: automatic red-flags for leakage, missing fixative, or single-jar multi-organ; immediate call-back and re-submission within 24–48 h; regular correspondence with referring centres.

Conclusion

In summary, nearly three in five attempted submissions failed to produce an informative histopathology opinion once intake rejections were counted. The preservation/dispatch problems are the dominant cause and autopsy-side omissions a smaller, fully preventable contributor. Implementing focused efforts on sampling, fixation/packaging, and intake control should improve diagnostic yield and reduce avoidable loss of evidentiary value.

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