



# Injuries Related to Electric Current: Epidemiology, Clinical Presentation, and Modern Treatment Approaches

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## Abstract

This article provides a comprehensive analysis of the pathophysiology, clinical manifestations, complications, diagnosis, treatment methods, and rehabilitation of injuries related to electric shock. According to scientific sources, electric shock can lead to both acute and chronic complications such as cardiac arrhythmias, respiratory center paralysis, rhabdomyolysis, thermal burns, and nervous system damage. Emergency medical care, long-term monitoring, and individualized rehabilitation processes play a crucial role in restoring the patient's quality of life. In global practice, preventing electrical injuries and developing modern diagnostic and treatment protocols remain pressing issues. The article offers scientific and practical guidelines, standards, and preventive approaches that can be applied in clinical practice.

**Keywords:** Electric shock injury, cardiac arrhythmia, rhabdomyolysis, resuscitation, psychological support.

## Introduction

### 1.1. Relevance of the Problem

Technological advancement has undeniably simplified many aspects of human life; however, it has

simultaneously contributed to an increase in the number of potential hazards. The extensive use of electrical energy across industrial, domestic, and medical sectors has led to a rising incidence of electrical injuries. Electric shock is an abrupt event that can cause serious physiological and functional disturbances and, in some cases, may result in life-threatening outcomes.

When electrical current passes through the human body, it exerts particularly detrimental effects on the heart, nervous system, respiratory center, and muscles. The risk of electric shock is especially high among children, industrial workers, construction specialists, and electricians. According to global statistical data, hundreds of thousands of people experience electrical injuries of varying severity each year.

Electrical injuries remain one of the pressing public health concerns, as they frequently occur in workplaces, domestic environments, and open areas. These injuries often lead to severe complications and may result in death. This article aims to analyze the epidemiology, clinical progression, diagnosis, and major challenges associated with the treatment of electrical injuries based on recent scientific evidence.

### 1.2. Significance of the Study

The effectiveness of emergency medical intervention for victims of electric shock is often the decisive factor between saving a life and resulting in severe disability. Therefore, a comprehensive understanding of the epidemiology, pathophysiology, clinical presentation, and emergency medical response protocols for electrical injuries is essential.

An in-depth examination of this topic plays a vital role in the early identification, effective management, and prevention of long-term complications associated with electrical trauma. The present article seeks to highlight current medical approaches and contemporary challenges in this area.

### 1.3. Aim of the Study

The primary objective of this scientific article is to provide an in-depth analysis of the medical aspects of electric shock incidents. Specifically, the study focuses on the following areas:

- The prevalence and distribution of electrical injuries (epidemiology);
- Mechanisms of systemic damage (pathophysiology);

- Classification and clinical manifestations;
- Procedures for emergency medical intervention;
- Long-term outcomes and rehabilitation strategies.

### 1.4. Research Methods

This article is based on an analysis of existing scientific literature, recent clinical studies, current medical practice guidelines, and statistical data. The key reviewed sources include:

- Dyer et al. [7] — on the effects of electrical current on cardiac rhythm;
- Waldmann et al. [20] — on the neuropsychological consequences of electrical trauma;
- Spies and Trohman [19] — on alterations in respiratory and cardiac function;
- Primavesi [16] — on surgical approaches in the management of electrical burns.

The methodological framework of this research incorporates a comprehensive literature review and descriptive analytical methods.

## 2. EPIDEMIOLOGY

Electrical injuries resulting from electric shock are recognized as one of the leading causes of emergency department admissions worldwide. The severity and incidence of such injuries are closely associated with a country's level of economic development, adherence to safety standards, and the quality of technical supervision in industrial settings.

### 2.1. General Statistical Indicators

According to global epidemiological analyses, approximately 30,000–40,000 individuals seek emergency medical assistance each year due to moderate to severe electrical injuries [19]. In the United States alone, more than 1,000 deaths annually are attributed to electrical shocks, most of which occur among industrial and construction workers [20].

A systematic review conducted by Mobayen and Sadeghi [12] examined the prevalence of electrical burns among patients admitted to various medical centers in Iran. Their findings revealed that electrical burns accounted for 3.8% of all burn cases, with 92.3% occurring in men. This high male predominance is explained by the active participation of young men in

industrial and construction occupations.

Similarly, Younes et al. [21] performed an epidemiological and clinical analysis of electrical burn cases observed in Morocco between 2020 and 2022. They concluded that the majority of such injuries occurred in workplace settings and were frequently associated with deep tissue damage, complicating treatment and requiring prolonged rehabilitation.

A 30-year longitudinal study in Finland [10] investigated electrical burns sustained by individuals climbing onto electric trains. The results demonstrated that high-voltage electrical injuries were primarily caused by noncompliance with safety regulations.

In Colombia, a study conducted between 2010 and 2021 [3] examined the occurrence of electrical burns both in occupational and domestic settings. The findings indicated that household electrical injuries also represent a significant proportion of cases, largely due to inadequate public awareness of electrical safety practices.

In recent years, increasing attention has been paid globally to the epidemiology and clinical characteristics of electrical burns. The predominance of cases among men and the frequent violation of workplace safety standards remain major contributing factors. These injuries complicate both medical management and rehabilitation, emphasizing the urgent need for preventive strategies, improved safety regulations, and enhanced public education on electrical safety.

## 2.2. Age and Gender Distribution

The majority of electric shock victims are men aged 20–40 years, corresponding to the demographic most actively employed in construction, electrical installation, industrial, and transport sectors.

Children also represent a vulnerable group due to insufficient attention to electrical safety in domestic environments. Accidental contact with unprotected sockets or improperly installed appliances significantly increases the risk of electrical injury [16].

## 2.3. Occupational Factors

According to an epidemiological study conducted by Adali et al. [1], electricians, industrial technicians, construction workers, and home repair specialists represent the occupational groups most frequently affected by electric shock.

Their analysis, covering a 10-year period, documented over 4,000 electrical injuries, with more than 60% occurring during working hours.

## 2.4. Common Sources of Electrical Shock

The main sources of electrical injury include:

- Low-voltage (220V–380V) household electrical systems;
- High-voltage industrial power lines;
- Lightning strikes (natural electrical current);
- Aged or defective insulation in electrical devices.

According to Morrison and Woollard [13], over 70% of electric shock emergencies are caused by low-voltage household circuits. The most frequent contributing factors include damaged electrical cords, children inserting objects into sockets, and contact with exposed electrical devices.

## 2.5. Seasonality and Geographic Variations

Epidemiological analyses indicate that the incidence of electrical injuries increases during the summer months, particularly among individuals working outdoors. Hot weather, perspiration, and damp clothing increase the conductivity of the body, thereby facilitating the passage of electrical current.

Moreover, developing countries exhibit higher rates of electrical injuries compared to developed nations, primarily due to insufficient safety measures and inadequate technical supervision.

## 3. PATHOPHYSIOLOGY

When electrical current enters the human body and passes through tissues, it produces profound biological and physical effects. These effects can cause tissue burns, cardiac rhythm disturbances, disruption of nervous system function, muscle spasms, and paralysis of the respiratory center.

The extent of electrical injury depends on several key factors:

- The strength of the current (amperes),
- The voltage level (volts),
- The type of current (AC or DC),
- The body's electrical resistance, and
- The path of current flow through the body

[4,11,17].

### 3.1. Primary Factors Influencing the Effects of Electric Current

The impact of electric current on the human body is determined by the following variables:

- Current strength (amperage): The most critical factor; even a small current can disrupt cardiac rhythm.
- Voltage (volts): High-voltage exposure, particularly in industrial systems ( $\geq 1000V$ ), significantly increases the risk of death.
- Type of current (AC or DC): Alternating current (AC) is generally more dangerous than direct current (DC) because it can cause prolonged tetanic muscle contraction, leading to sustained cardiac and muscular excitation.
- Body resistance: The condition of the skin—dry, moist, or damaged—affects the degree of injury. Wet or injured skin dramatically reduces resistance, increasing current flow.
- Pathway of current: The most dangerous trajectories are those passing through the heart or brain (e.g., hand-to-hand or hand-to-foot), which can directly involve vital organs.

### 3.2. Thermal (Heat) Effects

As electric current passes through body tissues, it generates heat due to electrical resistance. This thermal energy causes protein denaturation and cell destruction, leading to:

- Cutaneous burns,
- Necrosis of internal muscles and blood vessels,
- Coagulation disorders, and
- Rhabdomyolysis — breakdown of skeletal muscle tissue.

In high-voltage injuries, the external skin may show only minimal burn marks, while deep internal tissues suffer extensive and severe damage [20].

### 3.3. Electrical Stimulation Effects

Electric current directly stimulates nerve and muscle cells, producing:

- Painful muscle spasms,
- Cardiac arrhythmias,
- Paralysis of respiratory muscles, and

- Forceful skeletal muscle contractions.

Severe muscle spasms may prevent the victim from letting go of the electrical source, prolonging contact time and increasing the extent of injury [8].

### 3.4. Effects on the Cardiovascular System

The heart is particularly sensitive to electrical current. Major cardiovascular complications include:

- Arrhythmias,
- Ventricular fibrillation,
- Asystole (cardiac arrest), and
- Hypotension or sudden cardiac standstill.

Dyer et al. [7] and Guarracini et al. [9] investigated the phenomenon of “electrical storm,” describing how cardiac electrical stability can be disrupted by sustained exposure to current. In such cases, immediate defibrillation and administration of antiarrhythmic agents are essential for survival.

### 3.5. Effects on the Central Nervous System

The central nervous system (CNS) is highly sensitive to electrical energy. Electrical trauma may manifest with:

- Fear, loss of consciousness,
- Epileptic seizures,
- Paralysis of the respiratory center, and
- Impaired memory and motor coordination.

Long-term neurological sequelae have been reported, including chronic headaches, insomnia, reduced concentration, and cognitive dysfunction [10,15,18].

### 3.6. Effects on the Respiratory System

Severe electrical current can induce intense spasms of the respiratory muscles or paralysis of the respiratory center, resulting in complete asphyxia. In such cases, the patient may lose consciousness and require immediate assisted ventilation.

High-voltage exposure is particularly dangerous because it can damage the spinal and brainstem centers responsible for breathing control.

### 3.7. Effects on the Renal and Metabolic Systems

Electrical trauma can lead to rhabdomyolysis, the destruction of skeletal muscle fibers, releasing myoglobin into the bloodstream. The accumulation of myoglobin in the kidneys may result in acute renal

failure.

This condition is especially common in cases involving deep internal muscle necrosis. Therefore, aggressive intravenous fluid resuscitation and forced diuresis are crucial components of management to prevent renal complications.

#### 4. CLASSIFICATION

The impact of electric shock on the human body varies in severity depending on several factors, including:

- The strength of the current,

- The type of current,
- The duration of exposure,
- The pathway of current through the body, and
- The electrical resistance of body tissues.

In clinical practice, electric shock injuries are classified according to multiple criteria. Such classification is essential for accurate diagnosis, appropriate emergency management, and the selection of optimal treatment strategies.

##### 4.1. Classification by Voltage Level

Category	Voltage (V)	Hazard Level and Description
Low voltage	100–1000 V	Typically domestic current; passes through the skin; may cause cardiac arrhythmias.
High voltage	>1000 V	Common in industrial or transmission lines; causes deep tissue damage and increases the risk of cardiac arrest.
Ultra-high voltage	>100,000 V	Seen in power stations or lightning strikes; extremely life-threatening.

The degree of injury increases proportionally with voltage intensity [8,19].

##### 4.2. Classification by Type of Current (AC vs. DC)

Type of Current	Definition	Major Hazards
Alternating Current (AC)	Changes direction 50–60 times per second (50–60 Hz).	Increases risk of ventricular fibrillation and induces stronger muscle tetany.
Direct Current (DC)	Flows in a single direction.	Increases the likelihood of asystole; generally less damaging if exposure is brief.

Alternating current (particularly at 60 Hz) exerts the most detrimental effect on cardiac rhythm [11].

##### 4.3. Classification by Pathway of Current Through the Body

Pathway	Affected Organs	Description
Hand–Hand	Heart, lungs	May pass directly through the heart.
Hand–Foot	Heart, lungs, diaphragm	High probability of traversing the heart.
Head–Foot	Brain, heart, spinal cord	May result in paralysis due to neural and cardiac involvement.
Single-point (static)	Skin, muscle tissue	Produces localized burns and rhabdomyolysis; generally superficial injury.

The pathway of current largely determines which organs are damaged and the severity of physiological effects.

##### 4.4. Classification by Clinical Severity

Severity Level	Clinical Manifestations	Description
Mild	Fear, tremor, localized pain	Not life-threatening; outpatient observation sufficient.
Moderate	Muscle spasms, syncope, arrhythmias	Requires inpatient monitoring and treatment.
Severe	Cardiac arrest, respiratory paralysis, rhabdomyolysis	Requires intensive care and resuscitative intervention.

This grading system assists clinicians in rapid triage and prioritization of medical intervention [6,17].

**4.5. Classification by Affected Tissues**

Tissue Type	Effect	Clinical Significance
<b>Skin</b>	Superficial or deep burns	Risk of infection; requires wound management.
<b>Muscle</b>	Spasm, necrosis, rhabdomyolysis	May lead to acute renal failure.
<b>Heart</b>	Arrhythmias, fibrillation	High risk of sudden death.
<b>Nervous system</b>	Seizures, paralysis, loss of consciousness	Possible long-term neurological complications.
<b>Respiratory system</b>	Asphyxia, diaphragmatic paralysis	May necessitate artificial ventilation.

**4.6. Classification by Source of Electric Current**

Source Type	Description	Examples
<b>Domestic current</b>	Electrical outlets and household appliances	Common among children.
<b>Industrial current</b>	Generators, transformers, high-voltage lines	Frequent among industrial workers.
<b>Lightning strike</b>	Natural atmospheric discharge	Rare but extremely lethal.
<b>Medical equipment</b>	Defibrillators, electrocautery devices	Uncommon, but possible in clinical settings.

Accurate classification of electrical injuries is essential for proper patient assessment, the development of effective treatment strategies, and prevention of complications. It enhances the efficiency of emergency care and plays a crucial role in reducing mortality.

**5. CLINICAL PRESENTATION**

At initial admission, the patient’s vital functions — airway, breathing, circulation, disability, and exposure (ABCDE algorithm) — must be assessed. The source of electricity, duration of contact, type of current (AC or DC), pathway through the body, and extent of injury are also determined [6].

Electrical burns frequently result in deep tissue damage, cardiovascular dysfunction, and neurological impairment. Clinically, patients may present with respiratory distress, cardiac rhythm disturbances, and cognitive decline.

The management of electrical injuries requires rapid emergency intervention, cardiopulmonary resuscitation, and long-term rehabilitation [10,21].

The clinical manifestations of electrical injury depend on multiple factors, including current intensity and type, duration of exposure, the current’s pathway, and the patient’s general health and response time to medical intervention. The presentation usually involves neurological, cardiovascular, cutaneous, and musculoskeletal systems, as well as psychological

effects.

Key determinants of clinical severity include:

- Type and intensity of current (AC or DC)
- Duration of exposure
- Current pathway
- Patient’s age and health status
- Depth and localization of tissue damage

Based on these factors, electrical injuries are categorized as mild, moderate, or severe, each with characteristic clinical features.

**5.1. General Symptoms**

The clinical manifestations of electrical shock vary greatly depending on the exposure conditions, current intensity, duration, and body pathway. Some patients experience only mild burns and discomfort, while others develop life-threatening complications.

Therefore, every patient exposed to electrical current must undergo urgent clinical evaluation and continuous monitoring.

Clinical Symptom	Description
Fear and anxiety	Elevated adrenaline levels, tachycardia
Pain (localized or diffuse)	Most pronounced at entry and exit sites
Muscle spasms	Often prevent release from the electrical source
Tremors, dizziness	Result of neurovegetative response
Loss of consciousness	Common in moderate to severe cases

**5.2. Cardiovascular Manifestations**

Electrical shock frequently disrupts cardiac rhythm, representing one of the most life-threatening consequences. Documented abnormalities include ventricular fibrillation, asystole, bradycardia, tachycardia, and other arrhythmias [7]. These events

cause acute deterioration and demand immediate resuscitative measures.

Electrical injury may also lead to myocardial inflammation (myocarditis) or ischemic infarction due to direct myocardial damage [9].

Sign	Description
Tachycardia or bradycardia	Altered heart rate secondary to conduction abnormalities
Arrhythmia	Ventricular fibrillation poses the highest mortality risk
Asystole	Complete cessation of cardiac activity
Hypotension	Sharp decrease in arterial pressure
Circulatory failure	Weak or absent pulse, loss of consciousness

**5.3. Neurological Manifestations**

The nervous system is highly sensitive to electrical stimulation. Common presentations include headache, dizziness, drowsiness, convulsions, and paralysis [20]. Central nervous system involvement may result in cognitive impairment, memory loss, and psychomotor slowing.

Peripheral nerve injury may cause pain, sensory loss, and muscle weakness [11].

Psychological sequelae are also frequent, such as post-traumatic stress disorder (PTSD), depression, anxiety, insomnia, and persistent fear reactions [5,16]. These symptoms should be addressed during long-term rehabilitation.

Neurological Sign	Description
Convulsions	Especially in children or after head-to-foot current passage
Paresthesia	Tingling or numbness in limbs
Coordination disturbances	Vestibular system impairment
Syncope	Sudden cerebral electrical instability
Neurological deficits	Speech disturbances, paralysis, memory impairment (long-term effects)

**5.4. Respiratory Manifestations**

Electrical injury affecting the respiratory centers may

lead to respiratory arrest, pulmonary edema, or asphyxia [19]. Damage to thoracic nerves may result in diaphragmatic paralysis.

Sign	Description
Respiratory arrest	Due to brainstem center failure or diaphragmatic paralysis
Bradypnea	Reduced respiratory rate leading to asphyxia
Need for artificial ventilation	Immediate resuscitation required in severe cases

**5.5. Cutaneous and Burn Manifestations**

At the points of current entry and exit, localized burns typically occur — especially on moist or wet skin. These burns present as black or erythematous necrotic zones,

blisters, or tissue destruction [16].

The depth of the burn depends on current strength and exposure duration, and may extend to muscle and nerve fibers, causing deep necrosis.

Type of Burn	Description
Superficial burn	Erythema, edema, local pain
Deep tissue burn	Involvement of muscle and vascular structures
Electrocution marks	Charred, firm tissues at entry and exit sites

**5.6. Metabolic and Renal Manifestations**

Electrical injury may cause rhabdomyolysis — the

breakdown of muscle fibers releasing myoglobin into the bloodstream, leading to acute kidney injury (AKI).

Sign	Description
Dark urine (myoglobinuria)	Primary indicator of rhabdomyolysis
Renal failure	Due to dehydration and toxin accumulation
Hyper- or hypothermia	Secondary to metabolic stress

Adequate hydration therapy and renal monitoring are essential to prevent renal complications.

clinical approach. In particular, cardiac and neurological symptoms must be assessed immediately, as prompt intervention is vital to prevent fatal outcomes.

**5.7. Pediatric and Specific Clinical Cases**

In children, electric shock commonly results from:

- Playing with electrical outlets,
- Inserting electrical objects into the mouth,
- Heightened sensitivity leading to rapid loss of consciousness.

Typical pediatric symptoms include:

- Sudden loss of consciousness,
- Unexplained crying or tremors,
- Convulsions,
- Profound shock reactions [13].

The clinical spectrum of electrical injury is diverse and multifaceted. Each patient requires an individualized

**6. DIAGNOSTICS AND TREATMENT**

Accurate and timely diagnosis is of crucial importance in patients affected by electrical injury (electrocution). The main purpose of the diagnostic process is to identify life-threatening conditions, assess the extent of internal damage, and prevent possible complications. This process requires a systematic approach that combines clinical examination, laboratory tests, and instrumental diagnostics [6,17].

**6.1. Primary Assessment (ABCDE Approach)**

In emergency management, the ABCDE algorithm (Airway, Breathing, Circulation, Disability, Exposure) is applied to evaluate and stabilize the patient [6,17].

Stage	Description
<b>A – Airway</b>	Assessment of airway patency; intubation is performed if necessary.
<b>B – Breathing</b>	Evaluation of respiratory movements and oxygen saturation; artificial ventilation may be required.
<b>C – Circulation</b>	Monitoring of heart rate, pulse, and blood pressure; electrocardiography (ECG) should be performed.
<b>D – Disability</b>	Assessment of neurological status using the Glasgow Coma Scale (GCS).
<b>E – Exposure</b>	Full-body inspection to identify entry and exit points of electrical current.

**6.2. Laboratory Diagnostics**

Laboratory evaluation is essential for identifying internal

tissue damage and potential complications. The key tests are as follows:

Test	Purpose
<b>Troponin, CK-MB</b>	Detection of myocardial injury (to exclude infarction).
<b>Creatine kinase (CK)</b>	Assessment of rhabdomyolysis severity.
<b>Electrolytes (Na<sup>+</sup>, K<sup>+</sup>, Ca<sup>2+</sup>, Mg<sup>2+</sup>)</b>	Evaluation of electrolyte imbalances that may cause arrhythmia.
<b>Creatinine, BUN</b>	Monitoring of renal function.
<b>Myoglobin, urinalysis</b>	Detection of myoglobinuria and rhabdomyolysis.

Muscle breakdown (rhabdomyolysis) can lead to acute renal failure; therefore, early detection and monitoring of biochemical indicators are critical [9].

**6.3. Instrumental Examinations**

1. Electrocardiography (ECG) – A key diagnostic tool for identifying arrhythmias, fibrillation, bradycardia, or myocardial damage after electric shock [7].
2. Radiography and Computed Tomography (CT) – Useful for detecting thoracic injuries, pulmonary edema, or skeletal trauma.
3. Ultrasound (US) and Doppler Studies – Applied to assess internal organ injuries, hematomas, or vascular thrombosis.

**6.4. Principles of Treatment**

Management of electrical injuries requires a rapid, systematic, and multidisciplinary approach that includes emergency interventions and long-term rehabilitation

Burn Degree	Treatment Method
1st–2nd degree	Cooling, antiseptic treatment, and analgesics.
3rd–4th degree	Surgical debridement and skin grafting if necessary.

**D. Antiarrhythmic Therapy**

Administration of amiodarone, lidocaine, or magnesium sulfate is indicated in life-threatening arrhythmias caused by electrical shock [7].

**E. Rhabdomyolysis and Renal Protection**

- Early and adequate hydration, electrolyte monitoring.
- Hemodialysis in severe renal failure cases.

**F. Psychological and Neurological Rehabilitation**

Post-electrocution patients frequently develop post-traumatic stress disorder (PTSD), depression, anxiety, and sleep disturbances [16].

Long-term rehabilitation includes psychotherapy, neurological rehabilitation, and physiotherapy.

**G. Antibiotic Prophylaxis**

Antibiotics are prescribed in cases of deep burns or open wounds to prevent secondary infection [2].

**H. Pediatric Considerations**

In children, electrocution often results from domestic exposure (e.g., sockets or small appliances). Due to the

[9].

**A. Life-Saving Measures**

- Immediate disconnection from the electrical source and relocation to a safe area.
- Artificial respiration and cardiopulmonary resuscitation (CPR) if necessary.
- Defibrillation in cases of ventricular fibrillation.
- Chest compressions performed at a rate of 100–120 per minute and a depth of 5–6 cm [12,14,15].

**B. Infusion Therapy**

- Aggressive hydration (0.9% NaCl or Ringer’s solution) to prevent renal failure due to rhabdomyolysis.
- Correction of electrolyte imbalances (particularly hyper- or hypokalemia) to prevent cardiac dysfunction.

**C. Burn Management**

immature respiratory center and higher sensitivity, all pediatric patients should be monitored in a hospital setting—even in mild cases [13].

**6.5. Cardiopulmonary Resuscitation (CPR)**

If cardiac arrest occurs, cardiorespiratory resuscitation (CPR) must be initiated immediately [7,9].

- Chest compressions: Performed at a depth of 5–6 cm, rate of 100–120/min.
- Defibrillation: Applied in cases of ventricular fibrillation or tachycardia to restore normal rhythm.
- Artificial ventilation: 10–12 breaths per minute, each lasting approximately 1 second. Intubation and mechanical ventilation are required in prolonged or severe respiratory failure.

Effective synchronization of CPR and artificial ventilation is critical to ensure oxygenation and restore cardiac function.

Timely cardiopulmonary resuscitation (CPR) and artificial ventilation significantly increase the chances of survival in cases of cardiac and respiratory arrest caused by electrical shock. Therefore, the skill and promptness of healthcare providers in performing these procedures

are of critical importance.

## 7. COMPLICATIONS AND OUTCOMES

Electrical injury is a complex process that can cause severe damage to the human body. The nature and severity of complications depend on the strength and type of current, the pathway of electricity through the body, duration of exposure, as well as the patient's overall health and the timeliness and quality of medical care provided [1,6].

The consequences of electrical shock vary according to the patient's age, general health, type and strength of current, and the path it takes through the body. Even seemingly minor electrical injuries can result in serious internal organ damage. Some complications may persist for years despite treatment. Complications can be classified as acute or long-term (chronic).

### 7.1. Acute Complications

#### 1. Cardiac complications

The most dangerous and life-threatening complications include cardiac arrhythmias such as ventricular fibrillation, bradycardia, conduction blocks, and cardiac arrest [7]. Electrical current can directly damage myocardial tissue, potentially causing myocarditis or infarction. Long-term inflammation and rhythm disturbances may lead to chronic heart failure [9].

- o Ventricular fibrillation, asystole, ECG abnormalities

- o Cardiac rhythm disturbances are the leading cause of death following electrical injury [7,19]

#### 2. Respiratory center paralysis

Injury to the respiratory centers in the brainstem, diaphragmatic paralysis, or pulmonary edema may result in respiratory insufficiency [19].

- o If the current affects the medulla oblongata, respiratory arrest can occur.

#### 3. Rhabdomyolysis and renal failure

Extensive muscle damage can release myoglobin into the bloodstream, impairing kidney function and potentially leading to renal failure [17].

- o Muscle cell breakdown releases myoglobin, damaging the kidneys.

#### 4. Thermal burns

Burns can lead to necrosis, infection, tissue death, and,

in severe cases, sepsis. Deep tissue injury may also involve muscles and skeletal structures [2].

- o Entry and exit wounds and deep tissue burns are prone to secondary infections.

#### 5. Nervous system injury

Both central and peripheral nervous system damage is common. Neuropathy, paralysis, headaches, cognitive impairment, epileptic seizures, and psychological disorders such as post-traumatic stress disorder (PTSD) and depression may develop [5,20].

- o Loss of consciousness, seizures, paralysis, absent reflexes.

#### 6. Musculoskeletal injuries

- o Electrical currents may induce muscle spasms leading to bone fractures or dislocations.

#### 7. Visual and auditory disturbances

- o Currents passing through the head can result in permanent blindness or hearing loss.

### 7.2. Long-Term (Chronic) Complications

#### 1. Neurological complications

- o Memory impairment, insomnia, cognitive deficits, post-traumatic epilepsy.

#### 2. Psychological disorders

- o PTSD, anxiety disorders, depression. Studies by Primavesi [16] and Waldman et al. [20] indicate that 30–50% of patients who suffer severe electrical injuries develop long-term psychological disturbances.

#### 3. Skin and scar changes

- o Hypertrophic scars, contractures, and cosmetic concerns may occur at burn sites.

#### 4. Persistent cardiac rhythm disturbances

- o Continuous ECG monitoring is recommended, particularly in patients who experienced electrical storms.

#### 5. Ongoing renal insufficiency

- o Delayed recognition of rhabdomyolysis can lead to chronic kidney disease.

#### 6. Loss of work capacity

- o A high proportion of industrial workers affected by electrical injury experience long-term disability [1].

### 7.3. Prognosis

Outcomes following electrical shock largely depend on the severity of injury and the medical care provided. Mild injuries may result in full recovery, whereas severe or prolonged electrical exposure can lead to long-term complications or death.

- Short-term outcomes: With prompt medical intervention, most patients recover within days or

weeks.

- Long-term outcomes: Complications may include chronic cardiovascular disease, neurological deficits, muscle weakness, and psychological disorders.
- Mortality risk: Cardiac arrest, myocardial injury, or respiratory center paralysis can result in death in 5–15% of cases [1].

Condition	Prognosis	Recommendations
Mild electrical injury	Usually full recovery	Monitoring sufficient
Cases with cardiac arrhythmias	Risk of recurrence	Cardiologist supervision required
Burns and rhabdomyolysis	Rehabilitation may exceed 6 months	Surgical, nephrological, psychological follow-up
Respiratory paralysis or brain injury	Prolonged resuscitation, reduced quality of life	Rehabilitation interventions
Psychological trauma	Often requires long-term therapy	Psychotherapy, medications

Electrical injury requires urgent and comprehensive medical care. Complications affect multiple organ systems and can significantly impact the patient’s future quality of life. Therefore, a thorough and individualized approach is essential in diagnosis and treatment.

#### 7.4. Rehabilitation

Rehabilitation involves physiotherapy, psychological support, and, if necessary, social adaptation, as well as the treatment of post-traumatic stress and other psychiatric consequences [5]. Rehabilitation is an extremely important stage in electrical injuries and includes:

- Physiotherapy and movement therapy — restoring the musculoskeletal system
- Psychological support — overcoming the consequences of trauma
- Cardiological rehabilitation — monitoring heart function
- Speech and cognitive therapy — in cases of brain damage
- Social adaptation — returning to work, learning new professions

The consequences of electric shock can be much deeper and more multifaceted than superficial appearances suggest. Timely diagnosis, emergency care, and continuous medical management reduce complications and restore the patient’s quality of life. The rehabilitation process is an integral part of treatment.

#### 8. Discussion

Studies on the clinical presentation, diagnosis, treatment methods, and complications of electric shock, as well as approaches used in medical practice, show varying opinions in the scientific literature. In this section, the main scientific sources are analyzed, highlighting modern perspectives and challenges in clinical practice.

Dyer et al. [7] note that electric current primarily affects heart rhythm and can lead to ventricular fibrillation. This condition requires urgent medical attention, as rapid and precise action is necessary to save the patient’s life.

Nevertheless, research by Morrison & Woollard [13] shows that some electric shock victims may be asymptomatic initially but are at risk of developing serious complications later. This underscores the need for at least 24-hour monitoring of all electric shock patients.

Continuous ECG monitoring is crucial for patients who have suffered electric shocks. According to Guarracini et al. [9], advanced cardiological care is necessary in cases of “electric storm” (recurrent arrhythmias).

Furthermore, Schieche [17] and Dumler & Zane [6] recommend timely laboratory tests, particularly for troponin and creatine kinase levels, which allow early detection of heart and muscle damage.

Standard protocols used in practice for electric shock (ABCDE, defibrillation, infusion therapy) have been scientifically validated. At the same time, Adalı et al. [1] in an epidemiological study showed that in some regions, insufficient emergency medical care increases

the risk of complications and death.

For burns caused by electric shock, surgical intervention, including debridement and skin grafting, is essential [16].

As many studies emphasize, electric shock causes not only physical injuries but also psychological problems. Primavesi [16] and Waldmann et al. [20] provide detailed information about post-traumatic stress, depression, and cognitive impairments in patients.

In such cases, psychological and social support are an integral part of rehabilitation.

Recommended directions:

- Study the long-term neuropsychological effects of electric shock
- Test new antiarrhythmic and neuroprotective drugs
- Develop and implement international standards for electric shock prevention
- Individualize rehabilitation programs and improve their effectiveness

Modern research on electric shock demonstrates the complex nature and wide-ranging consequences of these injuries. Therefore, a comprehensive approach in clinical practice—from emergency care to long-term rehabilitation—is essential.

## 9. Conclusions

Electric shocks involve multiple medically significant problems and require both urgent and long-term management. This article provides a detailed review of the pathophysiology, clinical presentation, diagnosis, treatment methods, and complications of electric shock.

Key conclusions:

1. Electric shock is life-threatening, particularly due to heart rhythm disturbances and respiratory center paralysis, requiring urgent medical intervention.
2. Diagnosis is complex, and ECG monitoring, laboratory tests, and instrumental examinations (X-ray, ultrasound) play an important role.
3. Initial management is based on the ABCDE algorithm, including emergency care, infusion therapy, antiarrhythmic treatment, burn management, and rehabilitation.
4. Complications may be acute or long-term,

including cardiac arrhythmias, rhabdomyolysis, neurological and psychological disorders, and post-burn scars.

5. Rehabilitation involves physiotherapy, psychological support, cardiological monitoring, and social adaptation.

6. Prevention and education efforts need strengthening, as most electric shocks occur at workplaces or at home.

7. Future research is needed on the neuropsychological and cardiological consequences of electric shock, as well as improvements in treatment methods.

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