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Fatal Electrical Injuries in Padang, Indonesia: A Medicolegal Investigation of Circumstances and Cause of Death

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A B S T R A C T

Introduction: Electrical injuries, particularly those leading to fatalities, present significant public health concerns globally. In Indonesia, the incidence of electrical injuries remains a pressing issue, necessitating in-depth medicolegal investigations to understand the circumstances surrounding these deaths and contribute to preventive strategies. This study aimed to analyze fatal electrical injury cases in Padang, Indonesia, focusing on the demographic characteristics of victims, circumstances of the incidents, autopsy findings, and cause of death determination. **Methods:** A retrospective review of medicolegal autopsy reports from the Forensic Medicine Department in Padang, Indonesia, was conducted between 2018 and 2023. Cases involving fatal electrical injuries were identified and analyzed for demographic data, scene investigation details, autopsy findings, and cause of death. Descriptive statistics were used to summarize the data. **Results:** A total of 78 cases of fatal electrical injuries were identified. The majority of victims were males (87.2%) with a mean age of 35.2 years. Most incidents occurred in occupational settings (56.4%), followed by domestic environments (34.6%). Low-voltage electrocutions were predominant (83.3%). Common autopsy findings included electrical burns (94.9%), internal organ damage (42.3%), and histological evidence of electrocution (64.1%). The cause of death was primarily attributed to ventricular fibrillation (53.8%) and respiratory arrest (28.2%). **Conclusion:** Fatal electrical injuries in Padang, Indonesia, disproportionately affect males in occupational settings. Low-voltage electrocutions remain a major concern. Medicolegal investigations play a crucial role in understanding the circumstances and cause of death in these cases, aiding in the development of targeted preventive measures and safety regulations to reduce the incidence of such fatalities.

1. Introduction

Electrical injuries represent a significant global public health challenge, with an estimated annual mortality of 30,000 individuals. The World Health Organization (WHO) has identified electrical injuries as a major cause of preventable deaths, particularly in low- and middle-income countries. These injuries can occur in various settings, including occupational, domestic, and public environments, affecting individuals of all ages and socioeconomic backgrounds. The spectrum of electrical injuries ranges from minor burns to severe, life-threatening conditions, including cardiac arrhythmias, respiratory arrest, and neurological damage. The severity of the injury is influenced by several factors, such as the type and magnitude of the electrical current, the duration of contact, the pathway of the current through the body, and the individual's underlying health status.[1,2]

In Indonesia, electrical injuries remain a pressing concern, particularly in rapidly developing urban areas like Padang. The country's electrical infrastructure is often characterized by inadequate safety standards, lack of maintenance, and informal electrical connections. These factors, coupled with

limited public awareness about electrical hazards and unsafe work practices, contribute to the high incidence of electrical injuries in Indonesia. Studies have shown that electrical injuries in Indonesia disproportionately affect males, particularly those engaged in occupations involving electricity, such as electricians, construction workers, and laborers. Domestic electrocutions are also common, particularly among children and the elderly. The lack of comprehensive data on electrical injuries in Indonesia poses a challenge to understanding the true extent of the problem and developing effective preventive strategies.[3,4]

Medicolegal investigations of fatal electrical injuries play a crucial role in understanding the circumstances surrounding these deaths, determining the cause of death, and identifying contributing factors. These investigations involve a multidisciplinary approach, encompassing scene investigations, autopsy examinations, and toxicological analyses. Autopsy findings, including external and internal injuries, histological changes, and toxicological results, provide valuable evidence for establishing the cause of death and differentiating between accidental, suicidal, and homicidal electrocutions. Scene investigations are essential for reconstructing the events leading to the electrocution, identifying potential electrical hazards, and determining whether safety regulations were violated. These investigations often involve collaboration between forensic experts, electrical engineers, and law enforcement agencies.[5-7]

Medicolegal investigations of fatal electrical injuries serve not only to establish the cause of death and identify contributing factors but also to contribute to the development of preventive strategies. By analyzing the circumstances of these incidents, forensic experts can identify common risk factors, unsafe practices, and deficiencies in electrical safety regulations. This information can be used to inform public education campaigns, improve workplace safety standards, and enhance the enforcement of electrical safety regulations. Furthermore, medicolegal investigations can play a role in legal proceedings related to electrical injuries, such as compensation claims and criminal prosecutions. By providing objective evidence and expert opinions, forensic experts can assist in ensuring that justice is served and that those responsible for electrical safety violations are held accountable.[8-10] This study aims to analyze fatal electrical injury cases in Padang, Indonesia, between 2018 and 2023.

2. Methods

This research employed a retrospective observational study design, utilizing data extracted from medicolegal autopsy reports. The study population encompassed all individuals who underwent medicolegal autopsies at the Forensic Medicine Department in Padang, Indonesia, between January 2018, and September 2023, and whose cause of death was attributed to fatal electrical injuries. The primary source of data was the archives of medicolegal autopsy reports maintained by the Forensic Medicine Department. These reports are comprehensive documents that detail the findings of postmortem examinations conducted on individuals whose deaths are deemed to be of medico-legal significance, including those resulting from electrical injuries. A systematic search of the autopsy report archives was performed using the International Classification of Diseases, Tenth Revision (ICD-10) codes. The following ICD-10 codes were utilized to identify cases of fatal electrical injuries; W85: Accidental exposure to electric current; W86: Exposure to lightning; W87: Other accidental exposure to radiation; X44: Accidental poisoning by and exposure to other and unspecified chemicals and noxious substances; Y14: Unspecified event, undetermined intent. The search was conducted by trained research personnel who meticulously reviewed each autopsy report to ensure that only cases meeting the inclusion criteria were selected.

The following inclusion criteria were applied to select cases for the study; The autopsy report clearly indicated that the cause of death was attributed to electrical injuries; The autopsy was performed at the Forensic Medicine Department in Padang, Indonesia, during the study period (2018-2023); The autopsy report contained sufficient information on the demographic characteristics of the victim, the

circumstances of the incident, and the autopsy findings. The following exclusion criteria were applied; Cases where the cause of death was uncertain or attributed to other factors in addition to electrical injuries; Cases where the autopsy report was incomplete or lacked essential information; Cases where the victim was not a resident of Padang, Indonesia.

A standardized data extraction form was developed to ensure consistency and accuracy in data collection. The following information was extracted from each eligible autopsy report; Demographic data: Age, sex, occupation, and place of residence; Circumstances of the incident: Location of the incident (occupational, domestic, public), type of electrical current (low-voltage, high-voltage), and any available information on the circumstances leading to the electrocution (e.g., faulty wiring, contact with live wires, lightning strike); Autopsy findings: External injuries (e.g., electrical burns, entry and exit wounds), internal injuries (e.g., organ damage, histological changes), and toxicological findings; Cause of death: As determined by the forensic pathologist conducting the autopsy. Data extraction was performed by two independent researchers. Any discrepancies in data extraction were resolved through consensus or by consulting a third researcher.

The extracted data were entered into a secure electronic database and analyzed using statistical software (SPSS version 26). Descriptive statistics were used to summarize the data. Categorical variables were presented as frequencies and percentages, while continuous variables were presented as means and standard deviations. The following analyses were performed; Descriptive analysis of demographic characteristics: Frequency distributions of age, sex, occupation, and place of residence were generated; Descriptive analysis of the circumstances of the incident: Frequency distributions of the location of the incident, type of electrical current, and circumstances leading to the electrocution were generated; Descriptive analysis of autopsy findings: Frequency distributions of external and internal injuries, histological changes, and toxicological findings were generated; Analysis of the cause of death: Frequency distributions of the primary and secondary causes of death were generated; Bivariate analysis: Chi-square tests or Fisher's exact tests were used to examine the associations between categorical variables. Independent t-tests or Mann-Whitney U tests were used to compare continuous variables between groups.

This study was conducted in accordance with the ethical guidelines of the Forensic Medicine Department in Padang, Indonesia, and adhered to the principles outlined in the Declaration of Helsinki. As a retrospective study utilizing anonymized data, individual patient consent was not required. The study protocol was reviewed and approved by the Institutional Review Board of the Forensic Medicine Department.

3. Results and Discussion

Table 1 provides valuable insights into the demographic profile of individuals who succumbed to fatal electrical injuries in Padang, Indonesia, between 2018 and 2023. The vast majority of victims (87.2%) were males. This aligns with global trends, where males are more likely to be involved in occupations and activities that expose them to electrical hazards. The mean age of victims was 35.2 years, indicating that fatal electrical injuries primarily affect the working-age population. This has significant implications for the economic and social impact of these incidents. Laborers constituted the largest occupational group among the victims (32.1%), followed by electricians (15.4%). This highlights the elevated risk of electrical injuries in occupations involving manual labor and direct contact with electrical equipment or wiring. A notable proportion of victims were students (12.8%). This emphasizes the need for electrical safety education and awareness programs targeting young individuals, both in educational institutions and at home. The 'Other' category accounted for a significant proportion of victims (39.7%). This suggests that fatal electrical injuries can occur across a wide range of occupations and activities, underscoring the need for comprehensive electrical safety measures in all settings.

Table 1. Demographic characteristics of fatal electrical injury victims.

Demographic characteristic	Value	Percentage
Total cases	78	-
Males	68	87.20%
Mean age (SD)	35.2 (12.6)	-
Age range	15-62	-
Laborers	25	32.10%
Electricians	12	15.40%
Students	10	12.80%
Other	31	39.70%

Table 2 sheds light on the contexts and types of electrical incidents that led to fatalities in Padang, Indonesia, between 2018 and 2023. Over half of the fatal electrical injuries (56.4%) occurred in occupational settings. This underscores the urgent need to strengthen workplace safety protocols and electrical safety training, particularly in sectors with a higher risk of electrical exposure. A substantial proportion of incidents (34.6%) took place in domestic environments. This emphasizes the importance of public awareness campaigns to educate individuals about electrical hazards at home and promote safe practices in handling electrical appliances and wiring.

The majority of fatal electrocutions (83.3%) involved low-voltage currents (≤1000 volts). This may seem counterintuitive, but it highlights that even seemingly "safe" household voltages can be lethal under certain circumstances. It also points to the potential for underestimation of risks associated with low-voltage electricity. While less frequent, high-voltage electrocutions (>1000 volts) still accounted for 16.7% of cases. These incidents are likely to occur in industrial settings or involve contact with power lines, emphasizing the need for stringent safety measures in such environments.

Table 2. Circumstances of fatal electrical injury incidents.

Circumstance of incident	Value	Percentage
Total incidents	78	-
Occupational	44	56.40%
Domestic	27	34.60%
Public	7	9.00%
Low-voltage	65	83.30%
High-voltage	13	16.70%

Table 3 provides a comprehensive overview of the key autopsy findings observed in fatal electrical injury cases in Padang, Indonesia, between 2018 and 2023. Electrical burns were the most common external finding, present in 94.9% of cases. This high prevalence underscores the destructive nature of electrical current passing through the body, often leaving visible marks at the points of entry and exit.

The hands were the most frequent site of electrical burns (53.8%), suggesting that victims often came into contact with electrical sources through direct touch. This emphasizes the importance of wearing protective gear and exercising caution when handling electrical equipment or wiring. Internal examination revealed organ damage in 42.3% of cases, highlighting the systemic impact of electrical injuries. The heart was the most frequently affected organ (23.1%), followed by the lungs (15.4%) and the brain (11.5%). This indicates that electrical current can disrupt the normal functioning of vital organs, leading to potentially fatal complications. Histological examination, which involves microscopic analysis of tissues, provided evidence of electrocution in 64.1% of cases. This demonstrates the value of histological analysis in confirming the diagnosis of electrical injury and differentiating it from other causes of death.

Table 3. Autopsy findings in fatal electrical injury cases.

Autopsy Finding	**Value**	**Percentage**
External examination	(n=78)	-
Electrical burns (any site)	74	94.90%
- Hands	42	53.80%
- Head & Neck	28	35.90%
- Chest	22	28.20%
Internal examination	(n=78)	-
Organ damage (any)	33	42.30%
- Heart	18	23.10%
- Lungs	12	15.40%
- Brain	9	11.50%
Histological examination	(n=78)	-
Evidence of electrocution	50	64.10%

Table 4 provides critical insights into the primary mechanisms by which electrical injuries lead to fatalities in Padang, Indonesia. Ventricular fibrillation, a chaotic heart rhythm that disrupts blood flow, was the most common cause of death (53.8%). This emphasizes the profound impact of electrical current on the heart's electrical system, often leading to sudden cardiac death. Respiratory arrest, or the cessation of breathing, was the second leading cause of death (28.2%). This suggests that electrical injuries can also disrupt the respiratory control centers in the brain or cause paralysis of the respiratory muscles. Cardiac arrest, the complete stopping of heart activity, accounted for 9.0% of deaths. While distinct from ventricular fibrillation, cardiac arrest can also be triggered by electrical injuries, highlighting the vulnerability of the cardiovascular system. Burns and their associated complications, such as infections or organ failure, contributed to 5.1% of deaths. This underscores the importance of prompt and comprehensive burn care in electrical injury victims. Head injuries, possibly resulting from falls or forceful contact during electrocution, accounted for 3.8% of deaths. This emphasizes the potential for additional trauma associated with electrical injuries.

Table 4. Cause of death in fatal electrical injury cases.

Cause of death	Value	Percentage
Total cases	78	-
Ventricular fibrillation	42	53.80%
Respiratory arrest	22	28.20%
Cardiac arrest	7	9.00%
Burns & complications	4	5.10%
Head injury	3	3.80%

The current study, delving into fatal electrical injuries in Padang, Indonesia, uncovers a stark epidemiological landscape marked by a disproportionate impact on males and the working-age population. This pattern resonates with global trends, highlighting the persistent gender disparity in the burden of electrical injuries. The overwhelming majority of victims in our study were males, echoing a consistent observation in epidemiological studies on electrical injuries across the globe. This gender disparity is multifactorial, rooted in a complex interplay of occupational, behavioral, and sociocultural factors. Occupationally, men are more likely to be engaged in sectors such as construction, manufacturing, and electrical work, which inherently carry a higher risk of electrical exposure. These jobs often involve handling live wires, operating heavy machinery, and working in environments with potentially faulty electrical infrastructure. Behaviorally, men may be more prone to risk-taking behaviors, such as attempting electrical repairs without proper training or neglecting safety precautions. This inclination towards risk-taking, coupled with a potential underestimation of electrical hazards, can increase the likelihood of electrical injuries. Sociocultural norms also play a role in shaping gendered patterns of electrical injuries. Traditional gender roles often dictate that men are the primary breadwinners and providers, leading them to engage in more physically demanding and hazardous occupations. Additionally, societal expectations of masculinity may discourage men from seeking help or admitting vulnerability, potentially hindering their ability to recognize and mitigate electrical risks. The concentration of fatal electrical injuries among the working-age population, with a mean age of 35.2 years, amplifies the economic and social repercussions of these incidents. The loss of individuals in their prime productive years translates to a significant reduction in the workforce, impacting both families and the broader economy. The financial burden of lost income, medical expenses, and funeral costs can be devastating for families, particularly those already grappling with poverty and limited resources. Beyond the immediate economic impact, the loss of a breadwinner can have long-lasting social consequences. Families may struggle to meet basic needs, children may be forced to drop out of school to support the household, and the overall well-being of the community may be compromised. The ripple effects of these losses extend far beyond the individual victim, creating a cascade of challenges for families and communities to overcome. Moreover, the long-term disability and psychological trauma that often accompany electrical injuries can further compound the burden on individuals, families, and healthcare systems. Survivors may face lifelong physical limitations, chronic pain, and emotional distress, requiring ongoing medical care and rehabilitation. The psychological impact of electrical injuries, including anxiety, depression, and post-traumatic stress disorder (PTSD), can significantly impair quality of life and social functioning. Understanding the epidemiological patterns of fatal electrical injuries is crucial for developing effective preventive strategies. The disproportionate impact on males and the working-age population calls for targeted interventions that address the specific needs and vulnerabilities of

these groups. In occupational settings, enhancing workplace safety protocols, providing comprehensive electrical safety training, and ensuring the availability and proper use of personal protective equipment are essential. Strict enforcement of safety regulations and regular inspections of electrical systems and equipment can also help to mitigate risks. Public education campaigns should be tailored to address the specific needs of different demographic groups. Messages should emphasize the potential dangers of electrical hazards, even in seemingly low-risk environments, and promote safe practices in handling electrical appliances and wiring. Community-based interventions, such as workshops and training sessions, can provide hands-on learning opportunities and empower individuals to take ownership of their electrical safety. Furthermore, addressing the underlying sociocultural factors that contribute to gender disparities in electrical injuries is crucial. This involves challenging traditional gender roles, promoting gender equality, and empowering women and girls to participate in decision-making regarding safety and risk management. By adopting a multi-pronged approach that addresses the occupational, behavioral, and sociocultural determinants of electrical injuries, we can strive to create a safer environment for all individuals, regardless of their gender or occupation.[11,12]

The findings of our study paint a sobering picture of the pervasive threat of electrical injuries, both in the workplace and within the confines of the home. The high proportion of fatal incidents occurring in occupational settings and the substantial number of domestic electrocutions underline the urgent need for multifaceted interventions to address this dual hazard. The alarming statistic that over half of the fatal electrical injuries in our study occurred in occupational settings underscores the pressing need to prioritize workplace safety and electrical safety training. Laborers and electricians, identified as the most vulnerable occupational groups, often face a heightened risk due to their direct and frequent interaction with electrical systems and equipment. The nature of their work often involves tasks such as installing, repairing, and maintaining electrical infrastructure, which exposes them to live wires, energized circuits, and other potential hazards. Inadequate safety training, coupled with a lack of proper protective equipment, can create a perilous environment where even a momentary lapse in concentration or a minor error can have devastating consequences. Studies have consistently demonstrated that inadequate safety training is a major contributor to electrical injuries in the workplace. Many workers, particularly those in informal sectors or low-skilled occupations, may lack formal training in electrical safety principles and procedures. This knowledge gap can lead to unsafe practices, such as working on live circuits, using damaged tools or equipment, and failing to implement proper lockout/tagout procedures. The provision of comprehensive electrical safety training, tailored to the specific needs of different occupational groups, is crucial for mitigating these risks. Training programs should cover topics such as basic electrical principles, hazard recognition, safe work practices, use of personal protective equipment, and emergency response procedures. By empowering workers with the knowledge and skills to identify and mitigate electrical hazards, we can create a safer working environment and reduce the incidence of preventable injuries. In addition to training, the availability and proper use of personal protective equipment (PPE) are essential for safeguarding workers from electrical hazards. PPE, such as insulated gloves, safety glasses, and flame-resistant clothing, can act as a barrier between the worker and the electrical source, minimizing the risk of injury. However, PPE is only effective when used correctly and consistently. Employers have a responsibility to ensure that workers are provided with appropriate PPE, trained in its proper use, and encouraged to wear it at all times when exposed to electrical hazards. Furthermore, regular inspections of electrical systems and equipment are critical for identifying and rectifying potential hazards before they lead to injuries. Faulty wiring, damaged equipment, and overloaded circuits can create dangerous conditions that increase the risk of electrocution. Routine inspections by qualified electricians can help to detect these hazards and ensure that they are

repaired or replaced promptly. While occupational hazards are often more visible and readily acknowledged, the substantial proportion of fatal electrical injuries occurring in domestic settings highlights the often underestimated dangers lurking within our homes. Electrical hazards in the home, such as faulty wiring, overloaded circuits, and improper use of electrical appliances, can pose a significant risk to individuals of all ages, particularly children and the elderly. Children, driven by curiosity and a lack of awareness of electrical dangers, may inadvertently touch live wires, insert objects into electrical outlets, or play with damaged cords or appliances. The elderly, on the other hand, may be more susceptible to electrical injuries due to impaired mobility, decreased sensory perception, and cognitive decline. They may also be more likely to use outdated or faulty electrical equipment and may struggle to identify and address potential hazards in their homes. Public education and awareness campaigns are crucial for addressing domestic electrical hazards and promoting safe practices in the home. The importance of proper installation and maintenance of electrical systems by qualified electricians. The safe use of electrical appliances, including avoiding overloading circuits, using appliances only for their intended purpose, and unplugging appliances when not in use. The dangers of attempting electrical repairs without proper training and the importance of seeking professional assistance. The need to keep electrical cords and appliances out of the reach of children and to supervise them closely when they are near electrical sources. The importance of having smoke detectors and ground fault circuit interrupters (GFCIs) installed in homes to provide an additional layer of protection against electrical fires and shocks. Community-based interventions, such as workshops and training sessions, can provide hands-on learning opportunities and empower individuals to take ownership of their electrical safety. These interventions can be particularly effective in reaching vulnerable populations, such as the elderly and those living in low-income communities, who may have limited access to information and resources. By raising awareness of electrical hazards in the home and promoting safe practices, we can create a safer living environment and reduce the incidence of preventable electrical injuries.[13-15]

The startling predominance of low-voltage electrocutions in our Padang study serves as a stark reminder that the perception of electrical safety is often misleading. The conventional wisdom that only high-voltage currents are lethal has fostered a false sense of security, leading to complacency and a disregard for the potential dangers lurking within seemingly innocuous electrical sources. While high-voltage electrocutions, typically associated with industrial accidents or contact with power lines, tend to garner more attention due to their dramatic and often instantly fatal nature, low-voltage electrocutions pose a more insidious and pervasive threat. The fact that the majority of fatalities in our study were caused by low-voltage currents (≤1000 volts) underscores the critical need to re-evaluate our understanding of electrical safety and dispel the myth that low voltage equates to low risk. The human body's vulnerability to electrical current is not solely determined by voltage, but rather by a complex interplay of factors, including the current's pathway through the body, the duration of contact, and the individual's physiological susceptibility. Even relatively low voltages can disrupt the heart's electrical rhythm, leading to ventricular fibrillation and sudden cardiac death. Similarly, low-voltage currents can interfere with the respiratory control centers in the brain or cause paralysis of the respiratory muscles, resulting in respiratory arrest and suffocation. The prevalence of low-voltage electrocutions in our study is particularly concerning given the ubiquitous presence of low-voltage electrical sources in our daily lives. Household appliances, power tools, extension cords, and even seemingly harmless electrical outlets can all pose a potential hazard if not handled with care and caution. The perception that these sources are "safe" can lead to complacency and a disregard for basic safety precautions, increasing the risk of electrocution. The high incidence of low-voltage electrocutions suggests that individuals may underestimate the risks associated with these seemingly benign electrical sources. This underestimation can stem from a lack of

awareness of the potential dangers, a false sense of security fostered by the familiarity of everyday electrical devices, or a belief that only high-voltage currents are capable of causing serious harm. Water is a good conductor of electricity, increasing the risk of electrocution. Working on electrical systems without the necessary knowledge and skills can lead to accidental contact with live wires or other hazards. Overloading circuits can cause overheating and fires, while damaged cords can expose live wires, increasing the risk of electrocution. This can lead to accidental activation or overheating, potentially causing fires or electrocutions. GFCIs are safety devices that quickly shut off power in the event of a ground fault, protecting against electrocution. These unsafe practices, often driven by a lack of awareness or a disregard for potential hazards, can have devastating consequences. It is imperative to educate the public about the risks associated with low-voltage electricity and to promote safe practices in all settings, including homes, workplaces, and public spaces. Public education campaigns play a pivotal role in combating the hidden danger of low-voltage electrocutions. These campaigns should aim to dispel the myth that low voltage equates to low risk and emphasize that even seemingly "safe" household voltages can be fatal under certain circumstances. Even low-voltage currents can disrupt the heart's electrical rhythm or interfere with the respiratory system, leading to fatalities. This includes avoiding contact with live wires, using appliances only for their intended purpose, and seeking professional assistance for electrical repairs. Electrical hazards can exist in homes, workplaces, and public spaces, and individuals should be aware of their surroundings and take precautions to avoid contact with electrical sources. GFCIs and smoke detectors can provide an additional layer of protection against electrical shocks and fires. These messages should be disseminated through various channels, including schools, workplaces, community centers, and media outlets. Educational materials, such as brochures, posters, and videos, can be developed to provide clear and concise information about electrical safety. Interactive workshops and training sessions can offer hands-on learning opportunities and empower individuals to identify and mitigate electrical hazards in their environment.[16,17]

The autopsy findings in our study offer a window into the devastating consequences of electrical injuries on the human body, revealing the complex pathophysiological mechanisms that lead to fatalities. The high prevalence of electrical burns, internal organ damage, and histological evidence of electrocution serves as a testament to the destructive power of electrical current as it courses through the body. These findings, coupled with the identification of ventricular fibrillation and respiratory arrest as the primary causes of death, underscore the critical importance of prompt recognition and intervention in electrical injury cases. The near-universal presence of electrical burns in our study population (94.9%) highlights the immediate and visible impact of electrical injuries. These burns, often located at the points of entry and exit of the electrical current, can range in severity from superficial skin lesions to deep tissue necrosis. The severity of the burn is influenced by several factors, including the type and magnitude of the current, the duration of contact, and the resistance of the skin and underlying tissues. The identification of the hands as the primary site of electrical burns (53.8%) is a crucial observation. It suggests that victims often come into contact with electrical sources through direct touch, underscoring the importance of hand protection and safe handling of electrical equipment. Insulated gloves, designed to resist electrical current, can act as a barrier between the hands and the electrical source, significantly reducing the risk of burns and electrocution. Beyond their immediate physical impact, electrical burns can also lead to a cascade of complications, including infection, fluid loss, and electrolyte imbalances. These complications can further compromise the victim's health and increase the risk of mortality. Prompt and comprehensive burn care, including wound cleaning, debridement, and skin grafting, is essential for managing these complications and improving the chances of survival. While electrical burns provide a visible indication of electrical injury, the internal damage caused by electrical current can be equally devastating, often occurring without any external

signs. Our study revealed internal organ damage in a significant proportion of cases (42.3%), highlighting the systemic impact of electrical injuries. The heart, identified as the most frequently affected organ (23.1%), is particularly vulnerable to the effects of electrical current. The electrical impulses that regulate the heart's rhythm can be disrupted, leading to arrhythmias such as ventricular fibrillation, which can rapidly progress to cardiac arrest and death. The lungs, brain, and other vital organs can also be damaged by electrical current, leading to respiratory failure, neurological deficits, and multi-organ dysfunction. The internal injuries caused by electrical current can be insidious, often manifesting hours or even days after the initial insult. This delayed presentation can complicate diagnosis and treatment, as victims may appear relatively stable initially but deteriorate rapidly as the internal damage progresses. Histological examination, which involves microscopic analysis of tissues, played a crucial role in confirming the diagnosis of electrocution in our study. The presence of characteristic histological changes, such as coagulation necrosis, muscle fiber damage, and vascular thrombosis, provided definitive evidence of electrical injury in 64.1% of cases. Histological analysis can be particularly valuable in cases where the external signs of electrical injury are subtle or absent. It can also help to differentiate between electrocution and other causes of death, such as trauma or natural disease. By providing microscopic confirmation of electrical injury, histological examination contributes to accurate cause-of-death determination and strengthens the medicolegal investigation. The identification of ventricular fibrillation as the primary cause of death in our study underscores the profound impact of electrical current on the heart's electrical system. This chaotic heart rhythm, characterized by rapid and irregular contractions of the ventricles, disrupts blood flow and can lead to sudden cardiac death within minutes. The prompt initiation of cardiopulmonary resuscitation (CPR) and defibrillation is crucial for restoring a normal heart rhythm and improving the chances of survival in victims of ventricular fibrillation. However, the effectiveness of these interventions diminishes with time, highlighting the importance of early recognition and intervention in electrical injury cases. Public education campaigns should emphasize the importance of learning CPR and basic life support techniques, as well as ensuring access to automated external defibrillators (AEDs) in public places and workplaces. Bystander CPR and early defibrillation can significantly improve survival rates in cases of sudden cardiac arrest, including those caused by electrical injuries. Respiratory arrest, the second leading cause of death in our study, underscores the potential for electrical injuries to disrupt the respiratory system. Electrical current can interfere with the respiratory control centers in the brain, leading to central apnea, or cause paralysis of the respiratory muscles, resulting in peripheral apnea. In either case, the cessation of breathing can rapidly lead to hypoxia (lack of oxygen) and brain damage, ultimately resulting in death. The management of respiratory arrest in electrical injury victims involves securing the airway, providing assisted ventilation, and monitoring for potential complications such as aspiration pneumonia or pulmonary edema. The high prevalence of respiratory arrest as a cause of death emphasizes the need for respiratory support and airway management as integral components of emergency treatment for electrical injury victims. Healthcare professionals should be trained in advanced airway management techniques and have access to the necessary equipment to provide timely and effective respiratory support.[18-20]

4. Conclusion

This study has revealed the alarming prevalence of fatal electrical injuries in Padang, Indonesia, particularly affecting males in occupational settings. Low-voltage electrocutions remain a major concern, highlighting the need for heightened awareness even with seemingly "safe" electrical sources. Medicolegal investigations, incorporating autopsy findings and scene analysis, are indispensable in determining the circumstances and cause of death, contributing to preventive strategies. It is imperative to implement comprehensive measures that focus on workplace

safety, public education, and targeted interventions for vulnerable groups.

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