

## A Prospective, Autopsy Based Study of Spectrum, Patterns, and Medicolegal Implications of Resuscitation Induced Iatrogenic Artefacts

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### ABSTRACT

**Background:** In present days, intensive care and emergency medical procedures frequently leave behind unique physical marks on the hospitalized patients. In this, cardiopulmonary resuscitation (CPR) is a primary source of complex internal and external changes on the body. To differentiate antemortem injuries from these artefacts caused during resuscitation is a major challenge for forensic medicine expert. **Objectives:** To identify the different types of iatrogenic artefacts and calculate the percentage of each type and to determine the various factors contributing to the occurrence of iatrogenic artefacts. **Materials and Methods:** We conducted a prospective, autopsy based observational study on 120 hospitalized deaths at the Department of Forensic Medicine & Toxicology, S.M.S. Medical College & Attached Group of Hospitals, Jaipur, between June 2024 and May 2025. Brought dead cases, Traumatic cases involving chest injury and cases of decomposed dead bodies were excluded. The autopsy findings were systematically cross matched with clinical hospital records. **Results:** Resuscitation caused injuries were confirmed in 51.67% (n=62) of the total cases. Skeletal damage was frequently seen: left-sided rib fractures occurred in 38.33% (n=46) of cases, right-sided rib fractures in 27.50% (n=33), and sternal fractures in 15.00% (n=18). A severe combination injury involving left ribs, right ribs, and the sternum at the same time was found in 7.50% (n=9) of cases. Other than these skeletal injury, on further dissection revealed artificial airway-related trauma in 75.00% (n=90), pharyngeal mucosal bleeding due to digital manipulation in 51.67% (n=62), local changes from noradrenaline injections in 34.17% (n=41), mouth to mouth breathing markers in 20.83% (n=25), and defibrillator induced injuries in 16.67% (n=20). **Conclusion:** Resuscitation procedures produce a high number of wounds that can be easily confused with traumatic injuries. Forensic practitioners must perform detailed external and internal examination while thoroughly correlating findings with hospital treatment record to prevent wrong judicial judgement regarding violence, assault, or medical malpractice cases.

**Keywords:** *Iatrogenic artefacts, Cardiopulmonary resuscitation, Rib fractures, Medico-legal autopsy, Forensic pathology.*

### INTRODUCTION

Forensic medicine serves as a vital part in the administration of justice by offering objective, scientific assessment of bodily injuries, precise manners of death, and the circumstances leading to terminal events. While the postmortem examination remains the gold standard

for these conclusions, its real-world diagnostic accuracy is frequently complicated by iatrogenic artefacts. These modifications are defined as alterations or injuries produced unintentionally by diagnostic or therapeutic procedures carried out during the management of a patient.

With the rapid growth of modern medical sciences and an increasing dependency on advanced tertiary intensive care units (ICUs), the structural incidence of iatrogenic changes has grown considerably. In critically ill hospitalized patients, invasive procedures ranging from central venous catheterization and mechanical ventilation to high-quality cardiopulmonary resuscitation (CPR) leave characteristic external patterns and deep internal changes.

The critical core of this issue lies in the fact that these therapeutic marks closely resemble true antemortem trauma resulting from external violence. For example, needle puncture sites can easily be confused with non-therapeutic injection marks or fine puncture wounds; electrical defibrillator burn marks can be diagnosed as thermal assault; and resuscitation induced rib or sternal fractures can resemble heavy, blunt-force domestic or criminal assault. Misdiagnosing these medical marks can trigger severe medico-legal failures, including false allegations of criminal assault, wrongful arrests, or baseless lawsuits claiming medical negligence. Consequently, this prospective study was designed to map the exact morphological spectrum and frequencies of resuscitation artefacts within a major tertiary hospital zone to establish clear forensic baselines.

## MATERIAL AND METHODS

**Study Design & Setting:** A descriptive, cross-sectional, autopsy-based observational study carried out in the Mortuary of the Department of Forensic Medicine & Toxicology, S.M.S. Medical College & Attached Group of Hospitals, Jaipur, Rajasthan from June 2024 to May 2025.

**Inclusion Criteria:** All identified dead bodies with history of hospitalization at the time of death.

**Exclusion Criteria:** 1. Brought dead cases. 2. Traumatic cases involving chest injury. 3. Decomposed dead bodies. 4. Completely burnt or charred dead bodies. 5. Skeletonised remains. 6. Cases where complete treatment record is not available. 7. Cases with ambiguous History.

**Autopsy and Technical Protocol:** The body of deceased was received in the mortuary of Department of Forensic Medicine and toxicology at SMS Medical College Jaipur then the police paper, medico-legal report, treatment record and death summary was examined thoroughly after that history was taken from investigating officer of the case and legally authorized representative of deceased and witnesses and Informed consent was taken from the legally authorized representative of the deceased to conduct the autopsy then Preliminary demographic data was recorded and then whole body was examined for presence and types of iatrogenic artefacts due to CPR after that the data was recorded on a pre-approved proforma and photographs was taken and

recorded as needed and at last the data obtained was analysed using appropriate statistical tools.

**Statistical Analysis:** Gathered data were cross-tabulated using Microsoft Excel. Categorical parameters are reported as raw counts and absolute percentages. Chi-square ( $\chi^2$ ) analysis was applied to test correlations, with significance benchmarks locked at  $p < 0.05$ .

## RESULTS

### Demographic and Baseline Target Profiles

Among the 120 hospitalized deaths, the majority of cases belonged to the 40–49 years age group (29.17%), followed by the 50–59 years age group (25.00%) and 30–39 years age group (20.83%), indicating that middle-aged adults constituted the most affected population. Males accounted for 60.83% of cases, while females constituted 39.17%, showing a clear male predominance. Graduates formed the largest educational group (37.50%), followed by individuals educated up to the intermediate level (24.17%). Housewives (27.50%) constituted the largest occupational category, followed by salaried employees (25.83%), unemployed individuals (24.17%), and self-employed persons (17.50%). The highest number of deaths occurred during the evening hours (06:00 PM–11:59 PM) accounting for 35.00% of cases. Cardiac arrest (28.33%) was the most common cause of death recorded by the treating doctor, followed by intracranial hemorrhage (20.83%), septicemia (17.50%), and pneumonia (17.50%). At autopsy, septicemic shock (44.17%) emerged as the most common cause of death, followed by cranio-cerebral injury (27.50%), myocardial infarction (14.17%), and cardiogenic shock (14.17%). Left-sided rib fractures (38.33%) vs Right-sided rib fractures (27.50%) were the most common skeletal injury observed. Sternal fractures (15.00%) represented another significant complication of chest compressions. Combined fractures involving both ribs and sternum were identified in 7.50% of cases. The study confirmed that rib fractures were more common than sternal fractures following CPR. Airway-related injuries represented a major component of treatment-related artefacts. Artificial airway related injuries were identified in 75.00% of cases, making them the most common airway-associated finding. Defibrillator induced injuries were observed in 16.67% of cases and appeared as localized treatment-related skin lesions. Effects of injected noradrenaline were identified in 34.17% of cases, reflecting the frequent use of vasopressor therapy in critically ill patients. The study demonstrated that intensive care management, emergency procedures, and resuscitative efforts frequently produce identifiable artefacts that persist after death.

**The Structural Spectrum of Resuscitation Artefacts**  
Cardiopulmonary resuscitation-induced injuries were present in **51.67% (n=62)** of all autopsied bodies,

leaving only 48.33% (n=58) free of resuscitative damage.

**Table 1: Frequency and Morphological Spectrum of Iatrogenic Resuscitation Artefacts (N = 120)**

| Type of Resuscitation Intervention / Artefact Category   | Cases with Injury Present (n) | Percentage Incidence (%) |
|----------------------------------------------------------|-------------------------------|--------------------------|
| <b>Airway Management &amp; Ventilation Marks</b>         |                               |                          |
| Injury due to Artificial Airway (Intubation/Suction)     | 90                            | 75.00%                   |
| Pharyngeal Mucosa Bleeding due to Digital Manipulation   | 62                            | 51.67%                   |
| Injury due to Mouth to Mouth Resuscitation               | 25                            | 20.83%                   |
| <b>Skeletal Resuscitation Trauma</b>                     |                               |                          |
| Left Side Rib Fractures                                  | 46                            | 38.33%                   |
| Right Side Rib Fractures                                 | 33                            | 27.50%                   |
| Sternal Fractures                                        | 18                            | 15.00%                   |
| <b>Circulatory &amp; Electrical Intervention Changes</b> |                               |                          |
| Local Effects of Injected Noradrenaline                  | 41                            | 34.17%                   |
| Defibrillator Induced Injuries                           | 20                            | 16.67%                   |

Table 1 outlines the complete operational distribution of mechanical, skeletal, and soft-tissue procedure-driven alterations across the entire groups.

**Table 2: Number of cases according to Distribution of Fractures (N = 120)**

| Injury type                                           | Number of cases | Percentage (%) |
|-------------------------------------------------------|-----------------|----------------|
| Rib Fracture (left side)                              | 46              | 38.33%         |
| Rib Fracture (right side)                             | 33              | 27.50%         |
| Sternal Fracture                                      | 18              | 15.00%         |
| Combined Fractures (Right Ribs + Left Ribs + Sternum) | 9               | 7.50%          |

*(Note: Structural percentages do not total 100% due to concurrent multiple iatrogenic findings on single bodies).*

Among the 120 cases studied, left-sided rib fractures were the most common CPR-related skeletal injury, observed in 46 cases (38.33%), followed by right-sided rib fractures in 33 cases (27.50%). Sternal fractures were identified in 18 cases (15.00%), while a combination of right-sided rib fractures, left-sided rib fractures, and sternal fractures was present in 9 cases (7.50%). These findings indicate that rib and sternal fractures are common iatrogenic artefacts associated with vigorous chest compressions during cardiopulmonary resuscitation and are frequently encountered during autopsy of hospitalized patients.

**Table 3: Association between Age Group and Cardiopulmonary Resuscitation (CPR) Induced Injury**

| Age Group (Years) | CPR Injury Present (n) | CPR Injury Absent (n) | Total Group Count (N) |
|-------------------|------------------------|-----------------------|-----------------------|
| < 19              | 2                      | 0                     | 2                     |
| 20–29             | 7                      | 4                     | 11                    |
| 30–39             | 11                     | 14                    | 25                    |
| 40–49             | 13                     | 22                    | 35                    |
| 50–59             | 17                     | 13                    | 30                    |
| 60–69             | 8                      | 1                     | 9                     |
| 70–79             | 2                      | 3                     | 5                     |
| 80–89             | 2                      | 1                     | 3                     |
| Total             | 62                     | 58                    | 120                   |

In the present study, CPR-induced injuries were observed across all age groups. The highest number of cases with CPR-induced injuries was seen in the 50–59 years age group (17 cases), followed by the 40–49 years age group (13 cases) and 30–39 years age group (11 cases). Statistical analysis revealed no significant association between age and the occurrence of CPR-induced injuries ( $\chi^2 = 11.88$ ,  $p = 0.104$ ).

## DISCUSSION AND CONCLUSION

We conducted this autopsy based observational study to identify iatrogenic artefacts due to cardiopulmonary resuscitation (CPR) and other resuscitative procedures among hospitalized cases brought for medico legal autopsy at SMS Medical College, Jaipur. The study highlights the importance of identifying treatment related injuries during autopsy and differentiating them from antemortem traumatic injuries. A total of 120 hospitalized deaths were examined. The majority of cases belonged to the middle-aged age group, particularly 40–49 years and 50–59 years, indicating that requirement of intensive medical care and resuscitative measures are more commonly seen in critically ill patients of these age groups. Males outnumbered females, and most cases were married individuals. The study population was largely composed of educated persons and individuals engaged in household, salaried, or self-employed occupations, reflecting increased utilization of tertiary healthcare services among economically productive adults. Cardiac arrest was the most common cause of death reported by the treating doctors, while septicemic shock was the leading cause of death determined at autopsy. A significant proportion of patients suffered from severe infections, cardiovascular disorders, neurological conditions, and multi-organ dysfunction requiring intensive care management. These critically ill patients frequently underwent invasive procedures and repeated resuscitative efforts, thereby increasing the likelihood of developing iatrogenic artefacts. The study demonstrated that CPR-related injuries are common among hospitalized patients. More than half of the cases showed evidence of CPR-induced injuries. Thoracic skeletal injuries constituted the most important CPR-related findings. Left-sided rib fractures were the most common skeletal injury, followed by right-sided rib fractures and sternal fractures. These findings confirm that rib and sternal fractures are predictable consequences of effective chest compressions and should not be misinterpreted as injuries resulting from assault or blunt force trauma. Airway-related injuries formed another major category of iatrogenic artefacts. Injuries associated with artificial airway management were observed in a large proportion of cases. These findings indicate that procedures such as endotracheal intubation, laryngoscopy, suctioning, mechanical ventilation and repeated airway patency procedures can produce identifiable changes involving the oral cavity, pharynx, larynx, and trachea. The study also identified several other treatment related artefacts. Injection marks were commonly observed, proving repeated administration of medications and intravenous therapy. Effects of injected noradrenaline were found in a considerable proportion of cases, indicating the

widespread use of vasopressor support in critically ill patients. Defibrillator induced injuries were also encountered and typically appeared as localized skin lesion at electrode pad sites. These findings highlight that modern intensive care treatment and advanced life support procedures can leave recognizable marks that persist after death. An important observation of the present study is that many iatrogenic artefacts can closely resemble antemortem traumatic injuries. Rib fractures, sternal fractures, mucosal hemorrhages, defibrillator burns and airway-related lesions may create diagnostic confusion if the history of medical treatment is not carefully reviewed. Therefore, the interpretation of autopsy findings should always be performed in conjunction with hospital records, treatment charts, resuscitation details and clinical history. The present study highlights the important role of the forensic pathologist in distinguishing treatment-related injuries from injuries caused by disease, accidents, or other forms of trauma. Failure to recognize these iatrogenic artefacts may result in incorrect interpretation of the cause and manner of death. Iatrogenic artefacts due to cardiopulmonary resuscitation and intensive medical treatment were commonly seen in hospitalized deaths. Rib fractures, sternal fractures, airway related injuries, noradrenaline related changes, and defibrillator induced lesions were the major findings identified during autopsy. Careful recognition and documentation of these artefacts are essential for accurate medicolegal evaluation and for preventing misdiagnosing of autopsy findings.

## STRENGTHS OF THE STUDY

**Prospective Tracking Protocol:** Unlike retrospective record reviews, this prospective design ensured all external and internal medical marks were actively documented using a standardized proforma.

**Strict Screening Criteria:** Excluding primary mechanical chest trauma and advanced decomposition preserved data integrity, ensuring all documented bone breaks arises strictly from medical interventions.

**Comprehensive Clinical Integration:** Every postmortem finding was systematically cross verified against actual hospital bedside files, treatment records, and drug charts.

## STUDY LIMITATIONS

**Single-Center Focus:** The study was conducted at a single tertiary care centre; therefore, the findings may not be representative of all healthcare settings and populations.

**Lack of Advanced Imaging:** Radiological investigations such as postmortem CT scan or imaging

were not available for all cases and therefore occult injuries may have remained undetected.

**Resuscitation Style Variations:** Information regarding the experience and skill level of healthcare personnel performing CPR could not be assessed. Variations in CPR techniques, airway management practices, and intensive care protocols among different departments could not be evaluated.

## FUTURE RECOMMENDATIONS

**Sample size and center of study:** Future studies should be conducted on a larger sample size and across multiple centres to improve the reliability and generalizability of findings.

**Routine Use of PMCT Imaging:** Postmortem imaging and histopathological examination should be incorporated in future studies to improve detection and confirmation of iatrogenic artefacts.

**Joint Clinical-Forensic Audits:** Multidisciplinary studies involving forensic pathologists, intensivists, and emergency physicians are recommended to enhance understanding of treatment related injuries and their medicolegal significance.

## DECLARATIONS

**Ethical Committee Approval:** Institutional review board and ethical committee approval was taken prior to the study.

**Source of Funding:** Self

**Conflict of Interest:** None

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**Authors' Contributions:** All authors contributed to the conception and design of the study, data collection, analysis and interpretation of findings, preparation and critical revision of the manuscript, and approved the final version for publication.

**Data Availability:** The data generated and/or analyzed during the present study are not publicly available because they contain medico-legal and clinical information. Relevant anonymized data may be made available from the corresponding author on reasonable request, subject to institutional and ethical restrictions.

**AI Use Disclosure:** The authors declare that no generative artificial intelligence tools were used to generate or substantially modify the scientific content of this manuscript.

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