كليـــــــة الـطـب
والصيدلة - مراكش
FACULTÉ DE MÉDECINE
ET DE PHARMACIE - MARRAKECH
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Epidemiological, clinical characteristics and outcome of severe scorpion envenomation in the pediatric intensive care unit at the Children's Hospital of Marrakech: Multivariate analysis of 1595 cases.

THESIS

PRESENTED AND PUBLICLY DEFENDED ON 27/09/2023

BY

Mrs. Aliaâ TAFALI

Born on the 27th of January 1998 in Marrakech

TO OBTAIN A MEDICAL DOCTORATE

KEY WORDS

Scorpion – Envenomation – Epidemiology – Pediatric – Morocco – Public Health

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بسم الله الرحمن الرحيم

سورة الفاتحة

Hippocratic Oath

At the time of being admitted as a member of the medical profession:

I solemnly pledge to dedicate my life to the service of humanity; the health and well-being of my patient will be my first consideration;

I will respect the autonomy and dignity of my patient; I will maintain the utmost respect for human life; I will not permit considerations of age, disease or disability, greed, ethnic origin, gender, nationality, political affiliation, race, sexual orientation, social standing or any other factor to intervene between my duty and my patient;

I will respect the secrets that are confided in me, even after the patient has died; I will practice my profession with conscience and dignity and in accordance with good medical practices;

I will foster the honor and noble traditions of the medical profession; I will give to my teachers, colleagues, and students the respect and gratitude that is their due I will share my medical knowledge for the benefit of the patient and the advancement of healthcare;

I will attend to my health, well-being, and abilities in order to provide care of the highest standard; I will not use my medical knowledge to violate human rights and civil liberties, even under threat; I make these promises solemnly, freely and upon my honor.

Declaration of Geneva, 1948

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56	OUALI IDRISSI Mariem	P.E.S	Radiologie
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261	EL HAMDAOUI Omar	Pr Ass	Toxicologie
262	EL HAJJAMI Ayoub	Pr Ass	Radiologie
263	BOUMEDIANE El Mehdi	Pr Ass	Traumato-orthopédie
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265	JEBRANE Ilham	Pr Ass	Pharmacologie
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270	EL MOUHAFID Faisal	Pr Ass	Chirurgie générale

LISTE ARRETEE LE 06/09/2023


Dedications

Je dédie cette thèse à…

الْحَمْدُ لِلَّهِ الَّذِي هَدَانَا لِهَٰذَا وَمَا كُنَّا لِنَهْتَدِيَ لَوْلَا أَنْ هَدَانَا اللَّهُ

A la mémoire des victimes du séisme d'El Haouz du 08/09/2023.

إِنَّا لِلَّهِ وَإِنَّا إِلَيْهِ رَاجِعُونَ

À ma merveilleuse Maman,

Tu as été ma source de force, d'inspiration et de soutien inébranlable tout au long de ma vie, et particulièrement pendant cette incroyable aventure.

Ta présence bienveillante, tes mots d'encouragement et tes étreintes réconfortantes m'ont portée à travers les hauts et les bas.

En dédiant ma thèse à toi, ma mère extraordinaire, je veux te remercier du fond du cœur pour ta présence constante, ton soutien indéfectible et ton amour inébranlable.

Je t'aime plus que les mots ne peuvent l'exprimer, et je suis honorée de partager cette réalisation avec toi.

A toi Papa, l'homme de ma vie,

Tu as été un pilier solide dans ma vie, un guide bienveillant et un modèle de persévérance, de sagesse et de détermination.

Au fil des années, tu as été mon plus grand supporter, me poussant à croire en moi-même et à surmonter les obstacles qui se sont dressés sur ma route. Ta présence rassurante, tes encouragements constants et ton soutien inconditionnel m'ont donné la confiance nécessaire pour persévérer.

Cette thèse est le fruit de ton amour, de ton soutien et de ta confiance en moi.

وَقُلْ رَبِّي ارْحَمْهُمَا كَمَا رَبَّيَانِي صَغِيرًا

A ma soeur Zineb,

A ma confidente, mon amie et ma complice. A la merveilleuse personne que tu es et que tu vas devenir. Tu es présente, dans les bons moments de joie ou dans les épreuves, célébrant mes succès et apaisant mes larmes. Que cette dédicace soit une reconnaissance humble de notre lien spécial et de l'amour inconditionnel qui nous unit. Je t'aime tellement et suis honorée de t'avoir comme sœur et de partager cette réalisation avec toi.

A mon frère Aymane,

Merci pour ta solidité et ton soutien constant. Tu as été là pour m'écouter, me conseiller et me réconforter lorsque j'en avais le plus besoin. Ta présence bienveillante et ton amour inconditionnel ont été des repères constants dans ma vie, me donnant la force et la sécurité nécessaires pour avancer.

Que cette dédicace soit une humble reconnaissance de notre relation spéciale et de l'impact profond que tu as eu sur ma vie.

A mon frère Ouahb,

Tu es un rayon de soleil dans ma vie. En grandissant ensemble, j'ai pu observer ta curiosité insatiable et ta soif de connaissance. Ne cesse jamais de poursuivre tes rêves, de croire en toi-même et d'explorer le monde avec ta passion caractéristique. Je suis convaincu que tu accompliras de grandes choses.

Je veux que tu saches à quel point je t'aime, je serai toujours là pour toi. Que chaque instant de ta vie soit empreint de bonheur, de réussite et de réalisations.

A ma grand mère Laaziza KARAMI.

Puisse Dieu tout puissant vous protéger du mal, vous procurer longue vie, santé et bonheur.

A la mémoire de mes grands pères Jilali SLIMANI et Mohamed TAFALI,

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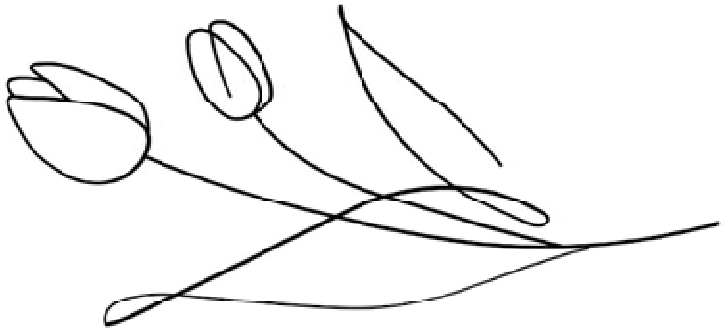

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Abreviations

List of abbreviations:

ABGS	:	Arterial blood gases
ALAT	:	Alanine Aminotransferase
ASAT	:	Aspartate Aminotransferase
BIPAP	:	BiLevel Positive Airway Pressure
BZD	:	Benzodiazepine
Ca2+	:	Calcium
CAPM	:	Centre Anti Poison et de Pharmacovigilance du Maroc (in French)
CBC	:	Complete Blood Count
CPAP	:	Continuous Positive Airway Pressure
Cl-	:	Chloride
Creat	:	Creatinine
ECG	:	Electrocardiogram
EEG	:	Electroencephalogram
EPT	:	Early Presentation Time
GCS	:	Glasgow Coma Scale
HB	:	Hemoglobin
ICU	:	Intensive Care Unit
IMV	:	Invasive Mechanical Ventilation
K+	:	Potassium
MRI	:	Magnetic Resonance Imaging

Na+	**:**	Sodium
ND	:	Non Determined, No Data
NFS	:	Numération Formule Sanguine (in French)
PLQ	:	Platelets
PST	:	Primary post-sting time
PVC	**:**	Peripheral Venous Catheter
SpO2	:	Pulse Oximetry Oxygen Saturation
CT	:	Computed Tomography Scan
TDM	**:**	Tomodensitométrie (in French)
TPP	:	Time to Presentation
TVI	:	Time-velocity integral
WBC	:	White Blood Cells

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Introduction

Scorpion envenomation is an important health problem in many countries of the world. Around 1753 species of scorpions have been described, 20 to 25 of those present medical interests. [1]

Studies estimate the incidence of scorpion stings to 1.2 millions worldwide causing 3250 deaths each year. [2] In North Africa, the annual incidence of scorpion stings is estimated between 50 and 420 per 100 000 inhabitants. [3]

Morocco is one of the Mediterranean countries where the greatest number of scorpion stings and envenomation are recorded. Indeed, the dry and arid climate of certain regions in Morocco, along with its ecological characteristics such as mountain ranges, plateaus, coastal plains, and dunes, and its climatic diversity influenced by the Atlantic, Saharan, and continental influences, contribute to one of the richest and most diverse scorpion fauna biodiversity in North Africa and even the Mediterranean region. [4]

Scorpion envenomation is the first cause of poisoning with 50 to 60% of cases reported to Anti-Poison and Pharmacovigilance Center of Morocco with an incidence rate ranging from 0 to 2.4% depending on the different regions and a rate of overall lethality of 0.82% and up to 5.3% in some areas. In 90% of cases, the deaths involve children under 15 years old. [5]

It appears, indeed, that children are more susceptible to severe clinical manifestations of envenomation.

Despite these staggering figures, the epidemiology of scorpionism is still poorly known.

The aims of the present study are to :

- Characterize both epidemiological and clinical manifestations following scorpion envenomation.
- Define predictive factors that may be associated with poor outcomes.

Materials and methods

I. Study Design :

1. Type of study :

This is a retrospective cohort study.

2. Location and period of the study :

Pediatric intensive care unit at the Mother and Child Hospital of the Mohammed 6 University Hospital in Marrakech.

Cross-sectional descriptive study spread over a 13-year period (from January 2010 to December 2022).

II. Methods:

1. Inclusion criteria :

We included all children hospitalized in the Pediatric Intensive Care Unit (ICU) at the Mother and Child Hospital, Mohammed VI Teaching Hospital, Marrakech (Morocco), admitted for moderate and severe scorpion envenomation admitted for advanced care.

2. Exclusion criteria :

- The subjects whose age is greater than or equal to 16 years.
- Patients with uncertain diagnoses.
- Incomplete or missing medical records.

Five cases were excluded as they did not meet the inclusion criteria for the study (bee sting, admission for another reason, missing data, etc.).

3. Data collection:

The demographic, diagnostic, and therapeutic data, as well as patient follow-up, were collected from chart reviews, hospital's patient files and electronic archives of the department (informatic system HOSIX).

The data collection was based on a pre-established questionnaire while ensuring the anonymity and confidentiality of the patients (Annexe 1). The exploitation sheet has been converted into a Google Form to facilitate statistical analysis.

The following data were collected :

- Epidemiological profile :

Age, sex, weight, province of origin, rural/urban area, method of regulation, pre-hospital care.

- Medical history :

We have searched for inflammatory diseases, heart disease, asthma, lung disease, neuropathy, and any previous scorpion envenomation (date, timing and severity) and any medical intervention such as hospitalization or admission to the intensive care unit.

- Information about the scorpion sting:

The diagnosis of scorpion envenomation was based on a detailed account of the patient's exposure to a scorpion sting or presence of a scorpion in the vicinity.

We have recorded the number of stings, location, laterality, timing (date and time), place of occurrence (indoors/at home, outdoors, or other), primary post-sting time (TPP1), secondary post-sting time, identification of the scorpion

❖ **Post-sting time (PST) : [6]**

PST refers to the time interval between the moment of scorpion sting and the patient's presentation to healthcare services to receive medical care. In other words, it is the duration from the sting to the initiation of appropriate medical treatment, in our study it corresponds to the arrival at the Pediatric Intensive Care Unit.

EPT1 (Early Presentation Time 1) corresponds to the time interval between the sting and the first medical contact or initial medical evaluation of the patient. It measures the speed at which the patient seeks medical care after the sting.

EPT2 (Early Presentation Time 2) refers to the time interval between the first medical contact or initial medical evaluation of the patient and the arrival at the Pediatric Intensive Care Unit.

- Management before admission to the intensive care unit :

The purpose was to examine the treatment received prior to the first consultation (including incision, scarification, suction, tourniquet application, use of traditional remedies, cryotherapy, or others).

We specify if the patient received oxygen therapy and the type, vascular access (number and type), and any medical treatment received, particularly Dobutamine (administered via infusion or push syringe), Corticosteroid therapy, calcium therapy, antibiotics, Antiulcer drugs, tetanus antiserum, local anesthetics/Lidocaine, antiemetics, benzodiazepines, antipyretics (such as paracetamol), insulin, antihypertensive drugs (such as Nicardipine), and others.

- Upon admission to the pediatric intensive care unit :

Reassessment of pre-admission management: the peripheral venous catheter (VVP) is in place and patent, dobutamine is being effectively administered.

The envenomation grade at admission (Grade I, Grade II, Grade III) is determined according to the classification proposed by the Ministry of Health.

❖ **Classification :**

Table I : Grading Signs and Symptoms of scorpion sting cases. [7]

Grade I : Mild envenomation.	Pain and/or paresthesia at the scorpion sting site, tingling, numbness and minor swelling in the skin area encompassing the sting *(local symptoms)* and absence of severe complications
Grade II : Moderate envenomation.	Fever, chills, tremor, excessive sweating, nausea, vomiting, diarrhea, hypertension and priapism *(systemic symptoms +/- locals symptoms)*
Grade III : Severe envenomation.	Severe systemic manifestations, including cardiovascular collapse, severe respiratory distress, or neurological complications.

Thus, initial clinical evaluation includes assessment of:

- Local signs (pain, tingling, numbness, redness, swelling, cutaneous traces of the sting, and others).
- General signs (fever, chills, hypothermia, excessive sweating, vomiting, diarrhea, abdominal pain, hypertension, abdominal distension, excessive salivation, tachycardia, priapism, agitation, and others).
- Specific assessment is conducted for signs of *cardiovascular distress* (gallop rhythm, mottling, cool extremities, skin recoloration time greater than 3 seconds, hypotension, weak pulses, and others), *respiratory distress* (crackles, tachypnea, bradypnea, cyanosis, tracheobronchial congestion, involvement of accessory muscles, respiratory arrest, and others), and *neurological signs* (seizures, irritability, confusion, temporal-spatial disorientation, nystagmus, strabismus, altered consciousness, coma, and others).

Vital signs are recorded, including heart rate in beats per minute, respiratory rate in breaths per minute, blood pressure in millimeters of mercury, ambient air oxygen saturation (SpO2) in percentage, temperature in degrees Celsius, blood glucose level in grams per liter, and Glasgow Coma Scale.

Table II : General Vital Signs and Guidelines [8]

Age	Heart Rate (beats/min)	Blood Pressure (mmHg)	Respiratory Rate (breaths/min)
Premature	110-170	SBP 55-75 DBP 35-45	40-70
0-3 months	110-160	SBP 65-85 DBP 45-55	35-55
3-6 months	110-160	SBP 70-90 DBP 50-65	30-45
6-12 months	90-160	SBP 80-100 DBP 55-65	22-38
1-3 years	80-150	SBP 90-105 DBP 55-70	22-30
3-6 years	70-120	SBP 95-110 DBP 60-75	20-24
6-12 years	60-110	SBP 100-120 DBP 60-75	16-22
> 12 years	60-100	SBP 110-135 DBP 65-85	12-20

❖ **Normal Vital Signs [8] :**

- Sp02⩾92%

  Hypoxemia was defined for SpO2 values below 92%.

- Temperature : 36.5-37.5℃ (rectal measurement)

  Hypothermia is defined when the temperature is below 36.5℃.

  Fever is defined when the temperature is above 38.5℃.

- Glycemia : 0.5-1.8g/L or 2.8-10.0 mmol/L

  Hypoglycemia is defined for blood glucose levels below 0.5g/L or 2.8mmol/L.

  Hyperglycemia is defined for values above 1.8g/L or 10.0mmol/L.

❖ **Glasgow Coma Scale [9] :**

The Glasgow Coma Scale divides into three parameters: best eye response (E), best verbal response (V) and best motor response (M). The Glasgow Coma Scale can be used in children older than 5 years with no modification.

Patients with Glasgow Coma Scale (GCS) ≤14 were considered to have altered consciousness levels, while those with GCS ≤8 were considered to have coma.

We categorize the patients into groups :

- GCS : 15/15, consciousness.
- GCS : 13-14/15, agitation.
- GCS : 9-12/15, confusion.
- GCS : ⩽8/15, coma state.

Table III : Modified Glasgow Coma Scale for Infants and Children [10]

Area Assessed	Infants	Children	Score
Eye opening	Open spontaneously	Open spontaneously	4
	Open in response to verbal stimuli	Open in response to verbal stimuli	3
	Open in response to pain only	Open in response to pain only	2
	No response	No response	1
Verbal response	Coos and babbles	Oriented, appropriate	5
	Irritable cries	Confused	4
	Cries in response to pain	Inappropriate words	3
	Moans in response to pain	Incomprehensible words or nonspecific sounds	2
	No response	No response	1
Motor response	Moves spontaneously and purposefully	Obeys commands	6
	Withdraws to touch	Localizes painful stimulus	5
	Withdraws in response to pain	Withdraws in response to pain	4
	Responds to pain with decorticate posturing (abnormal flexion)	Responds to pain with decorticate posturing (abnormal flexion)	3
	Responds to pain with decerebrate posturing (abnormal extension)	Responds to pain with decerebrate posturing (abnormal extension)	2
	No response	No response	1

- Biological assessment is conducted upon admission :

Complete Blood Count:

Table IV : Normal blood count values from birth to 18 years. [11]

Age	Hemoglobin (g/dl)	RBC ($\times10^{12}$/l)	Hematocrit	MCV (fl)	WBC ($\times10^{9}$/l)	Neutrophils ($\times10^{9}$/l)	Lymphocytes ($\times10^{9}$/l)	Monocytes ($\times10^{9}$/l)	Eosinophils ($\times10^{9}$/l)	Basophils ($\times10^{9}$/l)
Birth (term infants)	14.9–23.7	3.7–6.5	0.47–0.75	100–125	10–26	2.7–14.4	2.0–7.3	0–1.9	0–0.85	0–0.1
2 weeks	13.4–19.8	3.9–5.9	0.41–0.65	88–110	6–21	1.5–5.4	2.8–9.1	0.1–1.7	0–0.85	0–0.1
2 months	9.4–130	3.1–4.3	0.28–0.42	84–98	5–15	0.7–4.8	33–10.3	0.4–1.2	0.05–0.9	0.02–0.13
6 months	10.0–13.0	3.8–4.9	0.3–0.38	73–84	6–17	1–6	3.3–11.5	0.2–1.3	0.1–1.1	0.02–02
1 year	10.1–13.0	3.9–5.1	0.3–0.38	70–82	6–16	1–8	3.4–10.5	0.2–0.9	0.05–0.9	0.02–0.13
2–6 years	11.0–13.8	3.9–5.0	0.32–0.4	72–87	6–17	1.5–8.5	1.8–8.4	0.15–1.3	0.05–1.1	0.02–0.12
6–12 years	11.1–14.7	3.9–5.2	0.32–0.43	76–90	4.5–14.5	1.5–8.0	1.5–5.0	0.15–1.3	0.05–1.0	0.02–0.12
12–18 years										
Female	12.1–15.1	4.1–5.1	0.35–0.44	77–94						
					4.5–13	1.5–6	1.5–4.5	0.15–1.3	0.05–0.8	0.02–0.12
Male	12.1–16.6	4.2–5.6	0.35–0.49	77–92						

Table V: Platelet count ($\times$109/l) during childhood. [11]

Age	Both sexes	Girls	Boys
2 months	214–648 ($n = 119$)		
5 months	210–560 ($n = 106$)		
13 months	180–508 ($n = 101$)		
1–3 years	207–558 ($n = 68$)		
4–6 years		193–489 ($n = 118$)	205–450 ($n = 159$)
7–8 years		191–439 ($n = 155$)	194–420 ($n = 202$)
9–10 years		201–384 ($n = 182$)	174–415 ($n = 258$)
11–12 years		180–387 ($n = 206$)	178–382 ($n = 274$)
13–14 years		188–429 ($n = 129$)	183–370 ($n = 157$)
15–18 years		170–359 ($n = 151$)	189–374 ($n = 116$)

- Thrombocytosis is defined according to age-specific values.

❖ **Blood electrolyte panel [12] :**

The values are considered normal when they fall within the following ranges:

- ➢ Na+ : 135-145 mmol/L
- ➢ K+ : 3.5-5.5mmol/L
- ➢ Cl- : 98-106 mmol/L
- ➢ Calcium (total) : 8.8-10.8 mg/dL or 2,20-2,60 mmol/L
- ➢ Calcium (ionized) : 4,6-5,4 mg/dL or 1,15-1,35 mmol/L
- ➢ Creatinine :

Table VI: Creatinine according to age. [13]

Age	micromol/L	mg/dL
Premature (Day3)	25-91	2.9-10.4
Full-term newborn (Day 3)	21-75	2.4-8.5
2-12 months	15-37	1.7-4.2
1-3 years	21-36	2.4-4.1
3-5 years	27-42	3.1-4.7
5-7 years	28-52	3.2-5.9
7-9 years	35-53	4.0-6.0
9-11 years	34-65	3.9-7.3
11-13 years	46-70	5.3-7.9
13-15 years	50-77	5.7-8.7
Adult males	62-106	7.0-12.0
Adult females	44-80	5.0-9.0

➢ Urea : [13]

Children aged 0 - <1 year: 6 - 36 mg/dL

Children aged 1 - <10 years: 19 - 47 mg/dL

Girls aged 10 - 18 years: 15 - 41 mg/dL

Boys aged 10 - 18 years: 15 - 45 mg/dL

- Uremia is considered when the urea level exceeds 0,45 g/L or 7.6 mg/dL in the blood.

Other biological elements were requested, including:

Alanine Aminotransferase (ALT), Aspartate Aminotransferase (AST), Albumin, Proteinemia, CPK (Creatine Kinase), BNP (Brain Natriuretic Peptide), Lipase, Amylase and High-sensitivity Troponin.

Table VII : Laboratory Initiative on Pediatric Reference Intervals (CALIPER) [14]

		Male			Female		
Analyte	Age range, years	Lower limit	Upper limit	Median	Lower limit	Upper limit	Median
ALT, U/L	3–5	15	33	23	15	33	23
	6–8	16	37	24	16	37	24
	9–11	18	39	26	18	39	26
	12–17	17	50	26	14	41	24
AST, U/L	3–5	28	52	37	28	52	37
	6–11	25	47	33	23	44	32
	12–17	18	36	27	15	34	22
Albumin, g/L	3–5	3.9	5.0	4.5	3.9	5.0	4.5
	6–15	4.1	5.1	4.6	4.1	5.1	4.6
	16–17	4.6	5.3	4.8	3.9	5.0	4.4
Protein, total, g/dL	3–5	6.3	8.1	7.0	6.3	8.1	7.0
	6–17	6.8	8.2	7.4	6.8	8.2	7.4

The normal values are indicated below [14] :

- CPK (Creatine Kinase) : < 200 U/L (units per liter)
- BNP (Brain Natriuretic Peptide) : < 100 pg/mL (picograms per milliliter)
- Lipase levels : < 160 U/L
- Amylase levels : 30 - 110 U/L
- High-sensitivity Troponin : specific reference range provided by the laboratory conducting the test.

❖ **Arterial blood gas [8] :**

If indication and to the extent possible, arterial blood gas analysis is performed upon admission.

The values are considered normal when they fall within the following ranges :

- PH: 7.35-7.45
- Pa02: ⩾60mmhg
- PaCO2 : 35-45mmhg
- HCO3- : 22-28 mEq/L

In the case of acidosis, we distinguish:

Severe acidosis	Moderate acidosis	Mild acidosis
pH ≤ 7,10	pH ≤ 7,20	pH ≤ 7,30
HCO3- < 5 mmol/L	HCO3- < 10 mmol/L	HCO3- < 15 mmol/L

❖ **Electrocardiogram (ECG) [8] :**

Electrocardiograms aim to indicate the presence or absence of rhythm disturbances and/or repolarization abnormalities.

We specifically looked for rhythm disturbances such as:

Atrial Tachycardia, Supraventricular Tachycardia, Atrial Fibrillation, Sinus Bradycardia

And for repolarization disturbances such as:

1° Atrioventricular Block, 2° Atrioventricular Block- Type 2 (Mobitz II), 3° Atrioventricular Block (Complete Heart Block), Ventricular Tachycardia – Monomorphic, Ventricular Tachycardia – Polymorphic, Ventricular Tachycardia – Torsades de Pointes, Ventricular Fibrillation

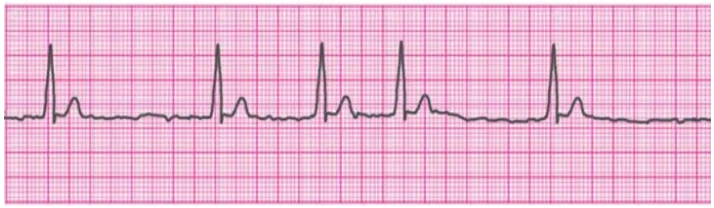


Figure 1 : Atrial Fibrillation

- *Radiological assessment upon admission :*
  - ➢ Chest X-ray to investigate the presence or absence of signs of pulmonary edema.
  - ➢ Transthoracic echocardiography (TTE) in search of the presence or absence of kinetic abnormalities with specific mention of ejection fraction (EF) and Time-velocity integral (TVI).
  - ➢ Brain computed tomography (CT) scan searching for cerebral ischemia, hemorrhage, and/or cerebral edema.
  - ➢ Brain magnetic resonance imaging (MRI) seeking for cerebral ischemia, hemorrhage, or cerebral edema.

- **Ejection fraction [15]:**

The ejection fraction is a measure that evaluates the percentage of blood ejected by the left ventricle with each cardiac contraction. It is typically expressed as a percentage.

A normal ejection fraction is generally between 50 and 70%. We defined an abnormal ejection fraction if it was less than 50%.

- **Velocity Time Integral (VTI):**

Velocity Time Integral is a Doppler echocardiographic measurement that quantifies the flow of blood through a specific region of the heart or blood vessel over time. It represents the product of the time and velocity profiles recorded by Doppler ultrasound.

VTI provides information about the total displacement of blood during a particular time period. It reflects the volume of blood flow across the region of interest. By analyzing the VTI, we can assess the forward or backward flow of blood, estimate stroke volume, evaluate valve function, and assess overall cardiovascular performance. [16]

The American Society of Echocardiography recognizes a normal VTI >18 cm in adults. In healthy children, normal values for VTI vary with age and body surface area, necessitating individual patient calculation. [79]

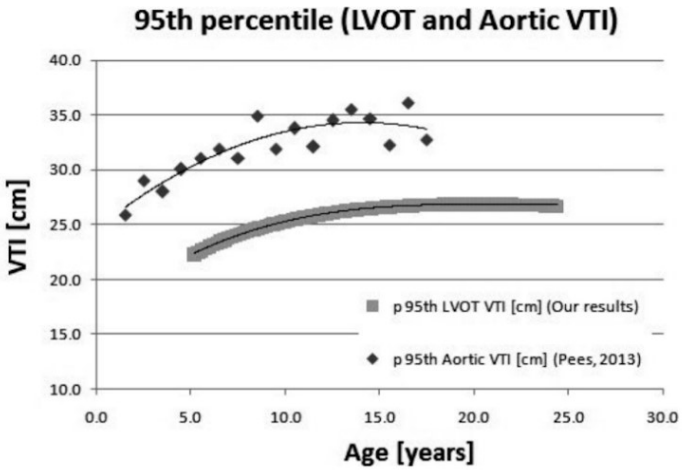


Figure 2 : Age-specific velocity time integral (VTI), percentiles 95th [79]

- **Pulmonary edema [17] :**

The diagnostic of pulmonary edema was retained if signs of respiratory distress were described, including tachypnea and inspiratory retraction of intercostal spaces and the presence of crackles on auscultation, in addition to the signs of interstitial and alveolar pulmonary edema on chest X-ray.

- **Management upon admission to the intensive care unit :**

The management protocol adopted in our department for scorpion envenomation is detailed in the appendix.

We have elaborated on the methods employed for patient care :

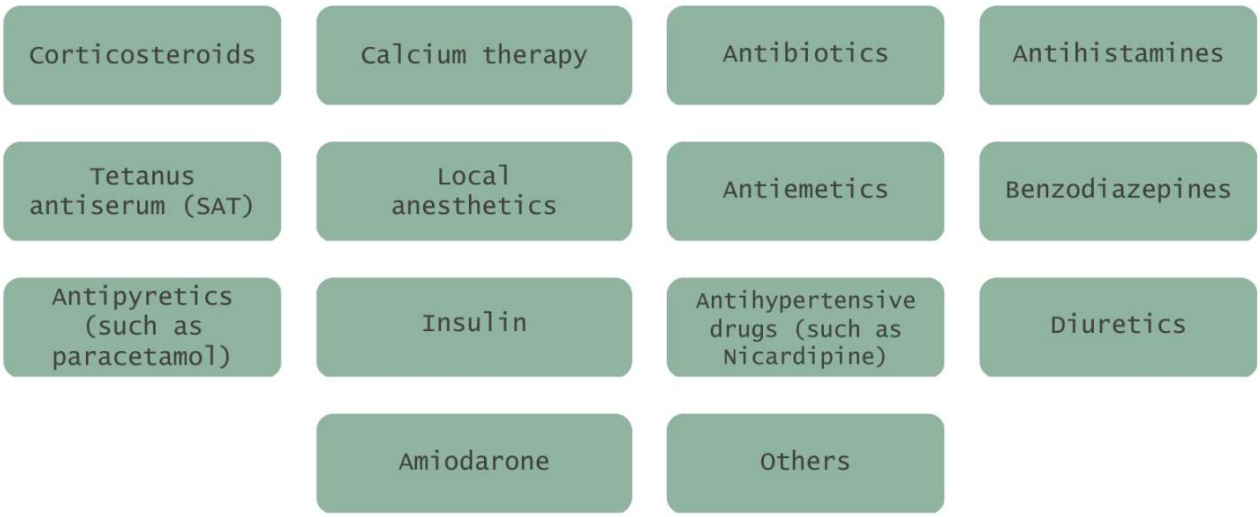
- **Oxygen therapy:**

If NIV is used, we specify the interface: Ventilation helmet, Total face mask, Nasal-buccal mask, and the mode: CPAP, BiPAP.

- **Vascular access:**

- **Nasogastric tube.**
- **Urinary catheter.**
- **Medications administered upon admission:**

We specifically researched the use of these medications :



❖ **Drug administered:**

According to the protocol proposed by the Ministry of Health (Annex).

- Outcome:

We will also specify the total duration of stay in the intensive care unit (in hours).

- Early complications :

For our study, we have identified the following situations revealing complications. They would be considered early if they occurred within the first 36 hours. *[18]*

- Change from Class II envenomation to Class III (Cardiovascular distress, Respiratory distress, Neurological distress complicating the initial condition).
- Use of additional drugs: Noradrenaline, Adrenaline, Milrinone.
- Use of invasive mechanical ventilation (specify duration in hours).
- Use of sedation: Midazolam, Fentanyl, Neuromuscular blockers.
- Use of cardioversion.
- Use of specialized medication: Amiodarone, Local anesthetics, Magnesium sulfate, Corticosteroids.

- Secondary complications [19] :

A nosocomial infection, or healthcare-associated infection, is an infection contracted during a stay in a healthcare facility. It can be directly related to medical care or occur during hospitalization, unrelated to any medical procedure.

As part of our study, we specifically sought information on the date and nature of the sample, site of infection, isolated pathogen, sensitivities, and resistances.

Beyond the 36-hour time limit, we considered the occurrence of multiorgan failure as a secondary complication.

- ► Hemodynamic failure
- ► Respiratory failure
- ► Renal failure
- ► Hepatic failure
- ► Hematological failure
- ► Encephalopathy

Shock [8] :

Diagnosing shock in the intensive care unit (ICU) involves a combination of clinical evaluation, vital sign monitoring, and laboratory tests.

For our study, the presence of shock was recorded if systolic blood pressure decreased (hypotension) < 5th percentile for age or systolic BP < 2 SD below normal for age associated with circulatory failure and organ dysfunction.

- Mortality and comorbidities after the occurrence of a complication:

We studied mortality and comorbidities after the occurrence of a complication, notably focusing on the consequence: survival or death.

We determined the type of complication that occurred, specifically looking at tracheostomy and neurological sequelae.

In the case of neurological sequelae, we assessed the severity of disability, including moderate disability, severe disability, and vegetative state

Poor Outcome :

A poor outcome describes a negative result or consequence following the envenomation.

In our study, we considered as a poor outcome a significant worsening of the patient's condition resulting in disability, and/or even death.

4. Data analysis

Data analysis was performed using Jamovi software (Version 2.3.28), 2022.

The results are expressed in raw numbers and as percentages for qualitative variables, and in average for quantitative variables, and then compared to the data from the literature.

The various parameters were calculated and subjected to univariate and multivariate analysis, with a comparison between the group of survivors without sequelae and the group of patients who had an unfavorable outcome.

The characteristics were analyzed by the chi-square. A p-value <0.05 was considered statistically significant. Odds ratio was estimated by a multiple logistic stepwise regression procedure, with respective 95% confidence intervals.

Odds Ratio (OR) :

- Odds Ratio (OR) = 1: This indicates no association between the two events or variables. The odds of the event occurring are equal in both groups.
- Odds Ratio (OR) > 1: This indicates a positive association or increased odds of the event occurring in the first group compared to the second group.
- Odds Ratio (OR) < 1: This indicates a negative association or decreased odds of the event occurring in the first group compared to the second group.

95% confidence interval (CI) :

If the 95% CI includes 1: This suggests that the odds ratio is not statistically significant, and there may be no true association between the variables. The association is considered not statistically significant.

If the 95% CI does not include 1: This suggests that the odds ratio is statistically significant, and there is evidence of an association between the variables. The association is considered statistically significant.

5. Study limitations

The retrospective nature of our study poses some challenges such as data loss, incomplete or inconsistent information. We note that in most of the cases the scorpion species was not identified and/or recorded.

Our result might be prone to selection bias and may not represent the entire population accurately.

In spite of the large number of parameters that we investigated, other risk factors may be present and were not measured.

6. Ethical considerations

The ethical rules regarding the respect of anonymity, confidentiality and the protection of patient data were followed during the completion of this work.

7. Conflict of interest

We have no conflicts of interest to disclose.


Results

I. Epidemiological profil :

1. Frequency :

Between January 2010 and December 2022, 1595 cases of scorpion envenomation were hospitalized at the Pediatric intensive care unit at the Mother and Child Hospital of the Mohammed 6 University Hospital in Marrakech.

On average, 123 patients per year were admitted for severe envenomation.

2. Demography:

2.1. Age :

The average age was 6.11 years with standard deviation of +/- 4.00, with extremes ranging from 1 month and 3 weeks to 16 years. We lacked data for 4 individuals.

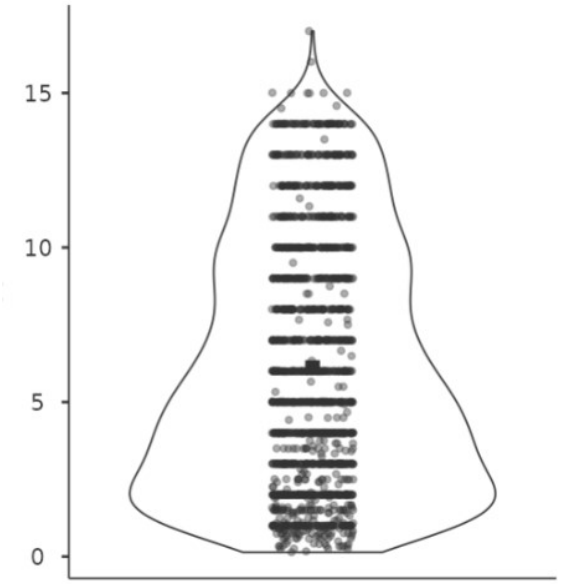


Figure 3 : Distribution of envenomations by age

2.2. Sex Ratio :

A predominance of male was noted, at 56.8% (n=905), with a sex ratio (M/F) of 1.31.

	Cases
Male	905
Female	690
Total	**1595**

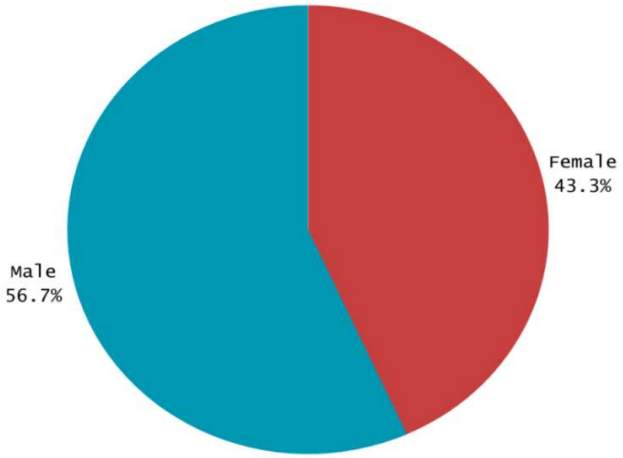


Figure 4 : Distribution of envenomations by gender

2.3. Weight :

The average weight of our population was 20,7kg, with values ranging from 1kg to 70kg. We lacked data for 90 individuals.

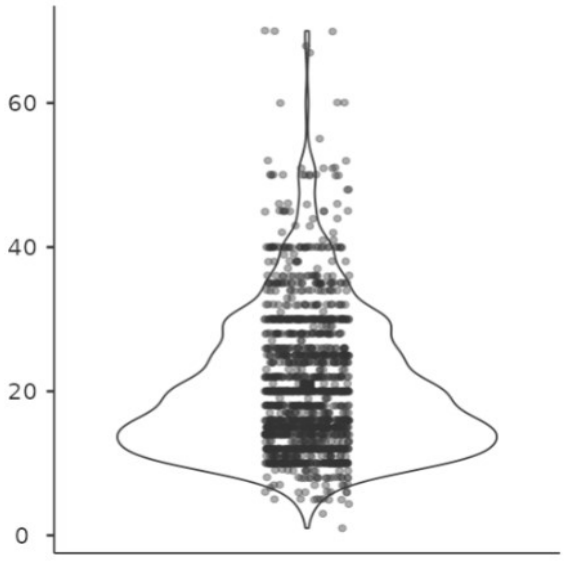


Figure 5 : Distribution of envenomations by weight

2.4. Geographical origin :

The provinces of the Marrakech-Safi region include Marrakech, Chichaoua, Al Haouz, El Kelâa Sraghna, Essaouira, Rehamna, Safi and Youssoufia.

Within the region, the El Haouz province dominates with the highest number of envenomation cases (459), followed by the province of Chichaoua (308) and then Marrakech (296).

Beside the Marrakech-Asfi region, the envenomation were frequently reported in Drâa Tafilalet Region (15), Casablanca-Settat region (6), Beni Mellal-Khénifra region (4) and the Souss-Massa Region (2).

Reported reason for transfer: lack of nearby hospital infrastructure, lack of space, saturation of available beds… We lacked data for 42 individuals.

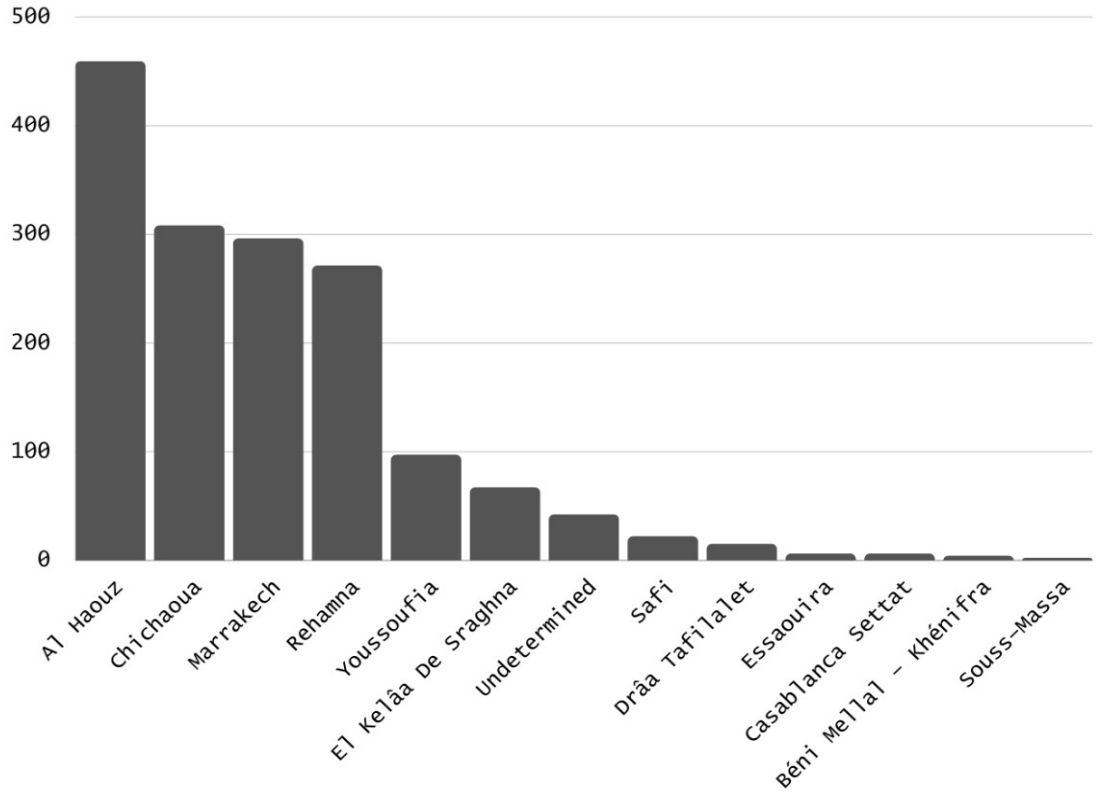


Figure 6 : Distribution of envenomations by geographic origin

Table VIII : Distribution of envenomations by geographic origin

Province	Cases	Percentage (in %)
Al Haouz	459	28,77
Chichaoua	308	19,31
Marrakech	296	18,55
Rehamna	271	16,99
Youssoufia	97	6,08
El Kelâa De Sraghna	67	4,20
Undetermined	42	2,63
Safi	22	1,37
Ouarzazate	8	0,50
Drâa Tafilalet	7	0,43
Essaouira	6	0,37
Casablanca - Settat	6	0,37
Béni Mellal-Khénifra	4	0,25
Agadir	2	0,12
Total	**1595**	**100**

2.5. Living environment :

In this study, 71.6 percent of all cases came from rural settings. We did not have data for 269 individuals.

Living environment	Cases
Rural	1142
Urban	184
Undefined	269
Total	**1595**

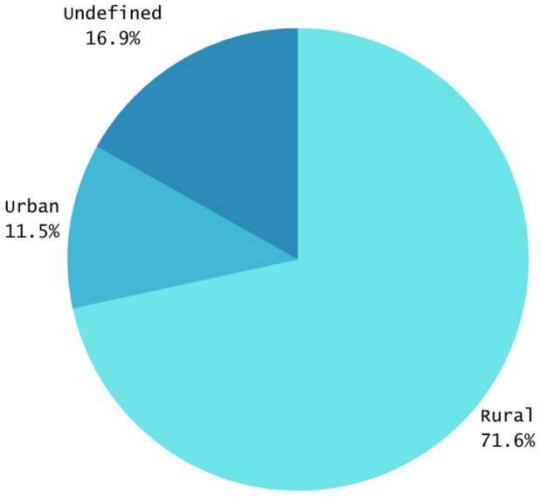


Figure 7 : Distribution of envenomations by living environment

2.6. Regulation :

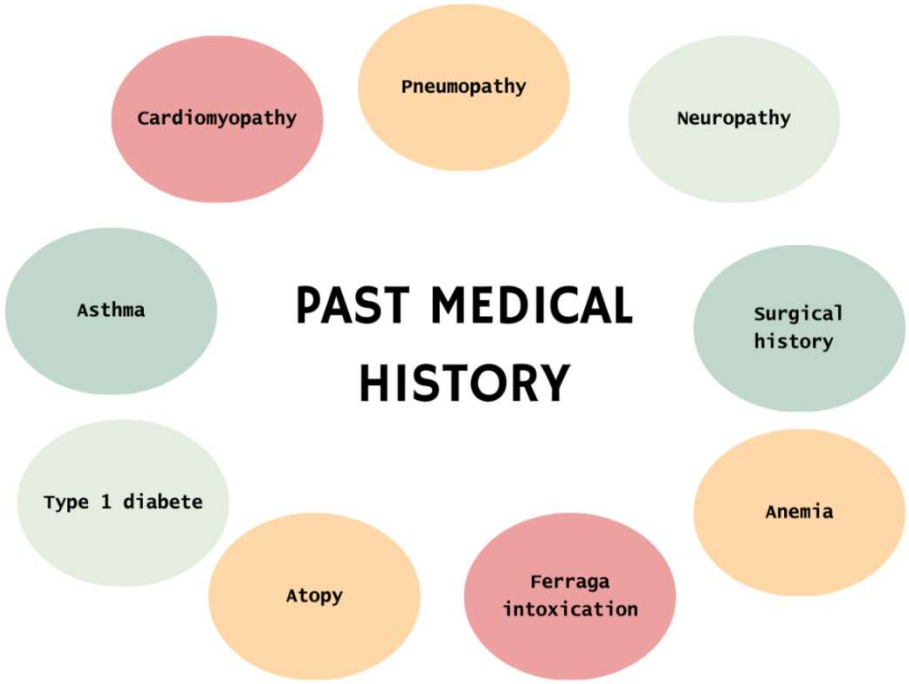
Of all patients coming, a majority of patients were transferred without regulation (40.0%). Only 23.0% were referred and properly regulated from a regional training. Data for 812 individuals was missing.

Table IX : Distribution of Patient Cases by Admission Type

	Cases	% Total	% cumulative
Directly admitted to the emergency department	290	37.0%	37.0%
Transfer without regulation	313	40.0%	77.0%
Transfer with regulation	180	23.0%	100.0%

II. Past Medical History :

We specifically searched for the concept of heart disease, asthma, atopic background, lung disease, neuropathy, and previous envenomations.



Out of 1595 study participants, only 27 (1.69 %) had prior health conditions. In our series, we have noted the following antecedents:

Table X : Past medical history of our population.

Anterior scorpion envenomation	4
Asthma	3
Neuropathy	3
Cardiomyopathy	2
Pneumopathy	2
Atopy	1
Diabetes (type 1)	1
Anemia	1
Malignant Fever	1
Ferraga Intoxication	1
Surgical history	8

Surgical history : Tonsillectomy (3), umbilical hernia (1), inguinal hernia (1), fracture (1), anorectal malformation (1), undescended testicle (1)

Neuropathy : Cerebral palsy (2), psychomotor delay (1).

III. Characterization of the envenomation :

1. Number of sting(s) :

The majority of envenomations occurred after a single sting (97.3%).

In 140 cases, the number of sting(s) was not recorded.

Number of sting	Cases
1	1416
2	30
3	6
4 and more	4
Total	**1456**

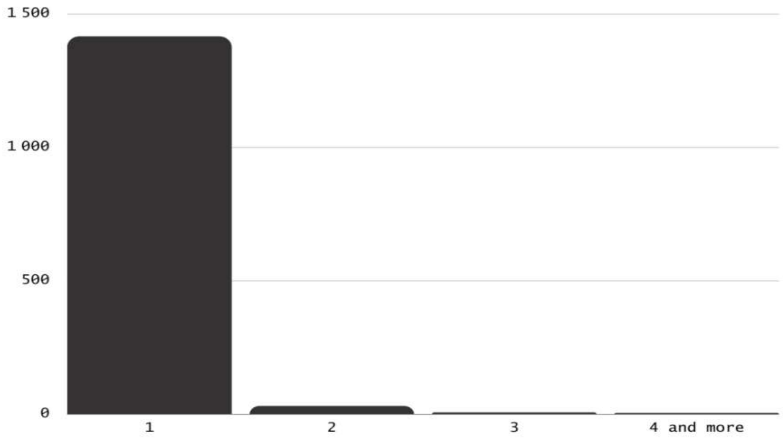


Figure 8 : Reported number of sting(s)

2. Site of the sting :

The localisation of sting was clarified in 1523 patients. We lacked data for 72 individuals.

Stings occurred more frequently in lower and upper extremities, and the least frequencies belong to the surface of the trunk and the gluteal region. Miss refers to the absence of puncture lesion at physical examination.

Site of the sting :	Cases
Lower extremities	850
Upper extremities	450
Head and Neck	100
Trunk	76
Undetermined	63
Miss	43
Gluteal region	13
Total	**1552**

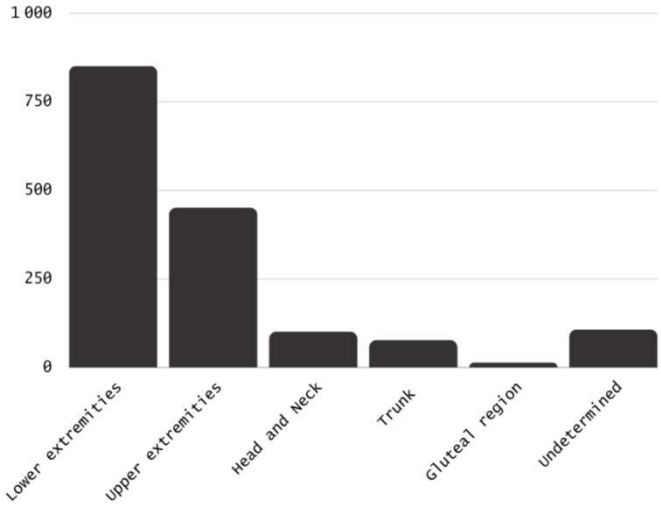


Figure 9 : Reported site of sting(s)

3. Laterality :

In this study, we note a slight predominance of stings on the right side.

The laterality of the sting was not recorded in 325 of the cases (20.5%).

Side	Number
Right	684
Left	586
Undetermined	325

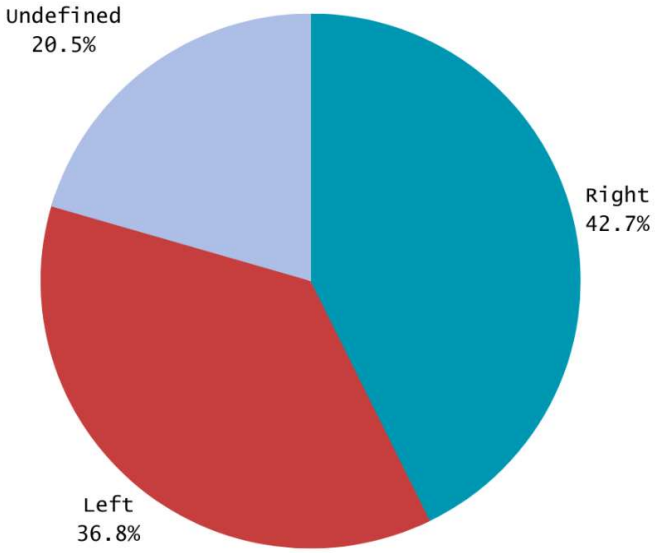


Figure 10 : Distribution of laterality in the sting

4. Date of the sting :

Our study revealed that the year 2017 had the highest number of case reported patients with 155 cases.

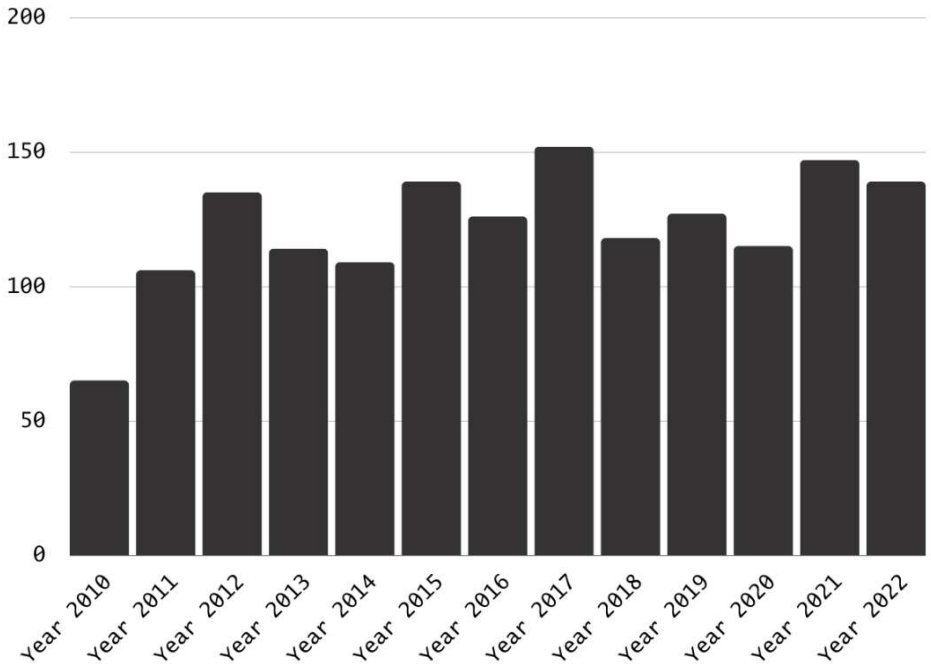


Figure 11 : Distribution of envenomations by year

Table XI : Distribution of envenomations by year

Year	Cases	Percentage (in %)
Year 2010	65	4,07
Year 2011	106	6,64
Year 2012	135	8,46
Year 2013	114	7,14
Year 2014	109	6,83
Year 2015	139	8,71
Year 2016	126	7,89
Year 2017	155	9,71
Year 2018	118	7,39
Year 2019	127	7,96
Year 2020	115	7,21
Year 2021	147	9,21
Year 2022	139	8,71
Total	**1595**	**100**

5. Month / Season :

January is the least represented month (1 case), while August is the most represented month with 27.28% of the recorded cases (433).

Envenomation occurred mostly during the summer months. Indeed 66.34% of our patients were admitted between June and August.

There were 8 missing data points.

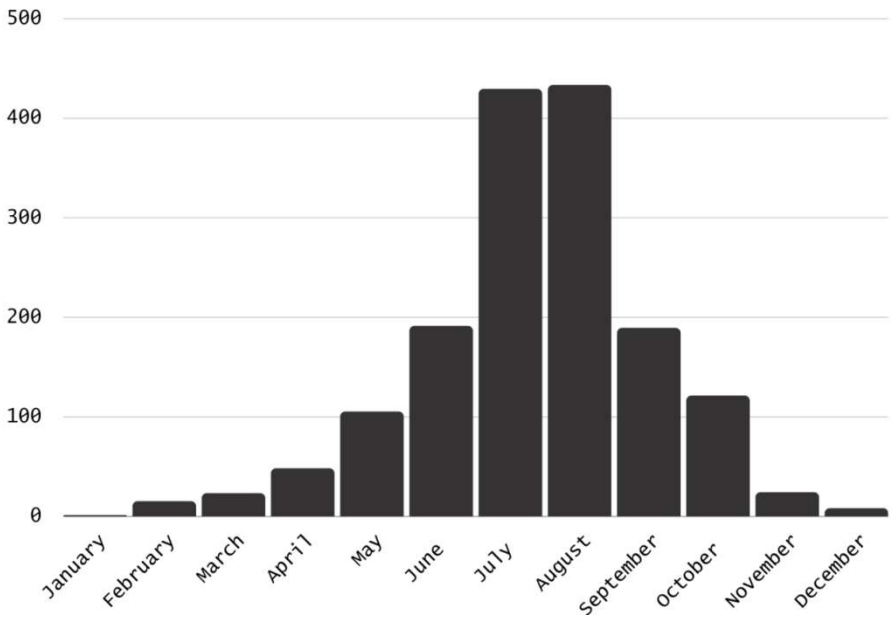


Figure 12 : Distribution of envenomation by month

Table XII : Distribution of envenomation by month

Months	Cases	Percentage (in %)
January	1	0,06
February	15	0,94
March	23	1,44
April	48	3,02
May	105	6,61
June	191	12,03
July	429	27,03
August	433	27,28
September	189	11,90
October	121	7,62
November	24	1,51
December	8	0,50
Total	**1587**	100

6. Time of the sting :

Among the 1553 collected data, 1106 were nocturnal (71.2%) and occurred between 6 PM and 6 AM.

There were 42 missing data points.

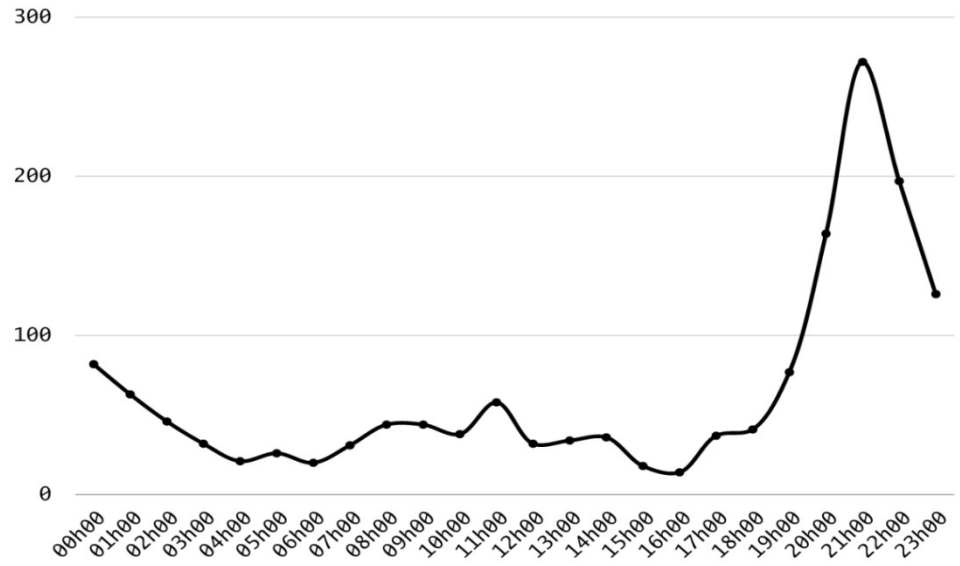


Figure 13 : Distribution of envenomation by time

7. Post-sting time (in minutes) :

The mean time between sting and admission was 277 minutes, equal to four hours and thirty-seven minutes, ranging from 10 minutes to 61 hours.

Only 36 patients sought medical attention within less than 1 hour (2.3)%, 775 within less than 4 hours (49.1)%, while 805 sought medical attention after more than 4 hours (50,9%).

The time between the sting and evaluation was greater than 8 hours for 166 patients, in 10.5 % of cases.

We count 16 missing data.

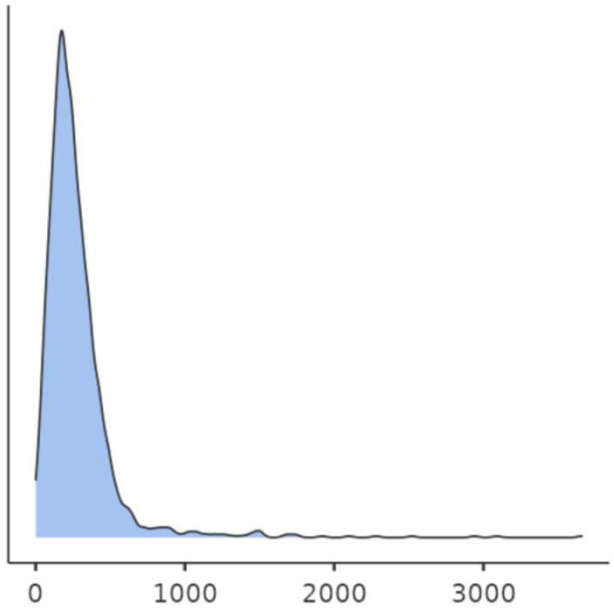


Figure 14 : Distribution of Cases by Post-Sting Time

	Total
N	1580
Missings	15
Mean	277
Median	240
Mode	180
Standard deviation	260
Variance	67637
Interquartile range	180
Range	3650
Minimum (in minutes)	10
Maximum (in minutes)	3660

8. Scorpion identification :

The species of the scorpion has been identified in only 5.6% of the cases.

In most of the cases, we were unable to discover the scorpion species.

Yes	88
No	1479
Total :	**1567**

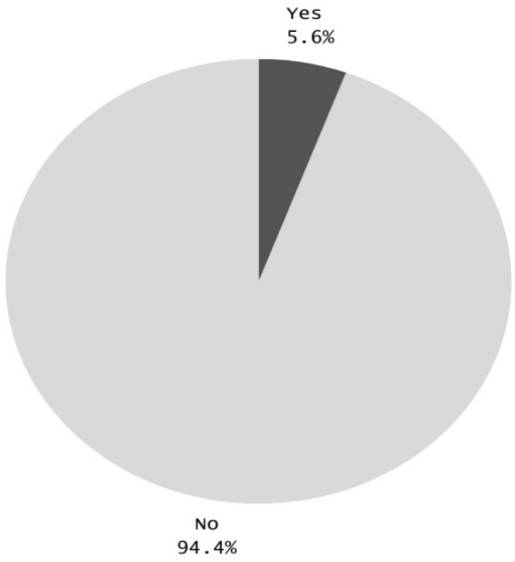
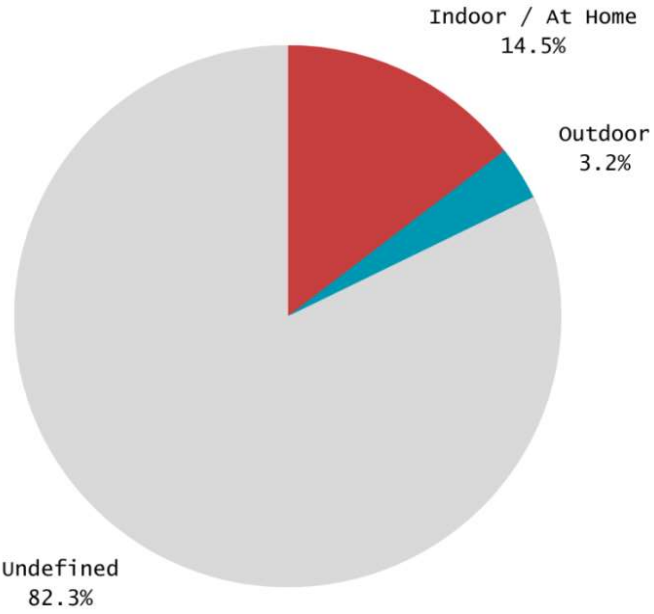


Figure 15 : Distribution of Identified and Unidentified Scorpions

9. Location where the sting occurred :

Most of the time, the sting occurs in an enclosed space, especially at home (232 cases), which is 81.9% of the collected data

In 1312, the location where the sting occurred was not defined.



Indoor / At home	232
Outdoor	51
Undefined	1312

Figure 16 : Distribution of the envenomation according to location

IV. Management before admission to intensive care :

1. Treatment before the first consultation :

Before the first consultation with a medical facility, 34 patients received initial care, which represents 2.18% of the cases.

The use of a tourniquet remains the most significant, accounting for half of the initial treatment reported (17).

The use of traditional methods (burns, henna..) was reported in 6 cases (17.64%).

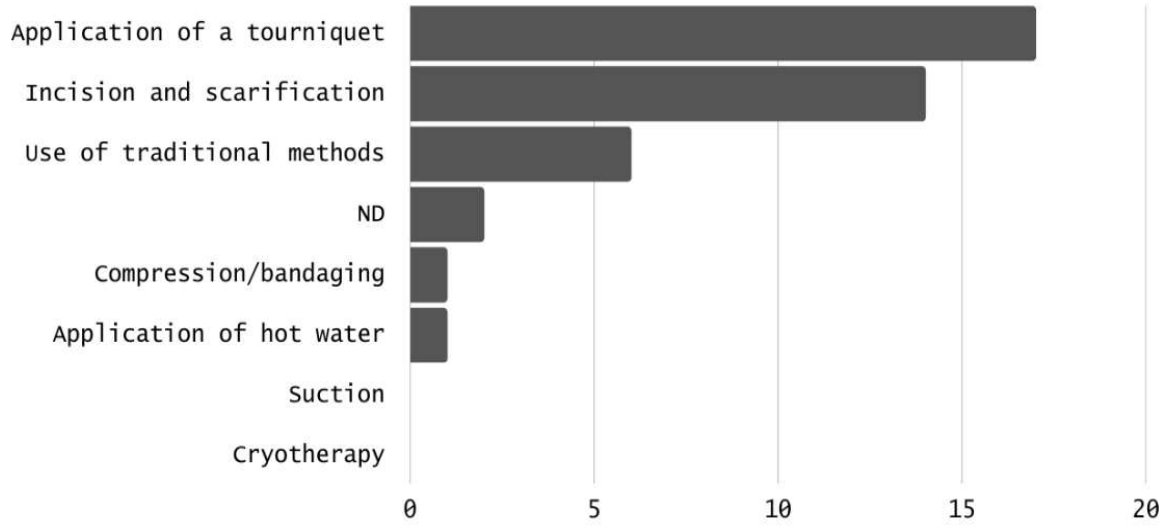


Figure 17 : Distribution of Treatment Methods

2. Institution where the first medical consultation took place :

The majority of patients (58.92%) consulted a level 2 primary healthcare facility in the first place.

Table XIII : Distribution of institution where the first medical consultation took place

	Cases	Percentage (in %)
Primary healthcare facility level 1 (Health center, dispensary, etc.)	318	20.6
Primary healthcare facility level 2 (District hospital, regional hospital, etc.)	911	58.9
Secondary healthcare facility (emergency room, university hospital)	288	18.6
Undetermined	29	1.9
Total	**1546**	**100**

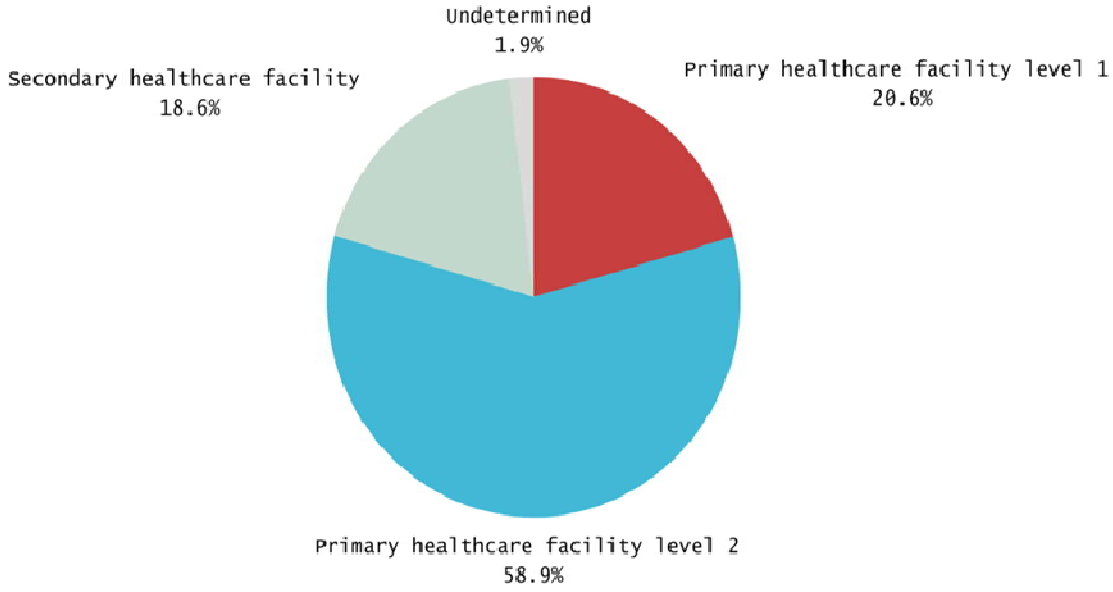


Figure 18 : Distribution of institution where the first medical consultation took place

3. Oxygen therapy :

Only 45 patients received oxygen therapy during the first consultation in a medicalized environment. Nasal Canulas are widely used (62.2%).

Table XIV : Distribution of Oxygen Therapy Methods in the Study Population

Type	Cases	Percentage (in %)
Nasal Canula	28	62,2
Mechanical ventilation	13	28,9
High concentration mask	4	8,9
Total	**45**	**100**

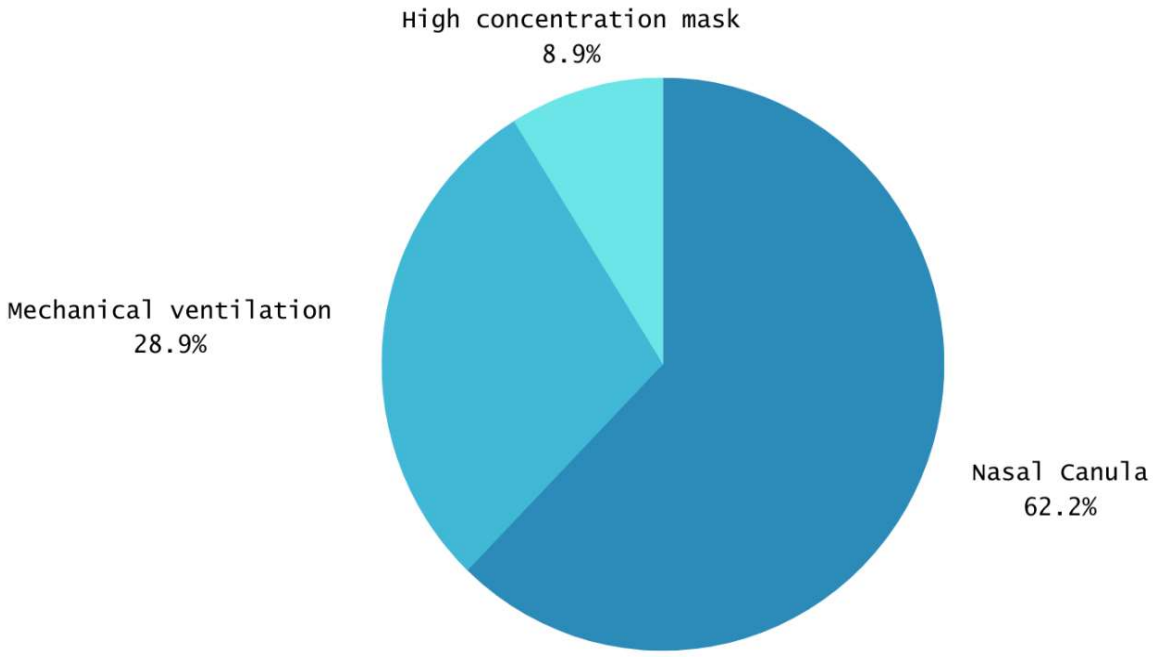


Figure 19: Distribution of Oxygen Therapy Methods in the Study Population

4. Vascular access :

The majority of patients (892 cases) were equipped with one peripheral intravenous catheter during their first consultation that represents 55.9% of all patients.

Among them, only 35 patients (3.92%) had two PVCs peripheral intravenous catheter placement.

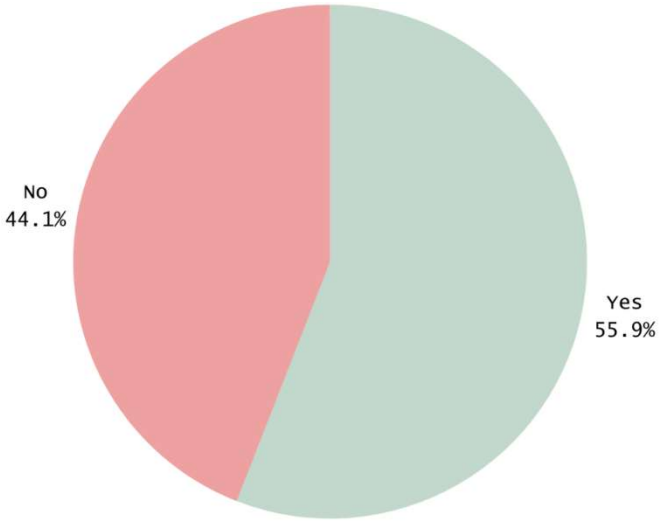


Figure 20 : Comparison of the number of patients with and without venous access

5. Medications :

The number of patients who received medication during their first consultation is 764.

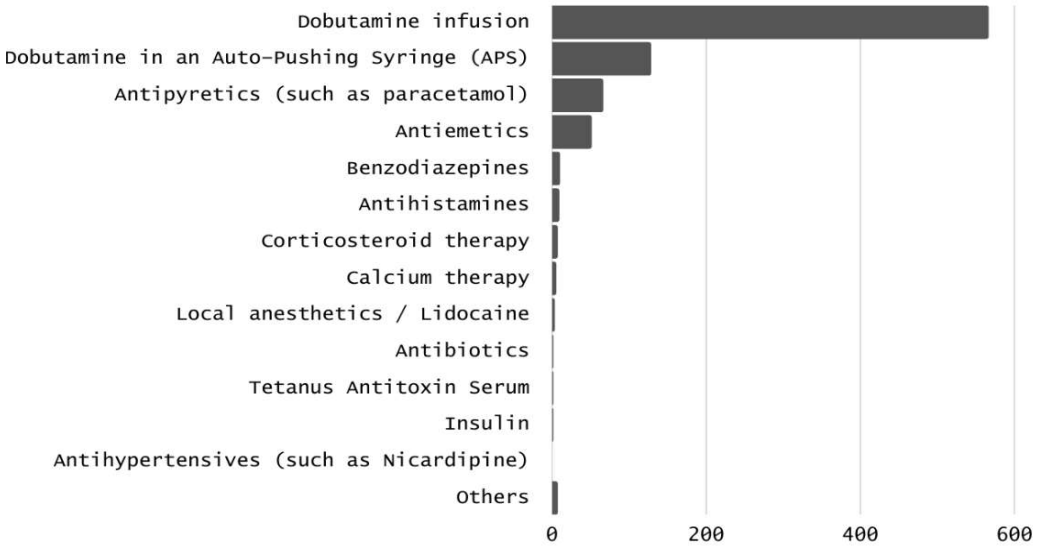


Figure 21 : Distribution of the medications administered at the first consultation

Table XV : Treatment received by the stung children.

Medication	Cases
Dobutamine infusion	566
Dobutamine in an Auto-Pushing Syringe (APS)	128
Antipyretics (such as paracetamol)	66
Antiemetics	51
Benzodiazepines	10
Antiulcer drugs	9
Corticosteroid therapy	7
Calcium therapy	5
Local anesthetics / Lidocaine	3
Antibiotics	1
Tetanus Antitoxin Serum	1
Insulin	1
Antihypertensives (such as Nicardipine)	0
Others	7

Others : Diuretic (6), antispasmodic (7), noradrenaline (2), atropine (1)

V. Admission to the pediatric intensive care unit:

1. Evaluation of pre-admission care :

As soon as patients are admitted to the pediatric intensive care, they are evaluated to assess the quality of pre-hospital care.

Yes	811
No	372
Total	**1183**

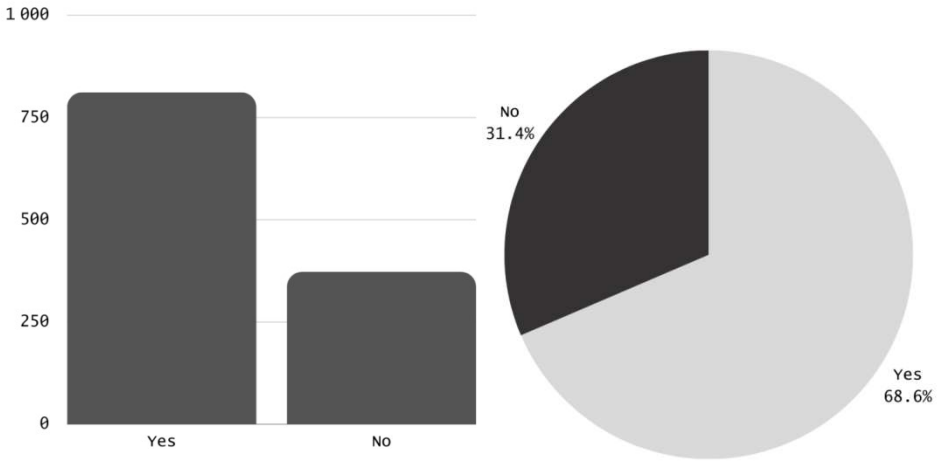


Figure 22 : Placement of a peripheral venous line

Yes	684
No	539
Total	**1223**

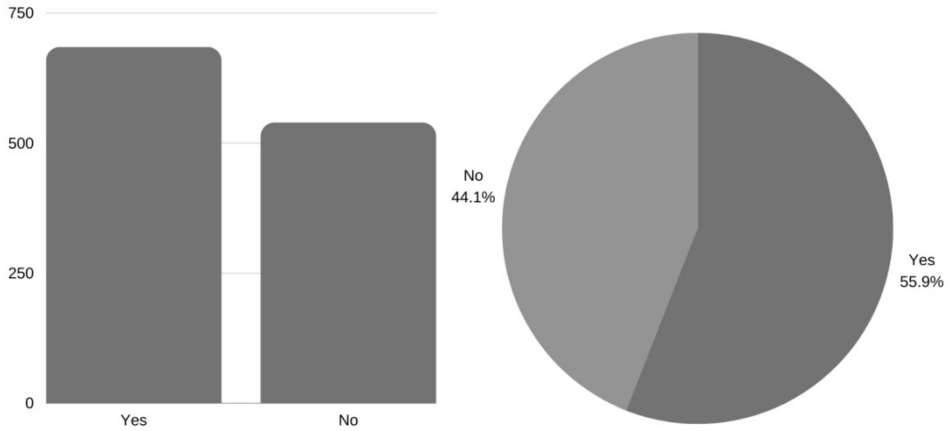


Figure 23 : Dobutamine Administration (given as an infusion or by SAP)

2. Envenomation Grade :

In our series, the majority of scorpion stings are classified as grade III with 914 cases, representing 57.4%.

Grade I	11
Grade II	670
Grade III	914
Total	**1595**

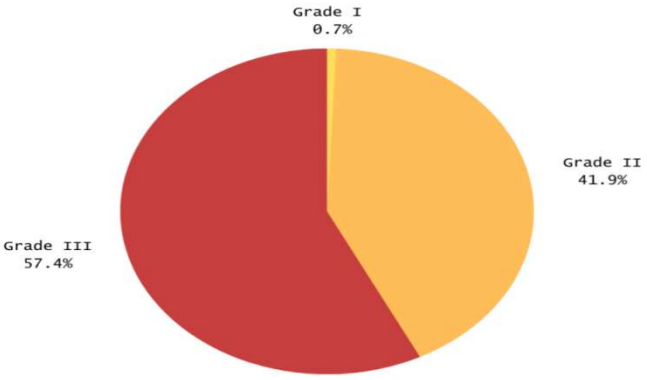


Figure 24 : Distribution of envenomations by grade

3. Reported local signs :

Apart from the sting puncture found in 75.2% of the cases, the main symptom is represented by pain/swarm with a percentage of 32.8%. We observe local redness in 25.5% of cases, local swelling in 24.8% of cases.

Traces of self-harm scars were found in 1 patient (0.7%).

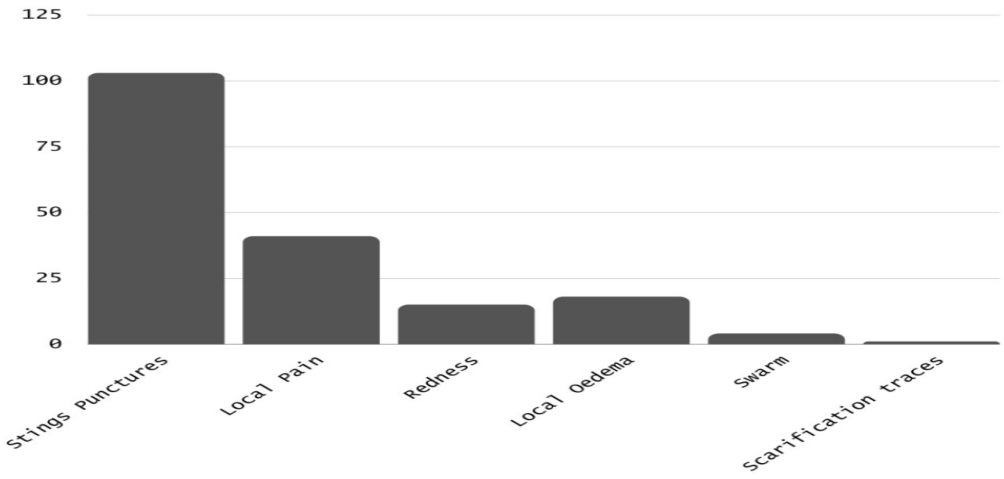


Figure 25 : Distribution of local/regional signs

4. Reported general signs :

The main general signs are represented in this table.

Table XVI : Distribution of Symptoms in the Study Population

Symptoms	Cases	Percentage (in %)
Vomiting	1348	84.51
Excessive sweating	1334	83.63
Priapism	546	34.23
Tachycardia	500	31.34
Abdominal pain	494	30.97
Agitation	412	25.83
Hypertension	234	14.67
Fever	225	14.10
Chills	143	8.96
Abdominal bloating	68	4.26
Hypothermia	54	3.38
Excessive salivation	32	2.01
Diarrhea	31	1.94
Nausea	5	0.31
Others	6	0.37

Others : Headaches (2), shortness of breath (1), thirst (1), drowsiness (1), mixed type dehydration (1)

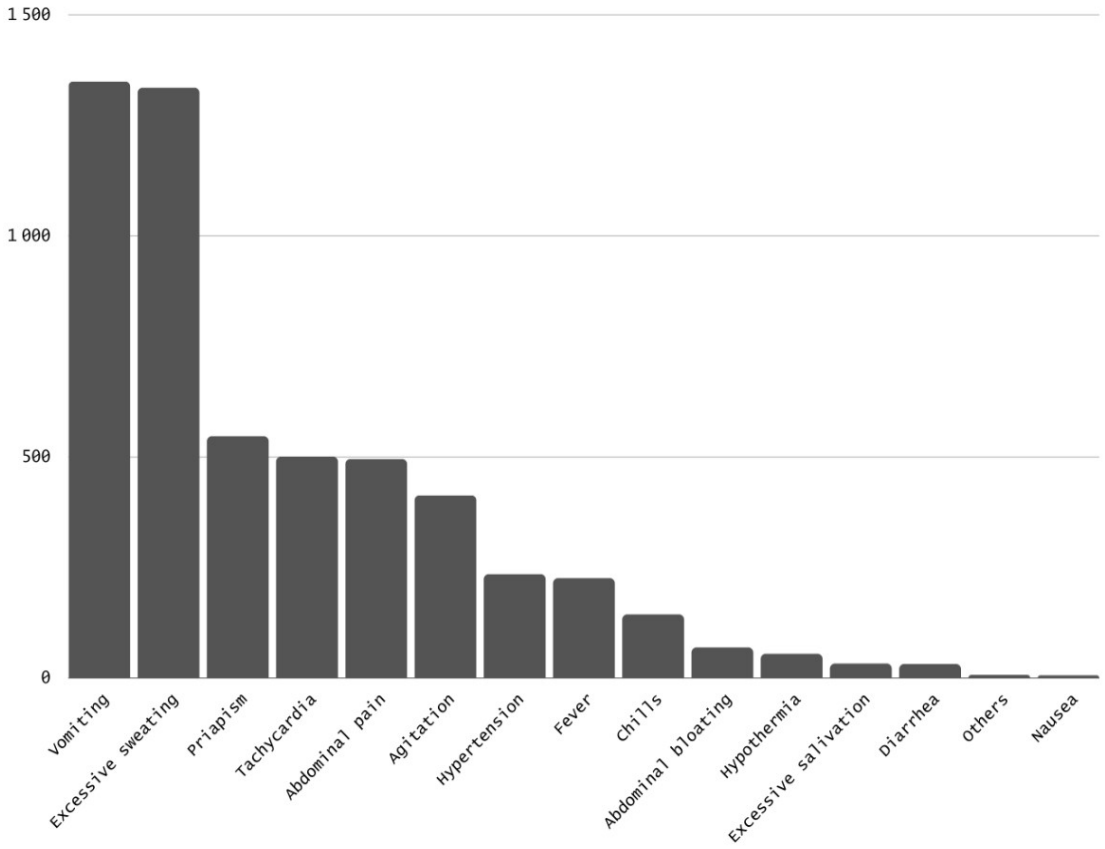


Figure 26 : Distribution of Symptoms in the Study Population

5. Cardiovascular Distress :

Patients were considered to be in circulatory distress if they exhibited the following clinical signs: Gallop sound, mottling, coolness of extremities, capillary refill time (CRT) > 3 seconds, hypotension, thready pulse. [7]

Among all patients, 906 patients experienced cardiovascular distress at the initial assessment (59.8%).

Table XVII : Distribution of Cardiovascular Symptoms in the Study Population

Cardiovascular Sign	Cases
Coolness of extremities	1019
Capillary refill time (CRT) > 3 seconds	172
Mottling	53
Thready pulse	38
Hypotension	28
Gallop sound	3

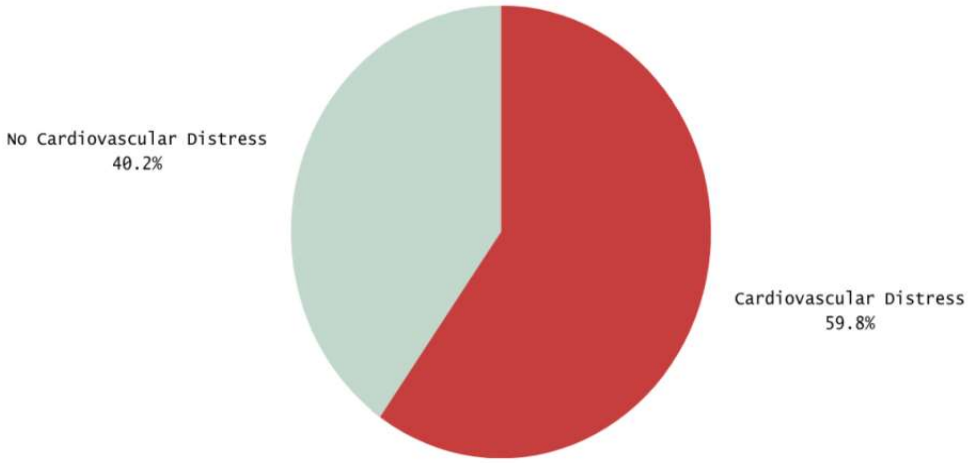


Figure 27 : Distribution of Cardiovascular Symptoms in the Study Population

6. Neurologic Distress :

Patients were considered to be in neurological distress if they exhibited the following clinical signs: Seizures, irritability, stupor, temporo-spatial disorientation, confusion, nystagmus, strabismus, altered level of consciousness, coma. [7]

Among all patients, 141 patients experienced neurologic distress at the initial assessment (8.8%).

Table XVIII : Distribution of Neurologic Symptoms in the Study Population

Neurological Sign	Cases
Altered level of consciousness	129
Stupor	61
Seizures	17
Coma	16
Strabismus	15
Irritability	7
Confusion	9
Temporo-spatial disorientation	2
Nystagmus	1

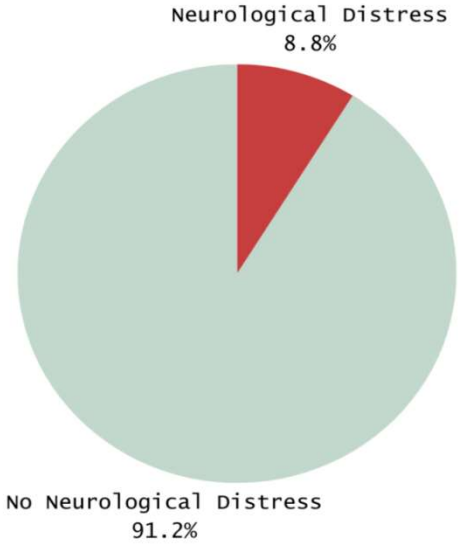


Figure 28 : Distribution of Neurologic Symptoms in the Study Population

7. Respiratory Distress :

Patients were considered to be in respiratory distress if they exhibited the following clinical signs: Crackling breath sounds, tachypnea, bradypnea, cyanosis, tracheobronchial congestion, involvement of accessory muscles, respiratory arrest. [7]

Among all patients, 146 patients experienced respiratory distress at the initial assessment (9.1%).

Table XIX : Distribution of Respiratory Symptoms in the Study Population

Respiratory Sign	Cases
Tachypnea	148
Crackling breath sounds	114
Cyanosis	60
Involvement of accessory muscles	51
Bradypnea	3
Tracheobronchial congestion	3
Respiratory arrest	1

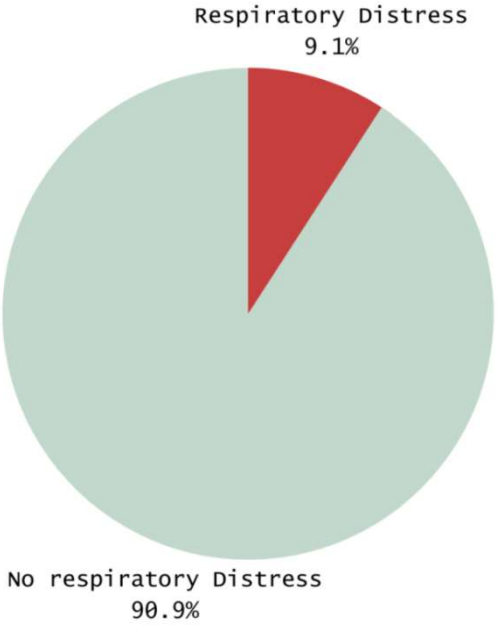


Figure 29 : Distribution of Respiratory Symptoms in the Study Population

8. Vitals:

8.1. Heart rate in bpm :

The patients are distributed as follows: 53.47% of patients having a normal heart rate, 37.11% being tachycardic, and only 1.56% being bradycardic.

N	1461
Missing	236
Mean	115
Median	110
Mode	110
Standard deviation	51.0
Range	1408
Minimum	11.0
Maximum	1419

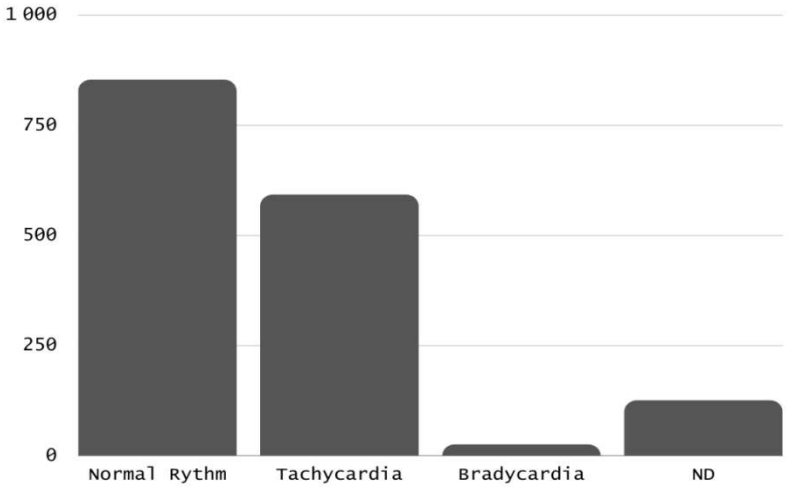


Figure 30 : Distribution of the population according to the cardiac rhythm

Table XX : State of cardiac rhythm in the population

Cardiac Rhythm	Cases	Percentage (in %)
Tachycardia	592	37.11
Normal Rhythm	853	53.47
Bradycardia	25	1.56
ND	125	7.83
Total	**1595**	**100**

8.2. Respiratory Rate :

The patients are distributed as follows: 598 of our patients were eupneic (representing 37.49%), 336 were tachypneic (21.06%) and 69 were bradypneic (4.32%).

Table XXI : State of the respiratory rate in the population

Respiratory rate	Cases	Percentage (in %)
Normal range	598	37.49
Tachypnea	336	21.06
Bradypnea	69	4.32
ND	592	37.11
Total	**1595**	**100**

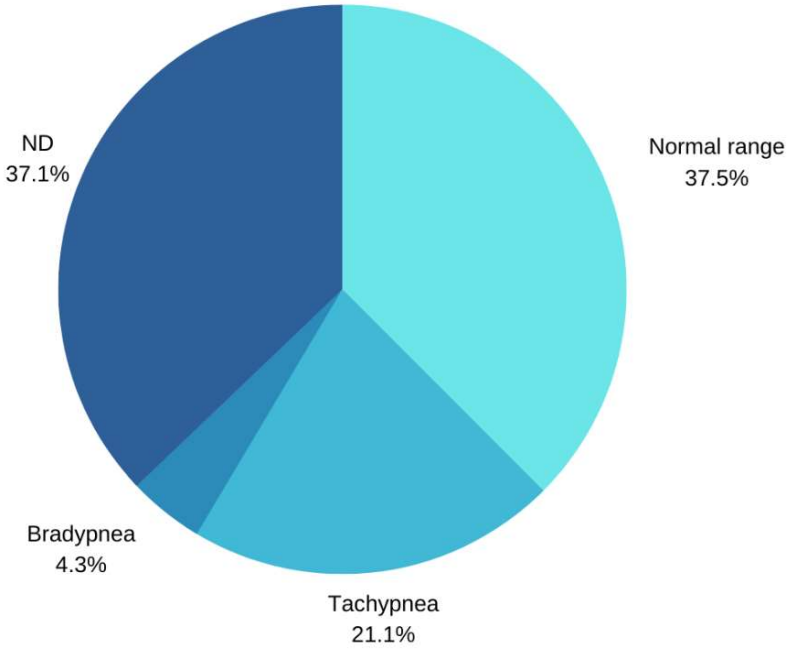


Figure 31 : State of the respiratory rate in the population

8.3. Systolic Blood Pressure :

The patients are distributed as follows: 26.14% of patients had a stable hemodynamic state upon admission, 10.28% had experienced hypotension, and 43.26% had hypertension.

Table XXII : State of the blood pressure in the population

Blood pressure	Cases	Percentage (in %)
Normal rate	417	26.14
Hypotension	164	10.28
Hypertension	690	43.26
ND	324	20.31
Total	1595	100

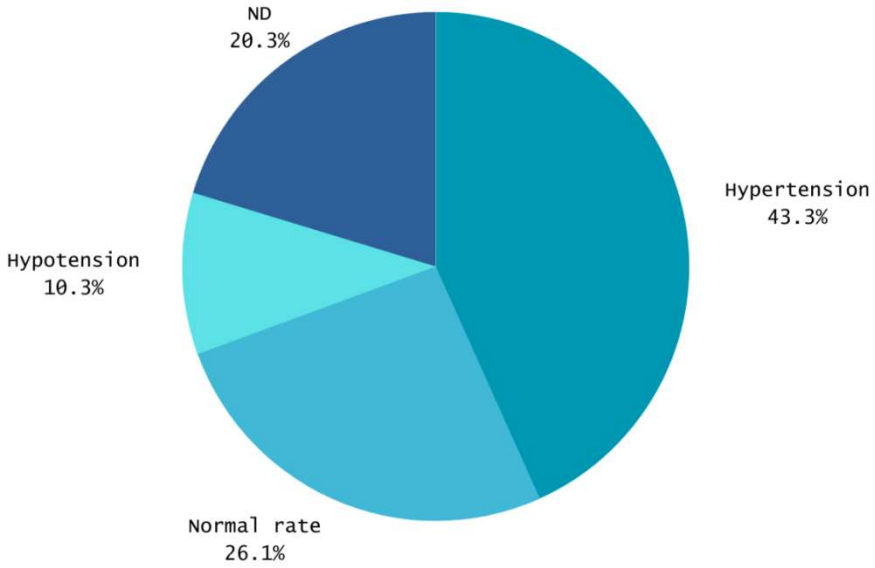


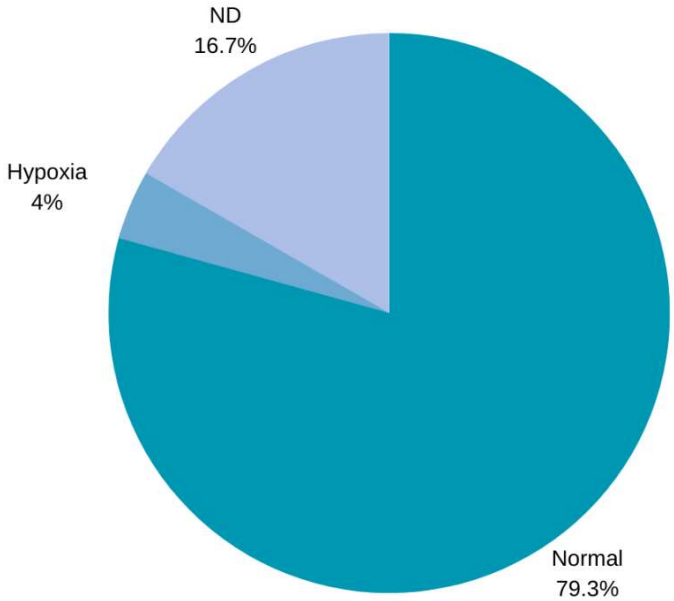
Figure 32 : State of the blood pressure in the population

8.4. Peripheral capillary oxygen saturation (Sp02) :

At admission, the average SpO2 under a high-concentration mask was 98%, with a range from 76% to 100%. Only 64 patients (4.01%) had hypoxia.

Table XXIII : Distribution of patients according to SpO2 at admission

	Cases	Percentage (in %)
Normal	1265	79.31
Hypoxia	64	4.01
ND	266	16.67
Total	**1595**	**100**



N	1318
Missing	379
Mean	98.0
Median	100
Mode	100
Standard deviation	6.99
Range	98.8

Figure 33 : Distribution of patients according to SpO2 at admission.

8.5. Temperature :

Body temperature was measured for 1197 patients, it was on average 37.0 Celsius ranging from 32.8 to 42.2 Celsius.

Table XXIV : Distribution of patients according to temperature at admission

Temperature	Cases	Percentage (in %)
Normal	940	58.93
Hyperthermia	29	1.81
Hypothermia	228	14.29
ND	398	24.95
Total	**1595**	**100**

N	1190
Missing	507
Mean	37.0
Median	37.0
Mode	37.0
Standard deviation	2.02
Variance	4.10
Ecart interquartile	0.500
Range	67.2
Minimum	32.8
Maximum	42.2

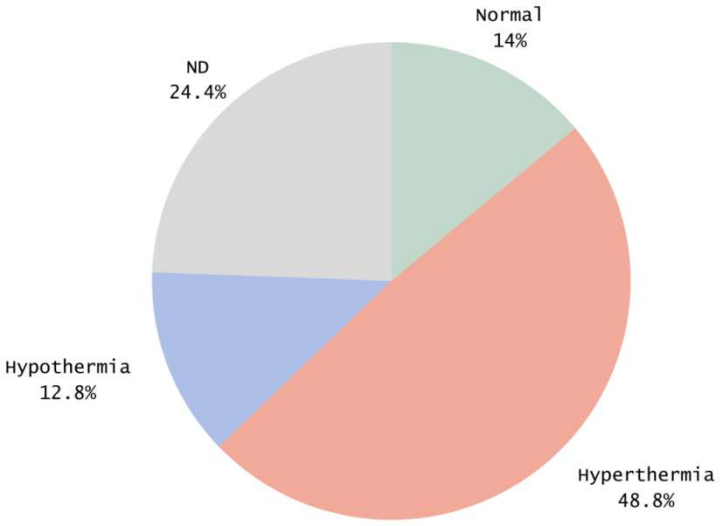


Figure 34 : Distribution of patients according to temperature at admission

8.6. Glycemia :

The mean blood sugar on admission was 1.47g/L, the median was 1.22g/L and the standard deviation at 0.780.

The blood glucose level was higher than 2.0g/l in 191 patients, ranging from 0.32 to 11.1g/L.

Table XXV : Distribution of Glycemia in our population

	Cases	Percentage (%)
Normal Glycemia	943	59.12
Hyperglycemia	253	15.86
Hypoglycemia	8	0.50
ND	391	24.51
Total	**1595**	**100**

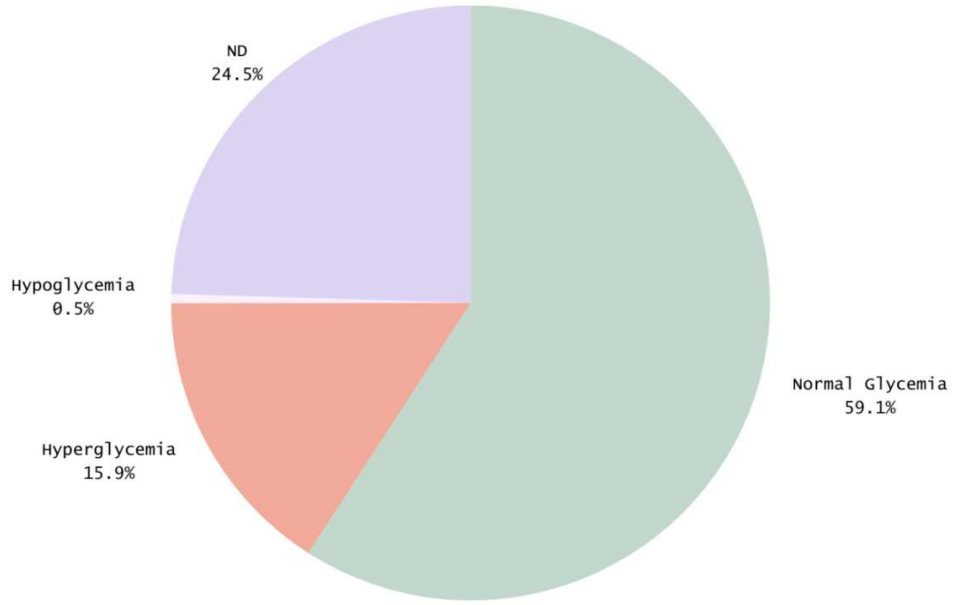


Figure 35 : Distribution of Glycemia in our population

8.7. Glasgow coma score (GCS):

Consciousness abnormality (Glasgow coma score <15) was observed in 180 patients (12.02% of all patients). 26 of these patients (1.63%) had a coma (Glasgow coma score ⩽8).

Mean for all the population: GCS = 14.82

Table XXVI : Distribution of Glasgow Coma Score in our population

Glasgow coma score	Cases	Percentage (in %)
Consciousness	1137	71.28
Agitation	118	7.39
Confusion	36	2.25
Coma State	26	1.63
ND	278	17.42
Total	**1595**	**100**

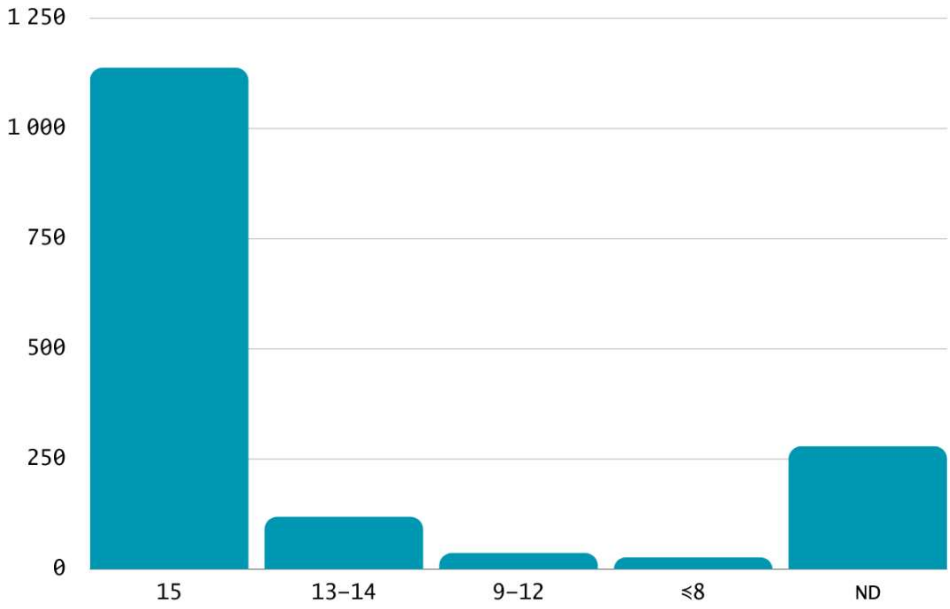


Figure 36 : Distribution of Glasgow Coma Score in our population

VI. Biological assessment upon admission :

1. Blood gas analysis :

734 arterial blood gases (ABGs) have been performed.

The mean pH on admission was at 7.34, median pH at 7.36, ranging from 6.67 to 7.69 with a standard deviation of 0.143.

Table XXVII : Distribution of patients according to their metabolic state.

Normal or compensated	**145**
Respiratory acidosis	79
Metabolic acidosis	121
Mixed acidosis	174
Acidosis non determined*	36
Total (acidosis)	**410**
Respiratory alkalosis	43
Metabolic alkalosis	4
Mixed alkalosis	111
Alkalosis non determined*	21
Total (Alkalosis)	**179**
Total	**734**

**due to a lack of data from other pHmetric parameters*

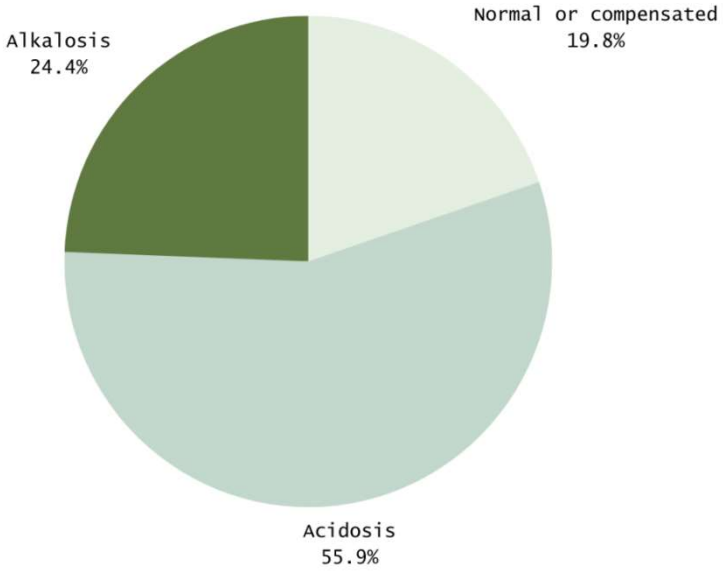


Figure 37 : Distribution of patients according to their metabolic state.

2. Metabolic Acidosis :

Severe acidosis	Moderate acidosis	Mild acidosis
pH ≤ 7,10	pH ≤ 7,20	pH ≤ 7,30
HCO3- < 5 mmol/L	HCO3- < 10 mmol/L	HCO3- < 15 mmol/L

The table presents the distribution of cases according to the severity of metabolic acidosis.

Out of the total of 121 cases analyzed, 54 cases were classified as mild acidosis.

Additionally, there were 9 cases categorized as moderate acidosis.

Furthermore, the analysis identified 6 cases classified as severe acidosis.

Table XXVIII : Distribution of Metabolic Acidosis Severity in the Study Population

Metabolic Acidosis	Cases	Percentage (in %)
Mild acidosis	54	44,62
Moderate acidosis	9	7,43
Severe acidosis	6	4,95
Total	**121**	**100**

3. Complete blood count (CBC)

Table XXIX : Statistical description of the main values of the complete blood count (CBC

	White blood cells (in 10^3/uL) :	Hemoglobin (in g/L) :	Hematocrit (in %) :	Platelets (in 10^3/uL) :
N	1261	1259	1240	1244
Missings	334	336	355	351
Mean	17.8	12.8	37.4	377
Median	16.3	12.9	37.6	367
Standard deviation	8.08	1.86	4.91	163
Minimum	14.1	6.9	21.7	65.0
Maximum	98.1	21.5	67.6	854.0

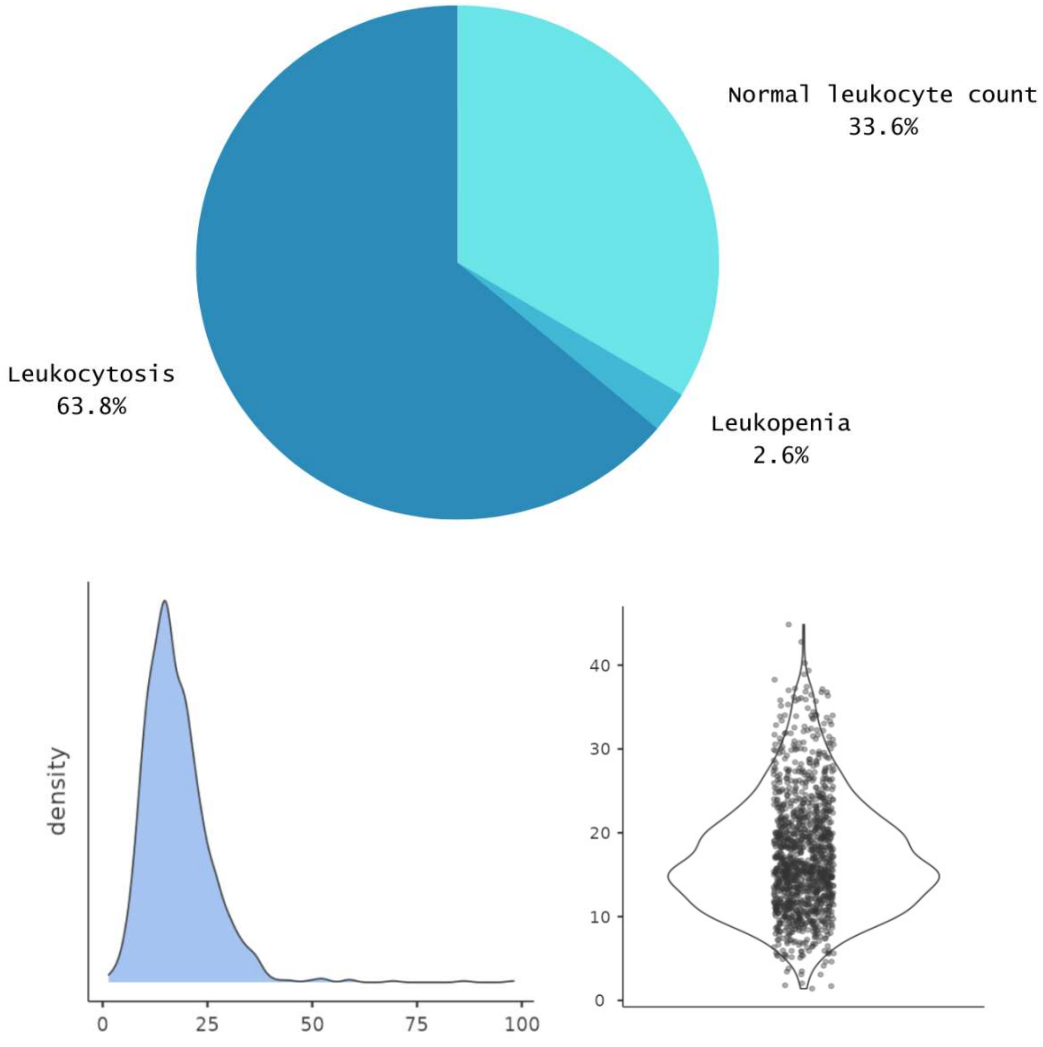
3.1. White blood cells (in 10^3/uL) :

We collected 1261 complete blood counts. The mean leukocyte count was 17.3x10^3/uL, with a range from 1,4x10^3/uL to 98,1x10^3/uL and standard deviation of 8.08.

A normal leukocyte count was found in 424 patients, representing 33.6% of the cases.

Leukopenia was present in 32 patients, accounting for 2.6% of the cases.

Leukocytosis was present in 805 cases, representing 63.8% of the cases.



Figure(s) 38 : Distribution of leukocyte levels in our population.

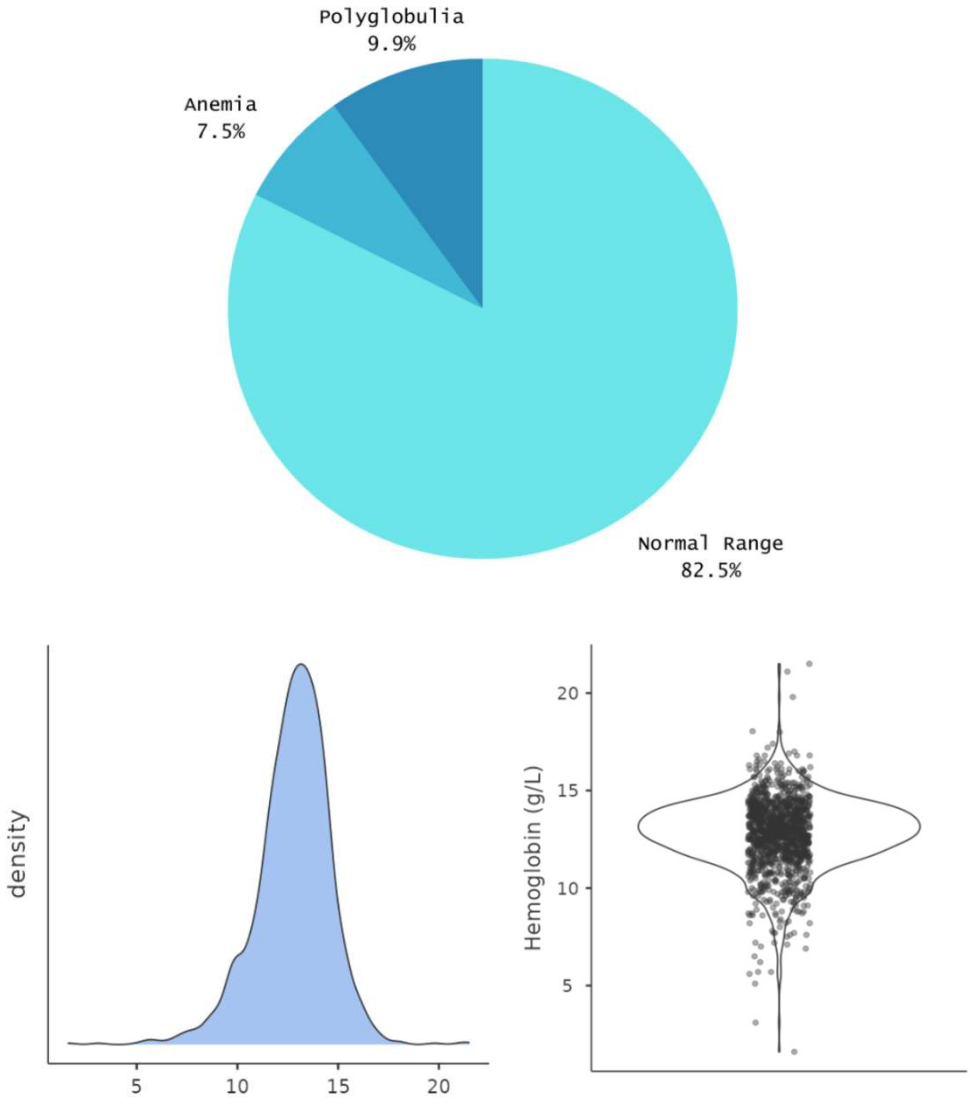
3.2. Hemoglobin (in g/L) :

The hemoglobin level was available for 1259 patients. The median hemoglobin value was 12.8g/L, and standard deviation of 1.86g/L.

The minimum hemoglobin value was 6.9 g/L , while the maximum value was 21.5 g/L.

Anemia had been reported for 95 patients, accounting for a percentage of 7.5%.

Polyglobulia was observed in 125 patients, representing a percentage of 9.9%



Figure(s) 39 : Distribution of hemoglobin levels in our population.

3.3. Hematocrit (in %) :

Hematocrit levels were obtained for 1240 patients.

High Hematocrit (Polycythemia) was present in 199 cases, representing 16% of the cases.

Low Hematocrit was observed in 258 patients, representing a percentage of 20.8%.

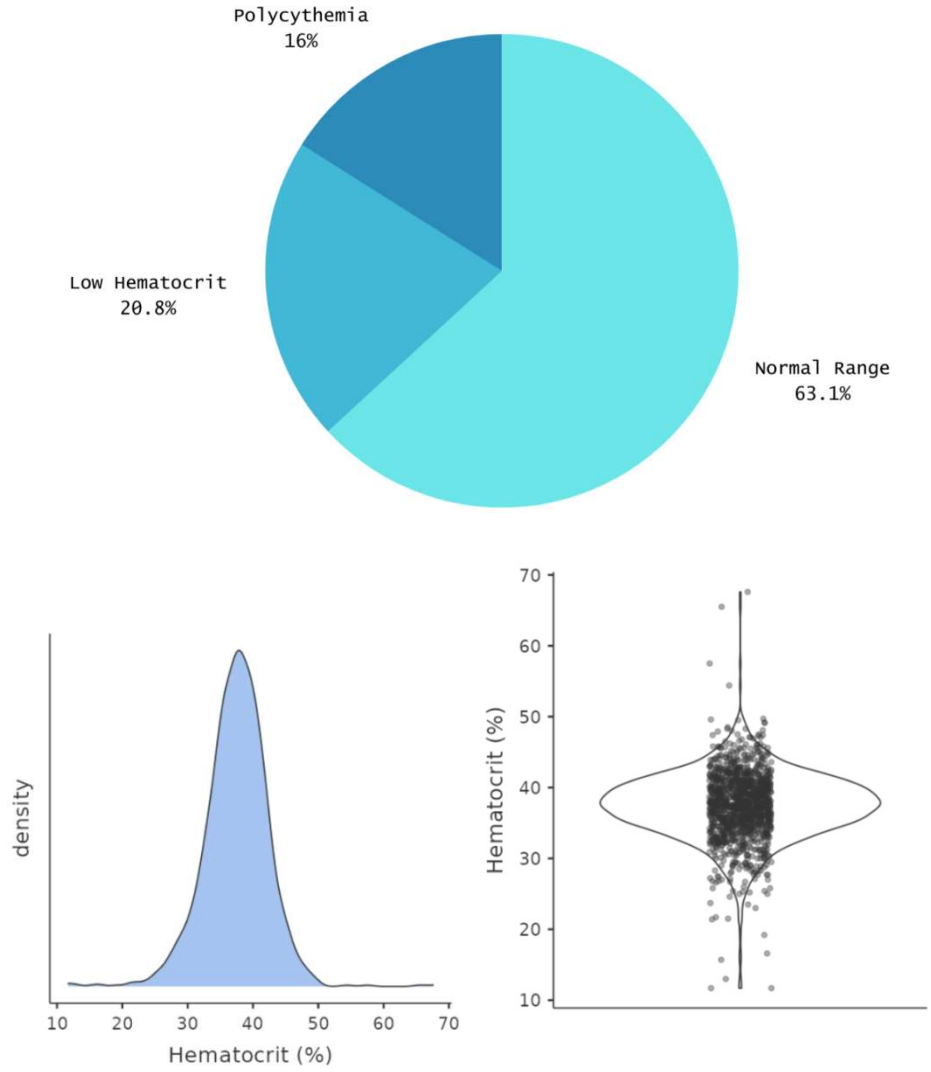


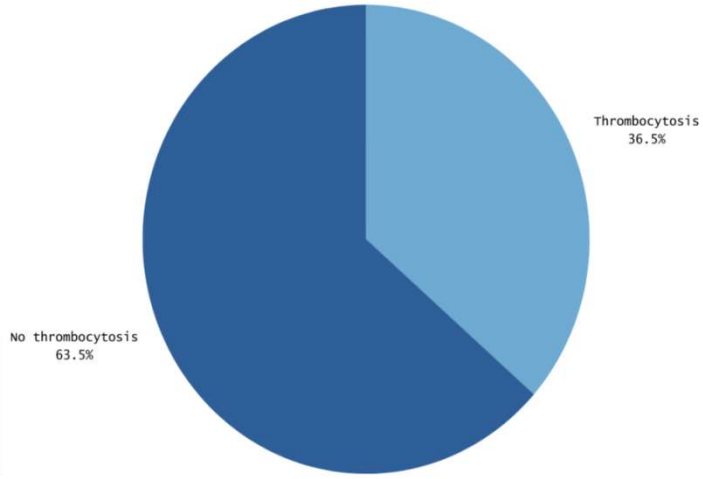
Figure 40: Distribution of hematocrit levels in our population.

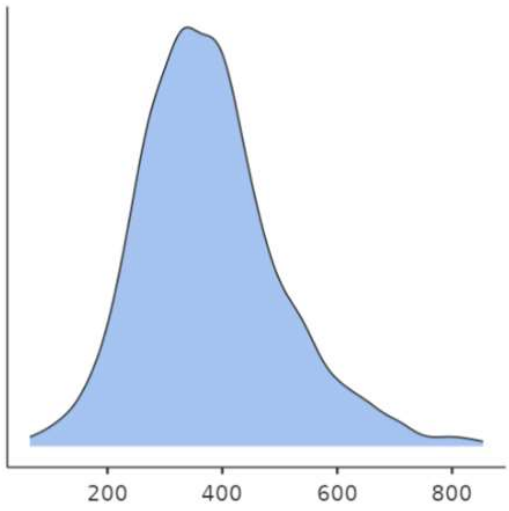
3.4. Platelets (in 10^3/uL) :

Platelets measurements were collected for a total of 1243 patients. The average platelet count was 384x10^3/uL, and standard deviation at 163x10^3/uL.

Thrombocytosis was present in 454 patients (36.5%).

Thrombocytosis	454
No thrombocytosis	790
Total	**1244**





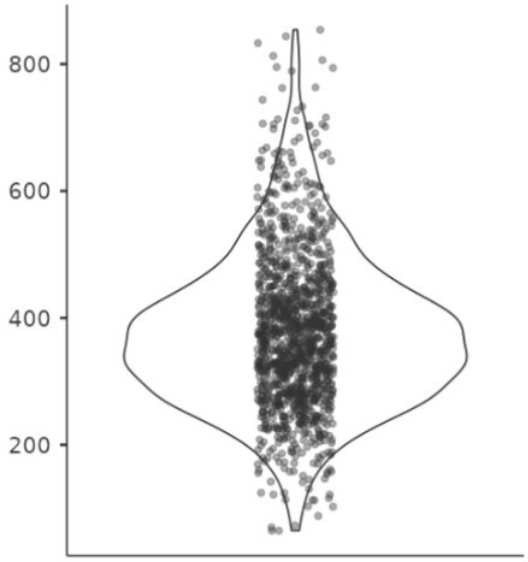


Figure 41: Distribution of platelet levels in our population.

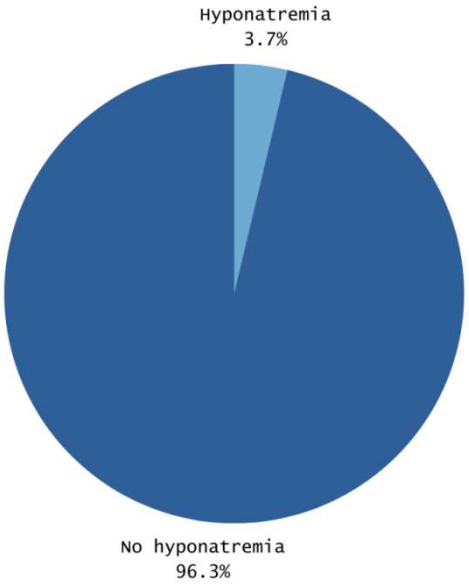
Table XXX: Statistical description of the main values of blood ionogram

	Sodium level Na+	Potassium level K+	Chloride level Cl-	Ionized Calcium level Ca2+
N	1132	1118	919	824
Missings	565	579	778	873
Mean	142	4.10	105	101
Median	142	4.00	105	100
Mode	141	4.00	103	100
Standard deviation	8.75	3.16	5.66	16.8
Variance	76.5	9.96	32.1	283
Interquartile range	6.00	0.898	6.00	9.00
Range	152	104	91.0	199
Minimum	125	1.70	60.0	0.980
Maximum	166	10.6	151	2.00

4. Blood ionogram :

The analysis of the blood ionogram, performed in 1128 cases, revealed hyponatremia in 42 patients, representing 3.7% of cases, and hypokalemia in 180 patients, representing 16.1% of cases.

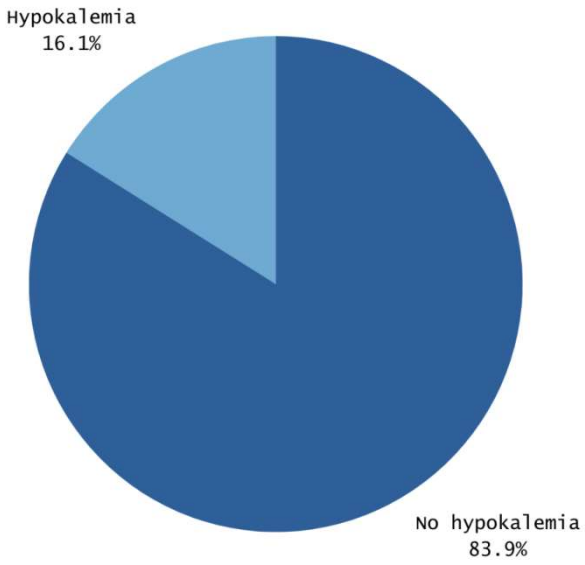
4.1. Sodium level Na+ :



Hyponatremia	42
No hyponatremia	1086
Total	**1128**

Figure 42 : Distribution of patients based on the presence or absence of hyponatremia.

4.2. Potassium level K+ :



Hypokalemia	180
No hypokalemia	937
Total	**1117**

Figure 43 : Distribution of patients based on the presence or absence of hypokalemia.

4.3. Chloride level Cl- :

We collected 925 chloride levels (missing 670 data points).

In the study, the results showed that 51 patients (5.5%) had hypochloremia, 323 patients (34.9%) had hyperchloremia, and 551 patients (59.6%) had normochloremia.

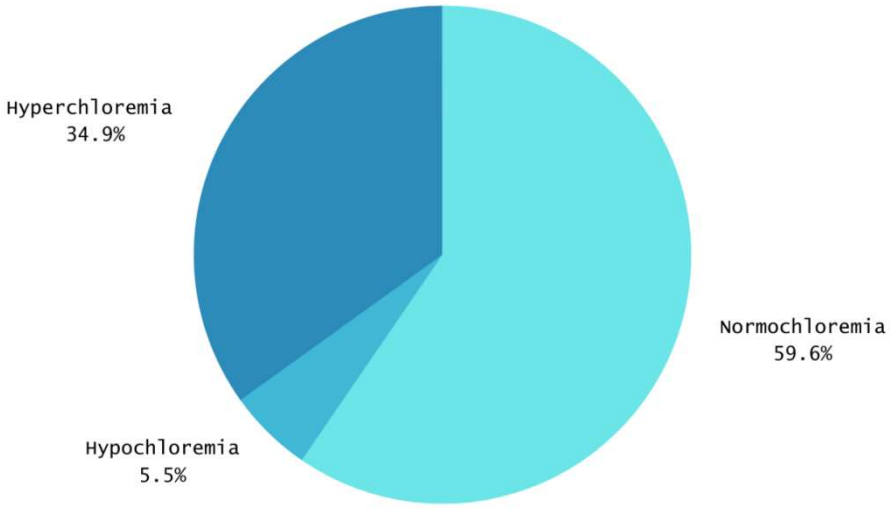
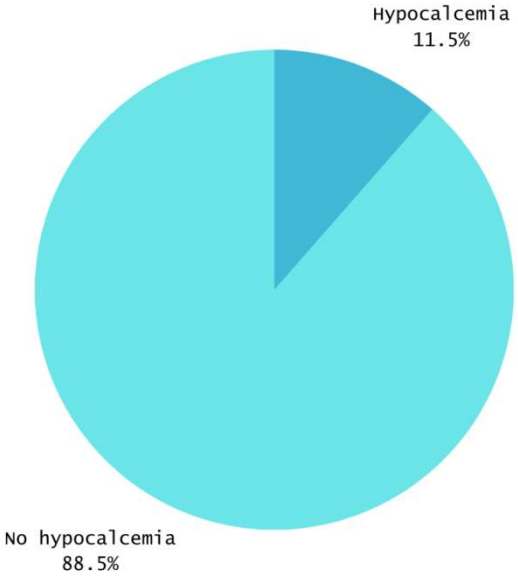


Figure 44 : Distribution of patients according to the state of chloremia.

4.4. Ionized calcium level Ca2+:

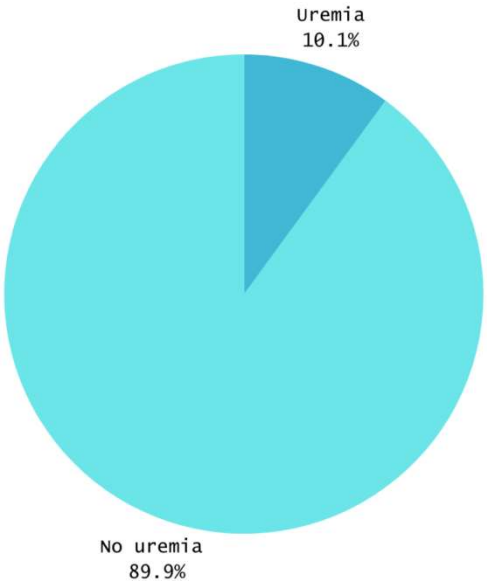


Hypocalcemia	95
No hypocalcemia	734
Total	**829**

Figure 45 : Distribution of patients based on the presence or absence of hypocalcemia.

4.5. Urea:

Uremia was found in 104 patients, which represents a percentage of 10.1%.



Uremia	104
No Uremia	930
Total	**1034**

Figure 46 : Comparison of the number of patients with and without uremia

5. Troponin :

The high-sensitivity troponin test was requested in 674 cases (42.2% of all cases). It was found to be within normal range in 108 cases (51.1%).

The average value found was 112.30, we observed a minimum of 0.003 and a maximum of 1856 units.

Thus, the abnormal troponin values were, on average, 35.9 units higher than the laboratory's limit. The results are expressed as multiples of the laboratory's normal range.

Table XXXI : Distribution of patients according to troponin levels

	Cases :	Percentage in (%) :
Normal troponin	108	16,02
Elevated troponin	567	84,12
Total	**674**	**100**

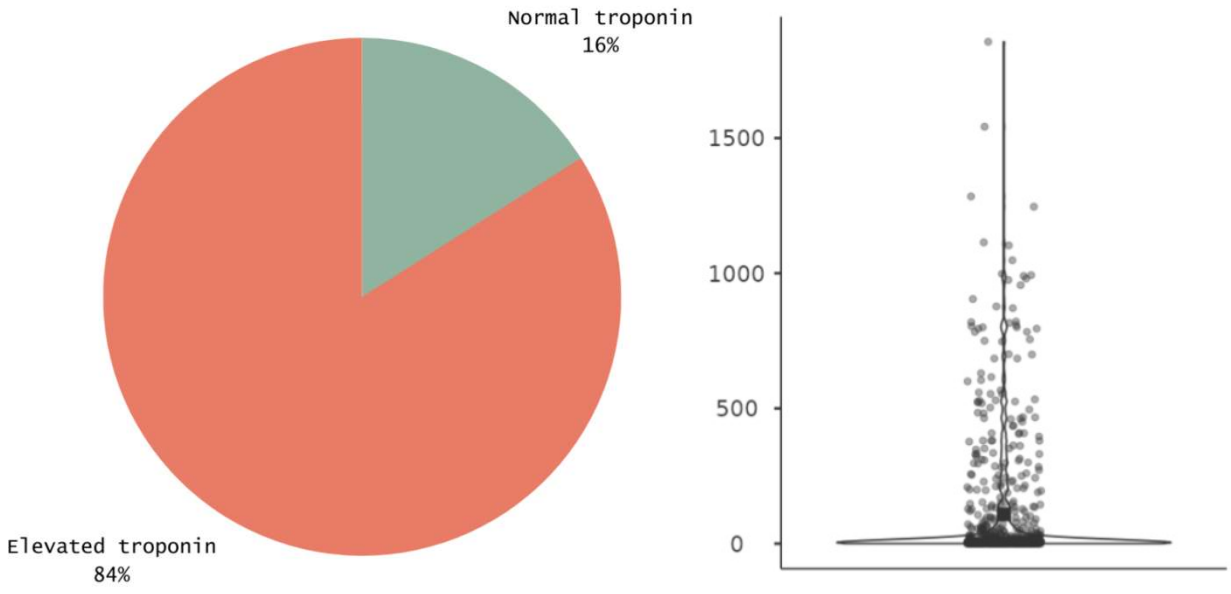


Figure 47 : Distribution of patients according to troponin levels

6. Biomarker levels :

Tables XXXII a/b/c: Biomarker Levels in the Study Population

Table a :	Cases	Mean	Minimum	Maximum	Number of lowers values	Lowers values (in %)	Number of high values	Higher values (in %)
Creatinine	1111	0,432	0,109	5,090	617	55,5	34	3,0
Total protein level	157	76,83	63,00	91,00	0	0	5	3,1
Albumin	260	8,28	1.31	58,80	3	1,1	18	6,9

Table b :	Cases	Mean	Minimum	Maximum
ratio AST/ ALT	727	1,97	0,31	34,0
AST	727	59,9	8	543
ALT	727	28,5	1	867

Table c :	Cases	Mean	Minimum	Maximum	Number of high values	High values (in %)
Creatine Phosphokinase (CPK)	129	324	26	4244	71	55.03
BNP (Brain Natriuretic Peptide)	3	34.20	1,62	86,00	0	0
Lipase level	146	60,18	2,0	1□206,00	8	5.47
Amylase level	4	139,5	74,00	268,00	2	50

VII. Paraclinical assessment upon admission :

1. Electrocardiogram :

The ECG performed on 146 patients revealed anomalies in 25 cases (17.12%). Conduction disorders were noted in 13 patients (8.90% of the total). These disorders consisted of right or left bundle branch block atrioventricular. Rhythm disorders were noted in 12 patients (8,21%), consisting of ventricular extrasystole, complete arrhythmia due to atrial fibrillation and atrial flutter.

2. Standard Chest X-ray

Chest X-ray was requested for 96 patients and showed signs of acute pulmonary edema in 36 cases (37.5%).

3. Echocardiography :

Echocardiography was performed on 107 patients, revealing anomalies in 19 of them, or 17.75% of cases.

Table XXXIII: Echocardiography data of our population.

Parameters	Number N=	Mean	Minimum	Maximum
Ejection fraction (EF)	51	57.92	17.00	99.30
Time-velocity integral	43	15.21	10	22

- The mean EF is 57.92, with a minimum value of 17.00 and a maximum value of 99.30. As we defined an abnormal ejection fraction if it was less than 50%, 21 children had a pathological ejection fraction.

- The mean VTI is 15.21, with a minimum value of 10 and a maximum value of 22.

According to their age and to the American Society of Echocardiography values [79], 13 children had an abnormal VTI.

4. Imaging of the brain :

Imaging of the brain was performed in 12 cases.

In total, 9 brain CT scans were performed. Among them, 3 CT scans revealed cerebral ischemia, and 4 of them showed cerebral edema.

No CT scan showed cerebral hemorrhage.

In our study, only 3 brain MRIs were performed. Only one abnormality, in the form of cerebral ischemia, was observed.

VIII. Management upon admission to intensive care :

1. Oxygen therapy :

Upon admission to the intensive care unit, 547 patients, accounting for 34.2% of the cases, received oxygen therapy.

This mainly involved the use of oxygen nasal cannula (63.1%) and invasive ventilatory support (20.5%). In our study, the high-concentration mask and non-invasive ventilation (NIV) were less frequently utilized.

Table XXXIV: Distribution of Respiratory Support Types

Type	Cases
Nasal Canula	345
Invasive Ventilatory Support	112
High Concentration Mask	45
Non-Invasive Ventilatory Support (NIV)	45

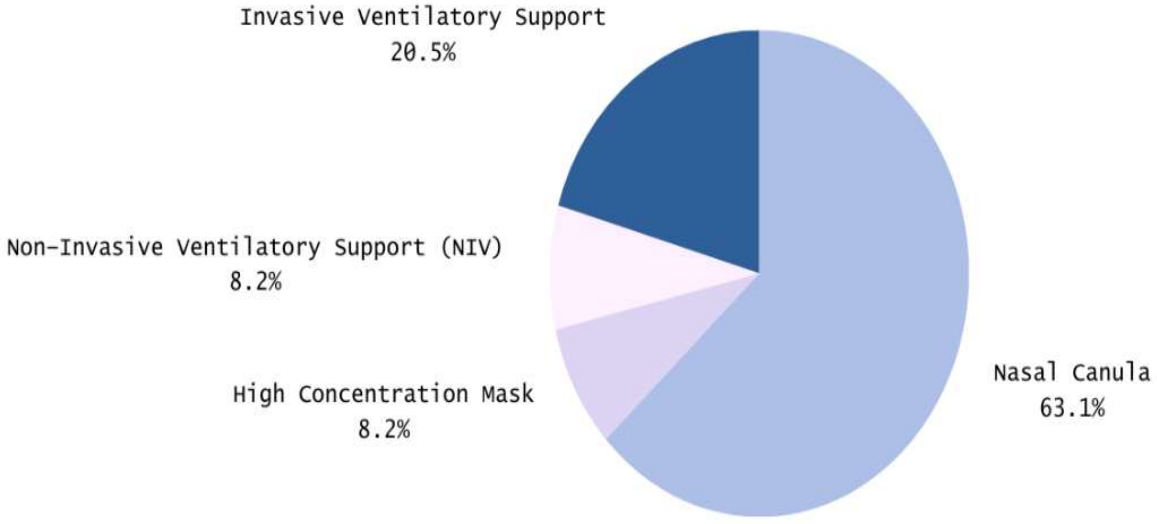


Figure 48 : Distribution of Respiratory Support Types

2. Non-invasive ventilatory support (NIV) :

Non-invasive ventilatory support was initiated for 46 patients.

Table XXXV : Distribution of non-invasive methods within our population.

Interface	Cases
Helmet	13
Total Face	1
Nasal-Buccal Mask	1
ND	31
Total	46

➢ Continuous Positive Airway Pressure (CPAP) was used in 100% of the cases.

3. Vascular access:

All patients were equipped with a Peripheral Venous Catheter (PVC).

A central venous line was placed in 66 cases (4.1%), and a central arterial catheter was required for 56 patients (3.5%).

- Number of peripheral venous catheters:

1 peripheral venous catheter	90
2 peripheral venous catheters	1410
No Data	36

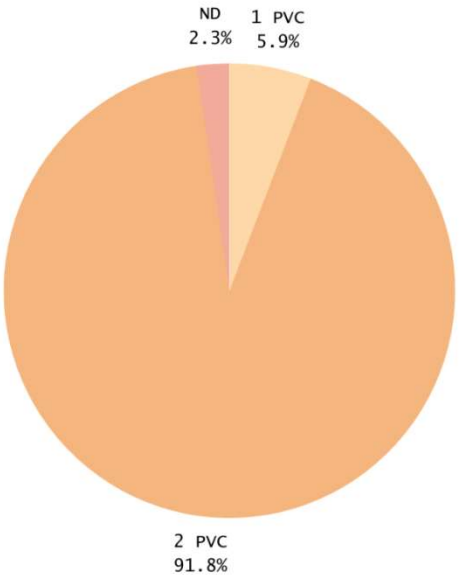
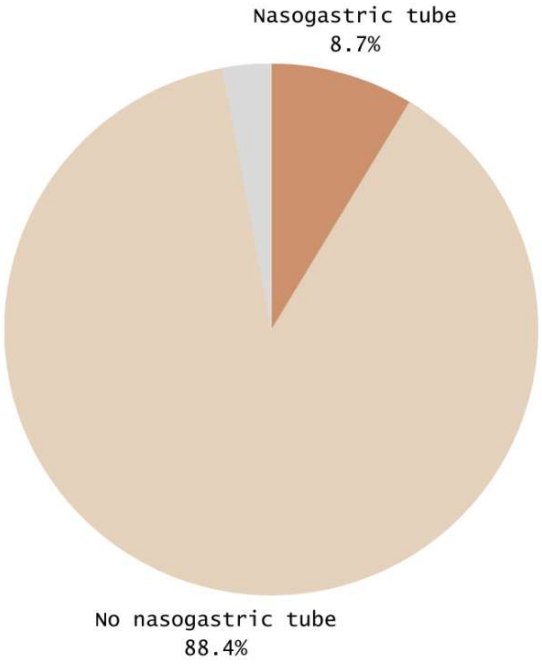


Figure 49 : Distribution of patients based on the number of peripheral venous catheters (VVP) placed.

4. Nasogastric tube :

The placement of a nasogastric tube was placed in 138 cases.

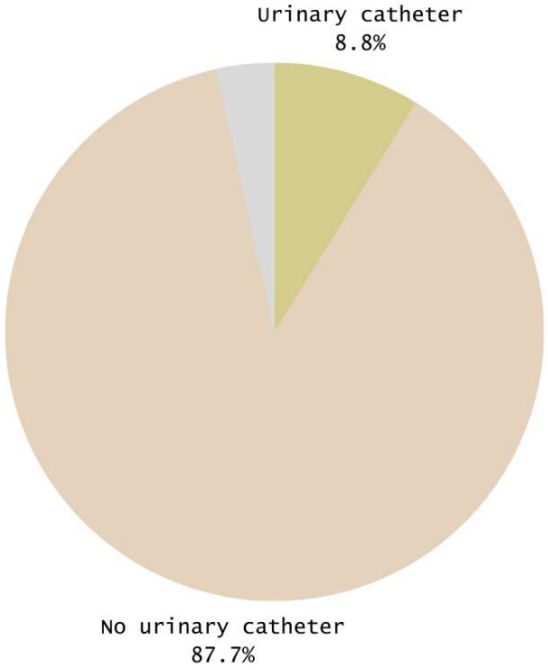


	Cases	Percentage (in %)
Nasogastric tube	138	8,65
No nasogastric tube	1410	88,40
No data	47	2,94
Total	**1595**	**100**

Figure 50 : Distribution of patients based on the placement or non-placement of a gastric tube.

5. Urinary catheter:

The placement of a urinary catheter was placed in 140 cases.



	Cases	Percentage (in %)
Urinary catheter	140	8,77
No urinary catheter	1399	87,71
No data	56	3,51
Total	1595	100

Figure 51 : Distribution of patients based on the placement or non-placement of a urinary catheter.

6. Medication treatment:

The administration of medications has been summarized below:

Table XXXVI : Different therapeutic modalities used in the patients of our series

Medication	Number
Antiulcer drugs	1282
Antipyretics (such as paracetamol)	1197
Calcium therapy	652
Antiemetics	179
Benzodiazepine	97
Antibiotics	46
Diuretic	45
Corticosteroid therapy	39
Antihypertensives (such as Nicardipine)	29
Insulin	12
Amiodarone	11
Local anesthetics / Lidocaine	5
Tetanus Antitoxin Serum	0
Others	15

Others : Morphine (4), Iron supplementation (1), Heparin (1)

7. Drugs administered:

7.1. Type of drugs administered

All patients in our series received dobutamine.

Table XXXVII : Distribution of Medications Used in our population

Drugs	Cases	Percentage (in %)
Dobutamine in syringe driver	1595	100%
Noradrenaline	58	3,6%
Adrenaline	42	2,6%
Milrinone	2	0,1%

7.2. Posology of dobutamine administered:

During the initial management, the most frequently administered dose of dobutamine is 15 Ɣ/kg/min, followed by the doses of 5 and 10 Ɣ/kg/min.

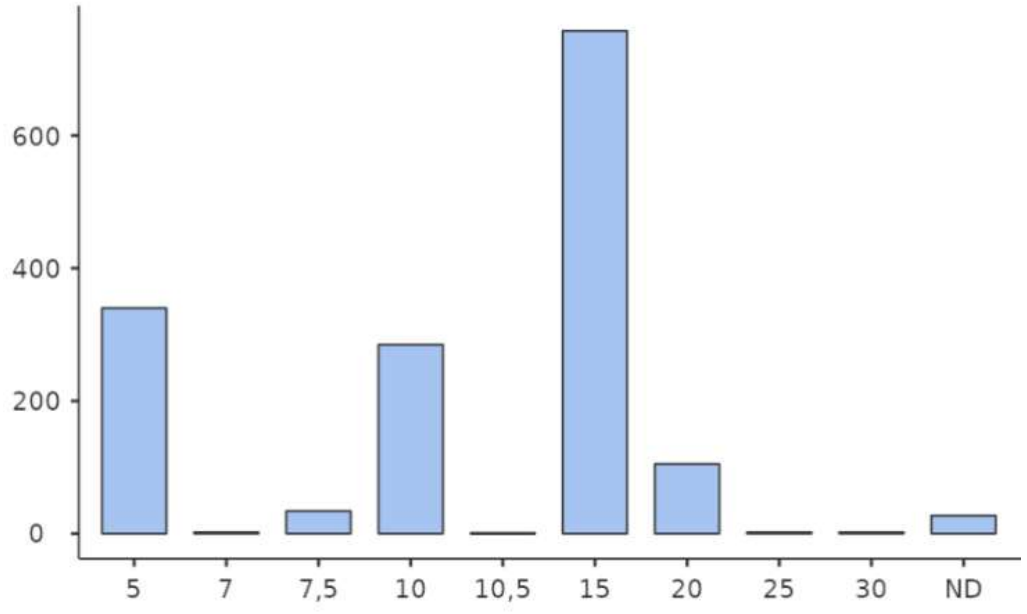


Figure 52 : Distribution of the dosage of dobutamine administered in our population

7.3. Duration of administration of Dobutamine

The mean time of dobutamine administration was 27,60 hours. We lacked data for 575 patients. The values ranged from 1 hour to 1134 hours (42 days and 6 hours).

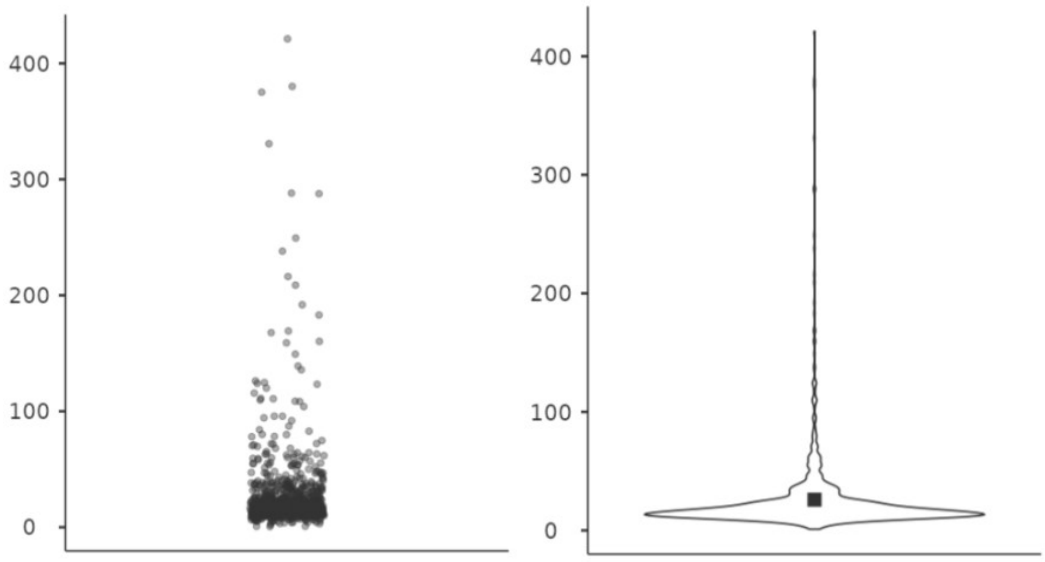


Figure 53 : Duration of administration of Dobutamine (in hours)

8. Total duration of stay in the intensive care unit (in hours):

The average length of stay was 27 hours and 30 minutes ± 50.4, with a maximum of 1134 hours (47,25 days) and a minimum of 1 hour.

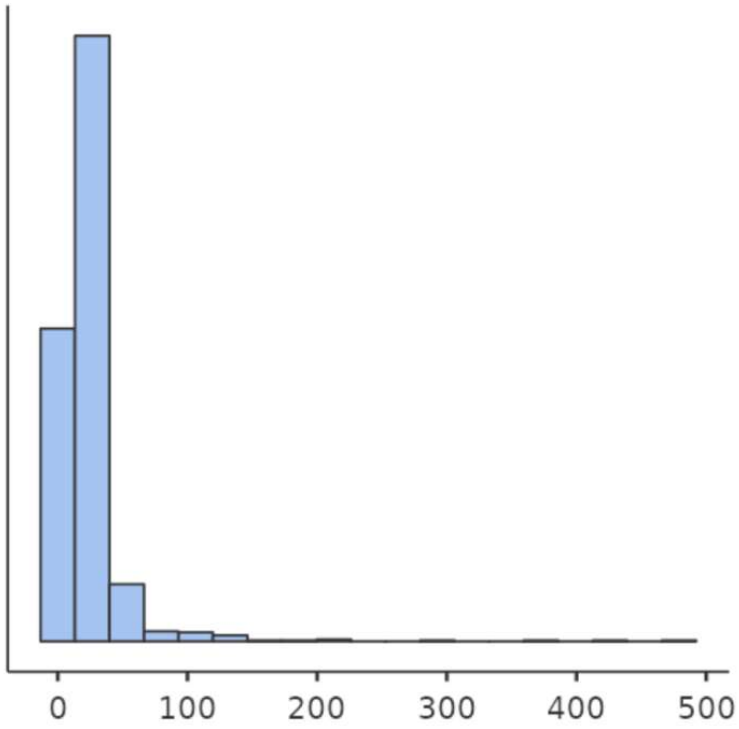


Figure 54 : Distribution of hospitalization duration in our population

IX. Evolution :

1. Mortality and comorbidities :

The outcome was favorable in most cases in our series (1504 patients or 94.5% of the total).

We counted 86 patients who had a poor clinical outcome.

Less than one percent of the patients (0.6%) survived and developed a co-morbidity, which corresponds to 8 patients.

In our series, the mortality rate was 4.89%, which corresponds to 78 patients.

The morbi-mortality was predominantly caused by cardiovascular conditions (74 cases, 86,04%), followed by severe rhythm disturbance (10 cases, 16.66%), 39 patients showed signs of acute pulmonary edema. Approximately a quarter of these patients (20 cases, 23.25%) presented neurological signs. Among the 8 patients who survived with comorbidities, 2 children underwent tracheotomy, and 2 patients experienced moderate neurological disability.

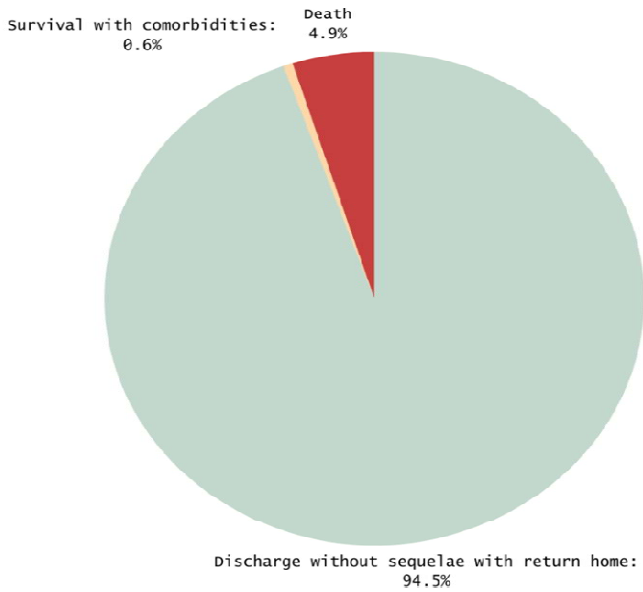


Figure 55 : Distribution of patients according to their evolution.

2. Early complications (within the first 36 hours):

2.1. Progression from class II envenomation to class III :

The condition of 26 patients has progressed to a more severe stage of envenomation.

Table XXXVII : Distribution of complicated patients according to vital distress.

	Cases	Percentage (in %)
Cardiovascular distress	12	46.15
Neurological distress	8	30.76
Respiratory distress	6	23.07

a. Cardiovascular distress :

Among the patients who experienced a complication related to circulatory distress:

- 43 children developed cardiogenic shock.
- A number of 22 patients experienced cardiac arrest.
- Four patients suffered from severe arrhythmia.
- Only two patients were diagnosed with distributive shock.

b. Neurological distress :

Among the reported cases,

- A total of 13 cases were identified with impairment of consciousness.
- Two cases of coma were documented, indicating a state of unconsciousness with no response to stimuli.
- Additionally, there was one reported case of intracranial hypertension.
- There were no reported cases of Status epilepticus

*c. **Respiratory distress :***

- 11 cases of Acute Pulmonary Edema.
- Respiratory failure was observed in five cases.
- Four cases of Acute Respiratory Distress Syndrome were recorded.
- There was one instance of Inhalation-related complications.

2.2. Additional drug use :

In case of non-response to initial treatments, 50 patients required additional drug interventions.

Table XXXVIII : Distribution of complicated patients according to the additional drug administered.

Drug	Cases
Adrenaline	44
Noradrenaline	38
Milrinone	2

2.3. Invasive mechanical ventilation :

In our study, the need for intubation was considered as a complication. Among the 86 patients considered complicated in our study, 54 patients (or 62.8% of them) required intubation.

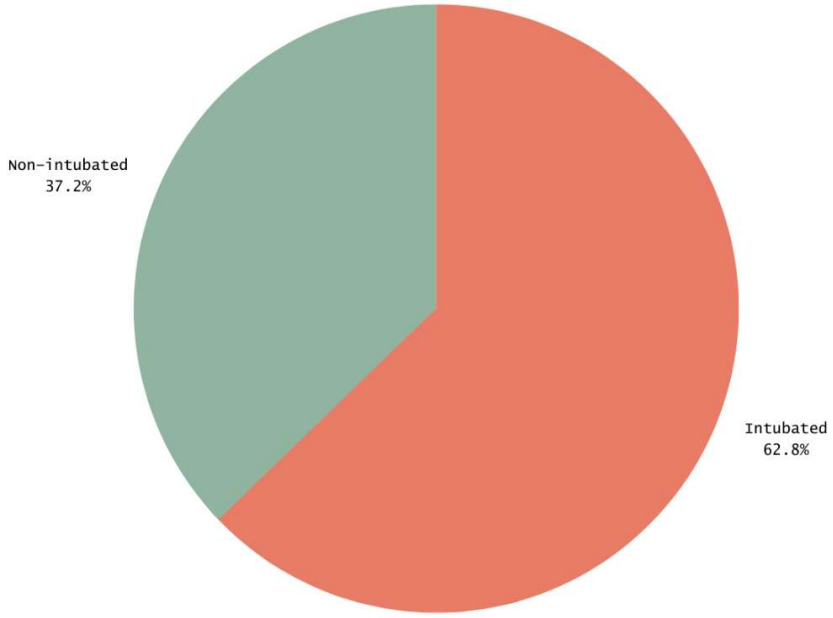


Figure 56 : Distribution of complicated patients based on whether they were intubated or not.

2.4. Sedation use :

1. Sedation had to be implemented for 48 patients. In order of frequency: fentanyl is the drug most frequently administered, followed by Midazolam and neuromuscular blocking agents.

	Cases
Fentanyl	36
Midazolam	30
Neuromuscular Blocking Agents	11
ND	2

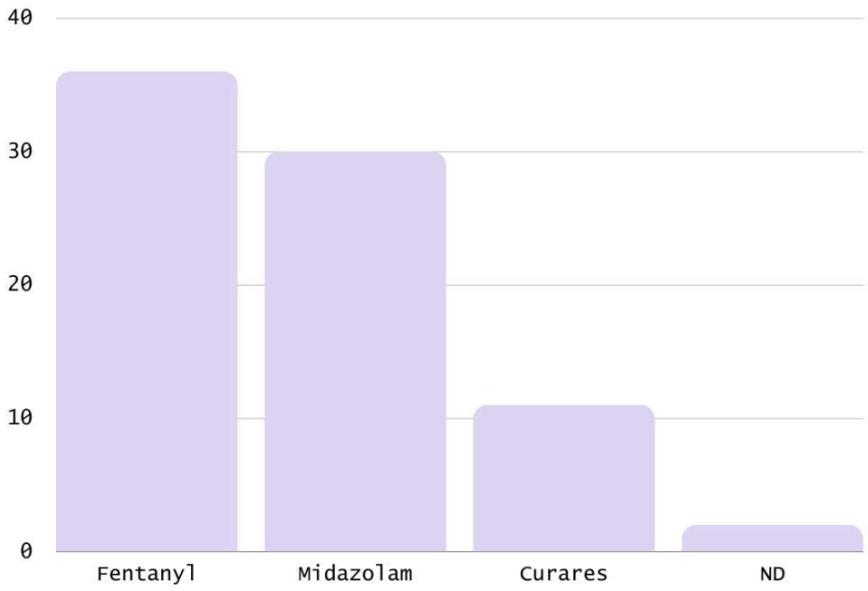


Figure 57 / Table XXXIX : Distribution of type of sedation in the complicated patients

2.5. Cardioversion use :

In the subgroup of complicated patients, 12 required cardioversion (14%).

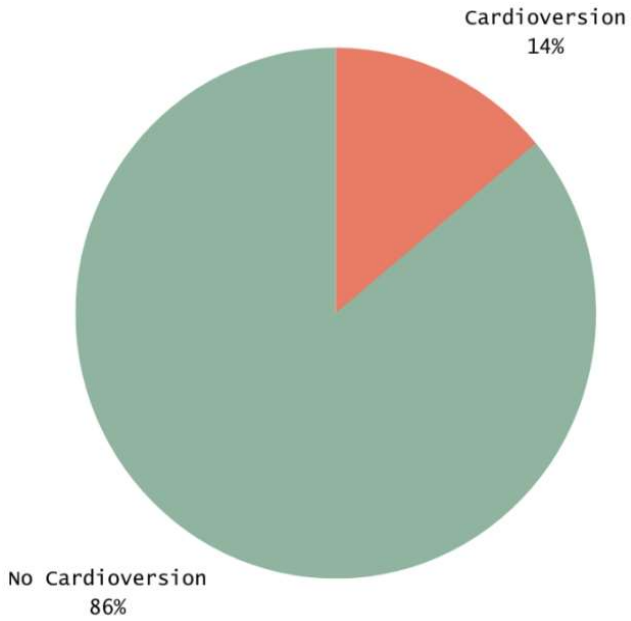


Figure 58 : Distribution of complicated patients according to the use of cardioversion.

2.6. Use of specialized medication

Table XXXX : Distribution of complicated patients according to the administration of specialized medication.

	Cases
Corticosteroid therapy	11
Magnesium sulfate	6
Amiodarone	3
Local anesthetics	2

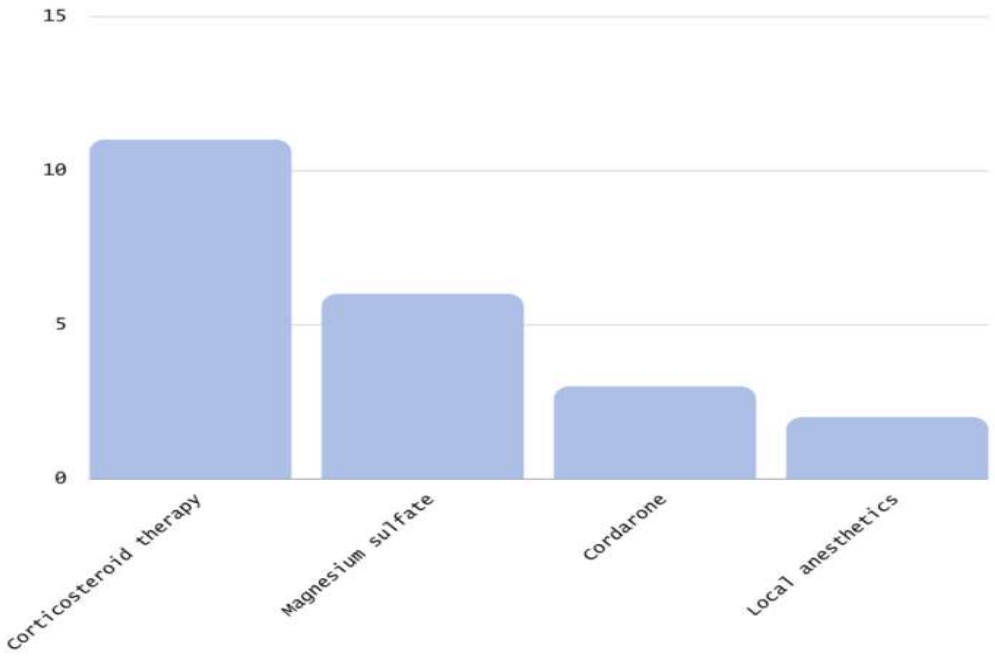


Figure 59 : Distribution of complicated patients according to the administration of specialized medication.

3. Secondary complications :

3.1. Nosocomial infections

Nosocomial infections were contracted by 10 patients.

a. Date of sampling:

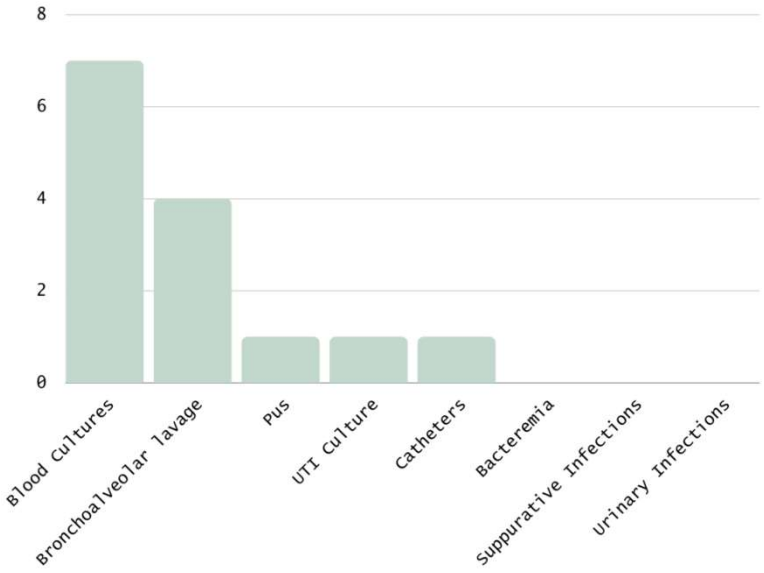
Table XXXXI: Distribution of sample dates within our population.

Date	Number of sampling
Sept. 2010	1
August 2011	1
September 2011	2*
June 2012	1
June 2013	1
August 2013	1
May 2017	1
July 2017	1
August 2017	1
July 2022	1
Total	**11**

*The same patient was sampled twice.

b. Nature of the sample:

The samples are primarily collected through blood culture.



Blood Cultures	7
Bronchoalveolar lavage	4
Pus	1
UTI Culture	1
Catheters	1
Bacteremia	0
Suppurative Infections	0
Urinary Infections	0

Figure 60 : Distribution of sample type within our population.

c. Isolated bacterial species :

During our study period, 6 bacterial species were isolated.

These include Staphylococcus aureus (2 cases), Streptococcus group G (1), Enterobacter cloacae (1), and Escherichia coli (1).

4. Multivisceral failure:

Table XXXXII : Distribution of multivisceral failures in complicated patients

	Cases	Percentage (in %)
Hemodynamic failure	25	67.56
Respiratory failure	3	8.10
Renal failure	3	8.10
Hepatic failure	3	8.10
Hematological failure	2	5.40
Encephalopathy	1	2.70
Total	**37**	**100**

Overall, a total of 37 cases were analyzed :

- Hemodynamic failure was the most prevalent, occurring in 67.5% of the cases.
- Respiratory, renal, hepatic, and hematological failures were each observed in 8.1% of the cases.
- Additionally, encephalopathy was identified in 2.7% of the cases.

X. Morbi-mortality factors in univariate analysis :

Table XXXXIII : Epidemiological morbidity/mortality factors in univariate analysis.

	Survivors without sequelae	Poor Outcome	P values
Age (years; mean ± standard deviation)	6.22 ± 4.01	4.32 ± 3.43	<0.001
Body weight (kg; mean ± standard deviation)	21.0 ± 11.3	16.7± 8.20	>0.05 p=0.977
Male gender (percentage, in %)	56.32%	60.46%	>0.05 p=0.524
Existence of medical history (percentage, in %)	1.65%	3.48%	>0.05 p=0.106
Province of origin (Al Haouz, percentage, in %)	29.09% N=439	20.93% N=18	<0.001
Rural origin (percentage, in %)	72.16% N=1089	60.46% N=52	<0.01

Table XXXXIV : Management morbi-mortality factors (pre admission to ICU) in univariate analysis

	Survivors without sequelae	Poor Outcome	P values
Pre hospital care (appropriate, percentage, in %)	32.33% N=488	26.74% N=23	>0.05 p=0.078
Time to admission (minutes ± standard deviation)	270.25min ± 244.16	387.14min ± 447.35	<0.001
Regulation (Yes, in percentage in %)	10.53%	23.25%	>0.05 p=0.201
First medical consultation in a primary healthcare facility level 2 (Yes, percentage, in %)	73.32% N=855	80.30% N=53	<0.05
Dobutamine administered from the first medical consultation. (Yes, percentage in %)	41.92% N=509	35.82% N=24	<0.05

Table XXXXV : Characterization of the sting in univariate analysis.

	Survivors without sequelae	Poor Outcome	P values
Number of stings (more than one, percentage, in %)	2.31% N=35	3.48% N=3	>0.05 p=0.412
Sting site (extremities; percentage, in %)	81.77% N=1234	65.11 N=56	>0.05 p=0.117
Place of occurrence (indoor/ at home, percentage, in%)	14.44% N=218	17.44% N=15	>0.05 p=0.342

Table XXXXVI : Clinical morbi-mortality factors in univariate analysis.

	Survivors without sequelae	Poor Outcome	P values
Glasgow Coma Scale (mean ± standard deviation)	14.74 ± 0.94	12.96 ± 2.94	<0.001
Grade III envenomation (Yes, percentage, %)	55.06% N=831	91.86% N=79	<0.01
Tachycardia (percentage, %)	64.21% N=969	66.27% N=57	<0.001
Hypertension (percentage, %)	45.72% N=690	29.06% N=25	>0.05 p=0.120
Hypotension (percentage, %)	10.86% N=164	24.41% N=21	>0.05 p=0.365
Pulse oxygen saturation (%; mean ± standard deviation)	98.32 ± 6.04	93.72± 12.80	<0.01

Table XXXXVII : Clinical morbi-mortality factors in univariate analysis. (bis)

	Survivors without sequelae	Poor Outcome	P values
Vomiting	84.75% N=1279	80.23% N=69	>0.05 p=0.163
Excessive sweating	83.83% N=1265	80.23% N=69	>0.05 p=0.531
Priapism*	58.47% N=497 on 850 males	73.07% N=38 on 52 males	<0.001
Abdominal pain	29.62% N=447	22.09% N=19	>0.05 p=0.782
Agitation	24.78% N=374	43.02% N=37	>0.05 p=0.485
Hypertension	14.84% N=224	11.62% N=10	>0.05 p=0.621
Fever >38.5 (rectal)	13.32% N=201	29.06% N=25	<0.05
Chills	9.14% N=138	5.81% N=5	>0.05 p=0.427
Abdominal bloating	3.84% N=58	11.62% N=10	>0.05 p=0.851
Hypothermia	4.77% N=72	6.97% N=6	>0.05 p=0.760
Coolness of extremities	63.55% N=959	69.79% N=60	>0.05 p=0.413
Excessive salivation	1.72% N=26	5.81 N=5	>0.05 p=0.919
Diarrhea	1.39% N=21	11.62% N=10	<0.05
Nausea	0.33% N=5	0% N=0	>0.05 p=0.991

Table XXXXVIII : Distribution of Distress Types in univariate analysis

	Survivors without sequelae	Poor Outcome	P values
Cardiovascular distress	66.91% N=1010	88.37% N=76	<0.001
Neurological distress	12.45% N=188	60.46% N=52	<0.001
Respiratory distress	13.18% N=199	53.48% N=46	<0.001

We detail in the table below the signs of cardiovascular distress :

Table XXXXIX : Cardiovascular Distress in univariate analysis

	Survivors without sequelae	Poor Outcome	P values
Gallop rhythm (presence, percentage in %)	0.13% N=2	1.16% N=1	>0.05 p= 0.917
Mottling (presence, percentage in %)	2.38% N=36	19.76% N=17	>0.05 p=0.533
Cool extremities (presence, percentage in %)	63.55% N=959	69.76% N=60	>0.05 p=0.674
Hypotension (presence, percentage in %)	1.39% N=21	8.13% N=7	>0.05 p=0.466
Weak pulses (presence, percentage in %)	1.92% N=29	10.46% N=9	>0.05 p=0.891

We detail in the table below the signs of neurologic distress :

Table L : Neurologic Distress in univariate analysis

	Survivors without sequelae	Poor Outcome	P values
Seizures (presence, percentage in %)	0.79% N=12	8.13% N=7	>0.05 p=0.591
Irritability (presence, percentage in %)	0.39% N=6	1.16% N=1	>0.05 p=0.816
Confusion (presence, percentage in %)	0.53% N=8	1.16% N=1	>0.05 p=0.770
Temporal-spatial disorientation (presence, percentage in %)	0.06% N=1	1.16% N=1	>0.05 p=0.944
Nystagmus (presence, percentage in %)	0.06% N=1	0% N=0	>0.05 p=0.971
Strabismus (presence, percentage in %)	0.59% N=9	6.97% N=6	>0.05 p=0.645
Coma (presence, percentage in %)	6.75% N=102	31.39% N=27	<0.001

Table LI : Respiratory Distress in univariate analysis

	Survivors without sequelae N=	Poor Outcome N=	P values
Crackles (presence, percentage in %)	5.69% N=85	33.72% N=29	<0.001
Tachypnea (presence, percentage in %)	7.95% N=120	32.55% N=28	<0.001
Bradypnea (presence, percentage in %)	0.13% N=2	1.16% N=1	>0.05 p=0.917
Cyanosis (presence, percentage in %)	3.11% N=47	15.11% N=13	>0.05 p=0.685
Tracheobronchial congestion (presence, percentage in %)	0.06% N=1	2.32% N=2	>0.05 p=0.917
Involvement of accessory muscles (presence, percentage in %)	2.5% N=38	26.74% N=23	>0.05 p=0.697
Respiratory arrest (presence, percentage in %)	0.06% N=1	2.32% N=2	>0.05 p=0.917
Acute pulmonary edema (Clinical presence, percentage in %)	0.19% N=3	45.34% N=39	<0.001

Table LII : Biological morbidity-mortality factors in univariate analysis

	Survivors without sequelae	Poor Outcome	P values
Leukocytes, 103 /mL	17.5 ± 7.88	20.9 ± 10.3	<0.001
Hemoglobin, g/dL	12.8 ± 1.83	12.3 ± 2.22	>0.05 p=0.332
Platelets, 103 /mL	381 ± 138	430 ± 379	<0.001
Urea, mg/dL	0.582 ± 2.86	0.613 ± 0.372	<0.001
Creatinine, mg/dL	4.88 ± 17.9	9.21 ± 6.42	>0.05 p=163
ALT, IU/L	26.2± 52.2	59.2± 95.0	<0,001
AST, IU/L	47.4± 67.9	125± 151	<0,001
CPK, IU/L	294 ± 408	1507 ± 2186	>0.05 p=0.264
Glucose, mg/dL	1.81 ± 0.66	1.83 ± 0.95	<0.001
Troponin-I, ng/mL	100± 219	371± 924	<0.001

BNP and amylasemia were not requested for patients with poor outcomes.

Table LIV : Metabolic state in univariate analysis

	Survivors without sequelae	Poor Outcome	P values
Leukocytosis	62.93% N=742	82.89% N=63	*<0.05*
Thrombocytosis	36.05% N=419	41.86% N=36	*<0.05*
Uremia	7.92% N=77	44.26% N=27	*<0.05*
Hepatic cytolysis	0.89% N=7	0.04% N=2	*>0.05 p=0.882*
Metabolic Acidosis (percentage, in %)	17.76% N=104	19.76% N=17	*<0.05*

In a more precise interpretation of the metabolic acidosis :

	Survivors without sequelae	Poor Outcome	P values
Mild acidosis	54	0	>0.05 p=0.572
Moderate acidosis	7	2	>0.05 p=0.793
Severe acidosis	6	0	>0.05 p=0.840

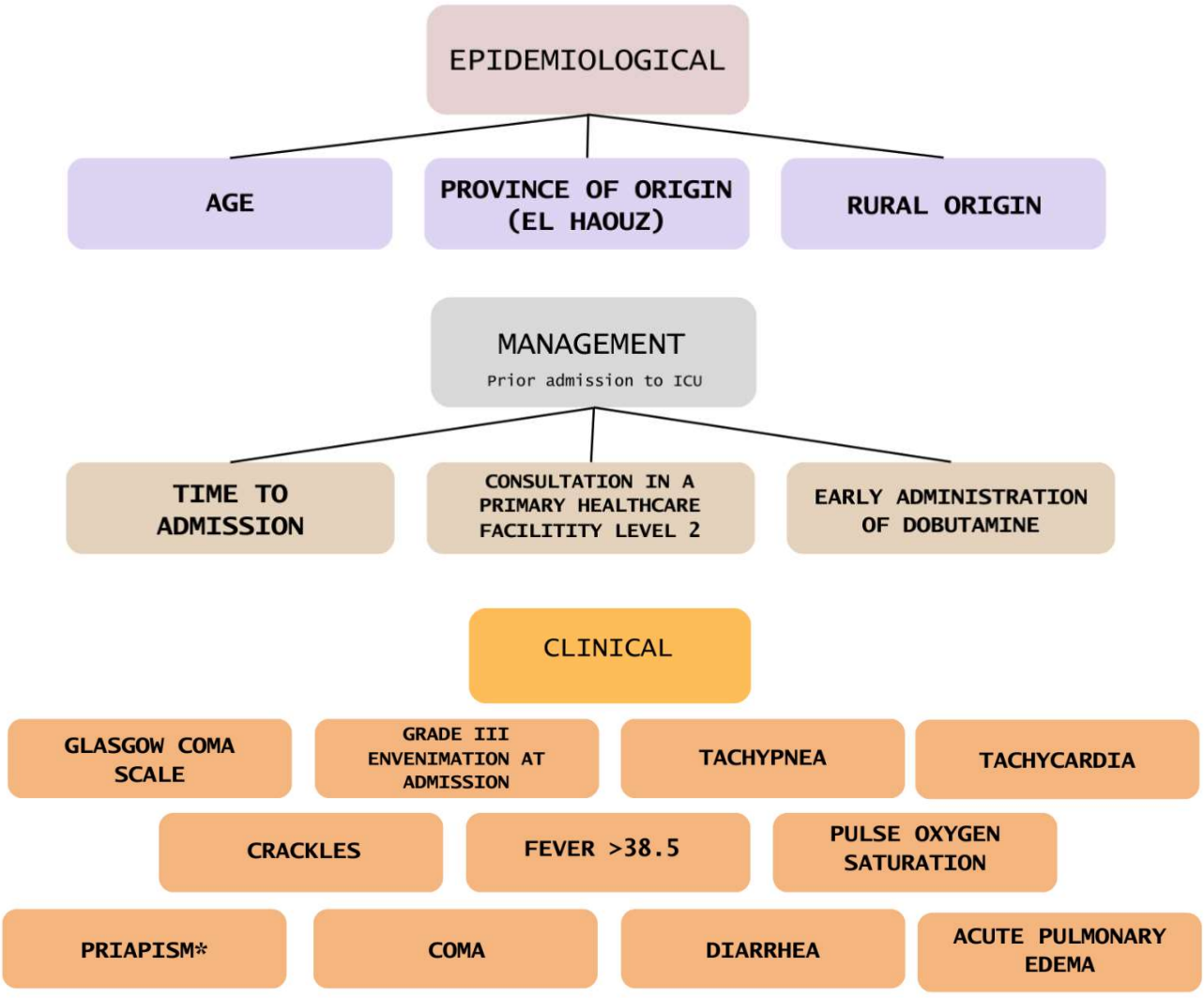
Table LV : Paraclinical factors in univariate analysis

	Survivors without sequelae	Poor Outcome	P values
ECG rhythm disturbance (percentage, in %)	3.17% N=4	40% N=8	<0.001
ECG repolarization disturbance (percentage, in %)	3.96% N=5	40% N=8	<0.05
Chest Xray (Signs of pulmonary edema, percentage, in %)	1.39% N=21	17.44% N=15	>0.05 p=0.662
Kinetic abnormalities (TTE)	14.00% N=14	71.42% N=5	>0.05 p=0.106
Ejection fraction (<50%, number)	N=17	N=2	>0.05 p=0.967
Time-velocity integral (abnormal)	N=11	N=2	<0.05

Table LVI : Management morbi-mortality factors (At the ICU) in univariate analysis

	Survivors without sequelae	Poor Outcome	P values
Use of Non-Invasive Ventilation (Yes, in %)	2.30% N=37	9.30% N=8	<0.05
Placement of a central line (arterial and/or venous) (Yes, in %)	3.91% N=54	66,17% N=45	<0.01
Placement of a nasogastric tube (Yes, in %)	5.63% N=85	60.46% N=52	>0.05 p=0.223
Placement of a urinary catheter (Yes, in %)	5.89% N=89	58.13% N=50	>0.05 p=0.124
Administration of another drug than dobutamine (adrenaline, noradrenaline, milrinone..)	2.25% N=34	45.34% N=39	>0.05 p=0.662
Administration of dobutamine for more than 24 hours (Yes, in %)	14.44% N=218	50% N=43	<0.01
Hospital stay, h	24.30 ± 31.42	77.77 ± 145.96	<0.05

At the end of our univariate study, the following elements are considered to be statistically significant:



**Only for male gender*

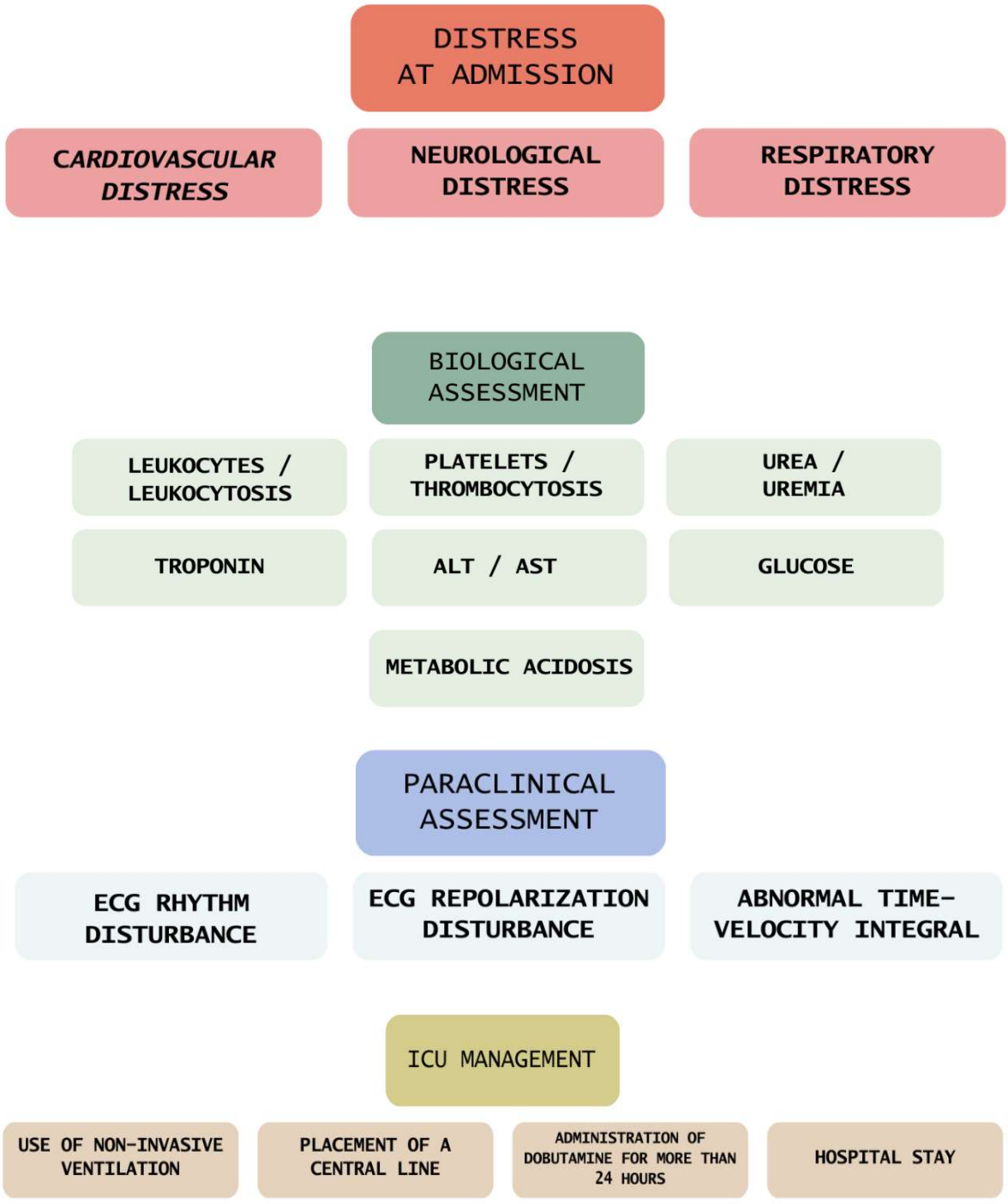


Figure 61 : Summary of statistically significant parameters in univariate study.

We have carried out a detailed multivariate analysis of each of those parameters.

XI. Morbi-mortality factors in multivariate analysis :

Multivariate logistic regression analysis allowed us to identify potential associations between the occurrence of death and various prognostic factors.

For this purpose, we calculated adjusted odds ratios and selected the final logistic regression model, which revealed that :

Table LVII : Epidemiological factors in multivariate analysis

		95% Confidence Interval	
Variables	Odds ratio	Lower	Upper
Age < 6 years old	2.804	1.99	3.25
Province of origin (Al Haouz)	0.797	0.192	3.31
Rural Origin	3.65	3.32	4.01

Table LVIII : Management factors (prior admission to ICU) in multivariate analysis

		95% Confidence Interval	
Variables	Odds ratio	Lower	Upper
Time to admission (More than 240 minutes).	1.02	2.40	4.36
Length of Stay (More than 24 hours).	0.804	0.392	1.65
Early administration of dobutamine	0.625	1.31	2.98

Table LIX: Clinical factors in multivariate analysis.

		95% Confidence Interval	
Variables	Odds ratio	Lower	Upper
Glasgow Coma Scale (GCS < 15/15)	0.586	0.254	1.35
Class III envenomation	4.14	2.44	7.00
Acute pulmonary edema	5.00	1.28	19.6
Tachypnea	1.57	7.44	33.0
Tachycardia	2.89	0.123	67.9
Crackles	1.33	0.378	4.67
Pulse Oxygen Saturation (SpO2<92%)	3.39	1.39	8.26
Priapism*	2.25	5.96	8.49
Fever >38,5C	1.26	0.321	4.98
Diarrhea	1.42	3.16	6.37
Coma	2.59	0.152	4.43

*only for male gender

Table LX : Vital distress at admission in multivariate analysis.

		95% Confidence Interval	
Variables	Odds ratio	Lower	Upper
Cardiovascular distress	6.17	1.64	2.32
Neurological distress	4.92	1.30	1.87
Respiratory distress	1.07	2.80	4.13

Table LXI : Biological factors in multivariate analysis.

		95% Confidence Interval	
Variables	Odds ratio	Lower	Upper
Leukocytes / Leukocytosis	2.31	6.41	8.31
Platelets / Thrombocytosis	1.25	3.86	4.05
Urea / Uremia	9.47	1.69	5.32
elevated ALT	3.94	8.17	19.0
elevated AST	1.67	2.25	4.23
Glucose	1.75	2.46	3.30
Elevated Troponin	9.02	4.63	6.00
Metabolic Acidosis	7.00	4.27	11.5

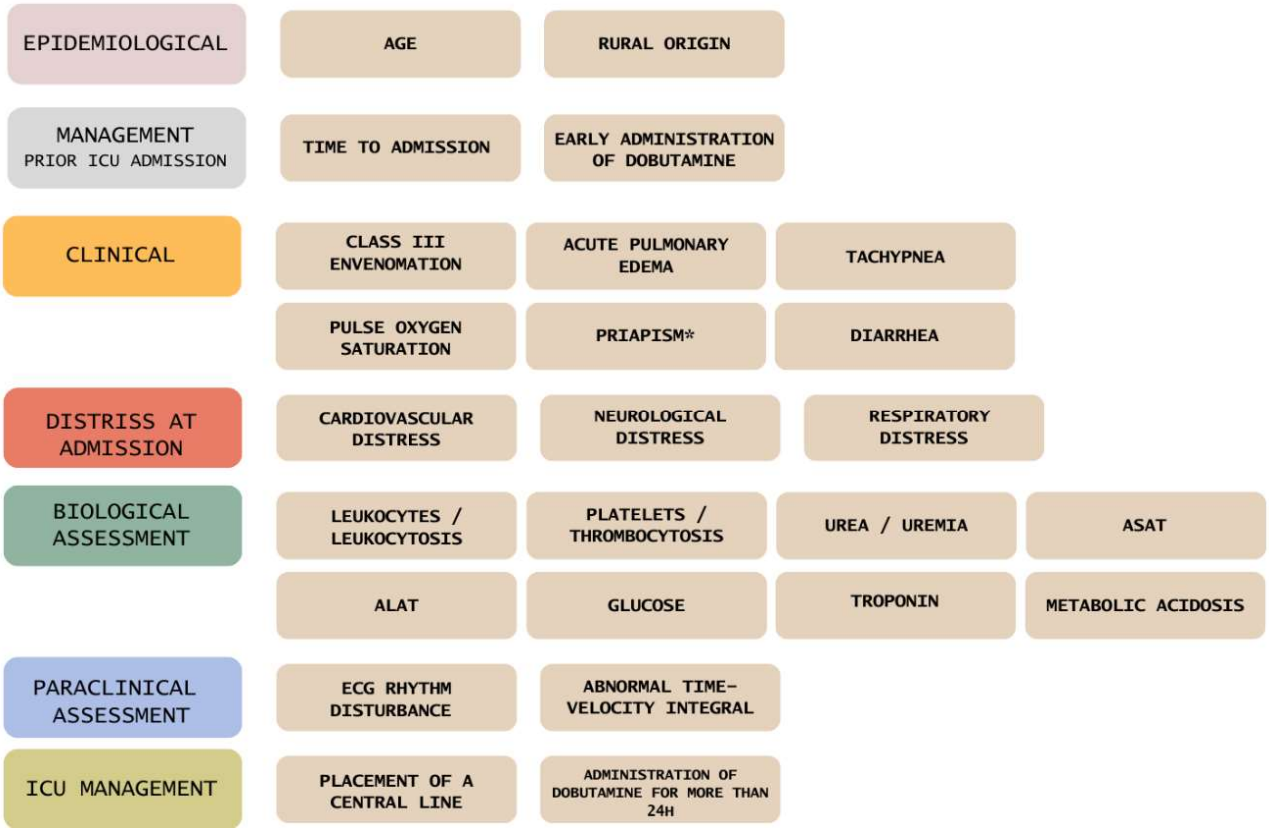
Table LXII : Paraclinical factors in multivariate analysis

		95% Confidence Interval	
Variables	Odds ratio	Lower	Upper
ECG rhythm disturbance	1.60	1.56	2.31
ECG repolarization disturbance	1.86	0.257	2.92
Abnormal Time-velocity integral	2.35	1.12	3.43

Table LXIII : Management factors in multivariate analysis

		95% Confidence Interval	
Variables	Odds ratio	Lower	Upper
Use of non-invasive ventilation	3.12	0.165	5.91
Placement of a central arterial line	3.89	1.47	10.3
Administration of dobutamine for more than 24h	1.37	2.87	6.51
Hospital stay (more than 24h)	0.655	0.272	1.58

At the end of our multivariate study, the following elements are considered to be statistically significant :



**only for male gender*

Figure 62 : Summary of statistically significant parameters in univariate study.

Discussion

I. Theoretical reminders :

1. The scorpion :

A scorpion belongs to the order Scorpiones, which is a group of arachnids. They are characterized by their distinct body structure, consisting of a cephalothorax and an abdomen. The cephalothorax bears a pair of chelicerae, which are used for feeding, and a pair of pedipalps, which function as sensory organs and pincers. The pedipalps are followed by four pairs of walking legs. [20]

The abdomen of a scorpion is segmented and elongated, ending with a specialized structure called the metasoma or tail. The metasoma consists of five segments, the last of which forms a bulbous structure called the vesicle. At the end of the vesicle, there is a sharp and curved stinger known as the aculeus, which is used to inject venom.

Scorpions have an exoskeleton composed of chitin, providing protection and support for their body. They possess multiple pairs of simple eyes, typically ranging from zero to five pairs, depending on the species. Scorpions are typically nocturnal, relying on their well-developed sensory organs to navigate their surroundings and locate prey. [20]

Reproduction in scorpions is unique, involving a courtship ritual and the transfer of a spermatophore from the male to the female. The female scorpion gives birth to live young, which are born fully formed and climb onto the mother's back for protection.

Scorpions exhibit a wide range of adaptations that allow them to survive in various habitats, including deserts, grasslands, forests, and caves. They are well-adapted to arid environments and possess the ability to conserve water. Some species are capable of surviving extreme temperatures and can go without food for extended periods. [21]

Many scorpions are venomous, and their venom is used primarily for subduing prey and defense. The potency and effects of scorpion venom can vary among species. While most scorpion stings are not life-threatening to humans, certain species, particularly those found in specific regions such as Morocco, can pose a significant medical risk and require medical attention if stung. [20]

Figure 63 : Scorpions brought by family (Tahanaout Hospital, December 2022)

2. Classification

Three families, seven genera, and 27 species and subspecies were identified. [22]

Yellow species:

- Scorpion Maurus: found in Tangier in the Rif, throughout the Mediterranean coast, the Middle Atlas, and the northern slope of the High Atlas; it is less dangerous than Androctonus Mauritanicus.
- Buthus Atlantus: found in the lower Sousse valley, on the Atlantic zone of Essaouira and Agadir.

Black species:

- Androctonus Mauritanicus: found throughout the Atlantic coastal zone, in the Sousse valley, on the slope of the High Atlas, and in Saharan regions
- Androctonus Aneas: found in Saharan regions and in the south of the Atlas.
- Buthus Frantzwereni Gentili: found in the Middle Atlas and in Saharan and pre-Saharan regions.

Androctonus Mauretanicus

Androctonus mauritanicus of the genus Androctonus is one of the most dangerous scorpion species in the world. Of moderate size, they attain a length of 10 cm. They are to be found in the arid and semi-arid regions. This species includes two subspecies : Androctonus mauritanicus mauritanicus and Androctonus mauritanicus bourdoni. [23]

Common in Morocco, where it is responsible for mortality and morbidity.

Figure 64 : Illustration of the most dangerous scorpions in Morocco [5]

A : Androctonus Mauritanicus B : Buthus Occitanus C : Hottentota Franzwerneri

D : Androctonus Amoreuxi E : Androctonus Bicolor F : Androctonus Australis

3. Ethnology :

Scorpions are found on every continent except Antarctica, but they are most diverse and abundant in tropical and subtropical areas. [24]

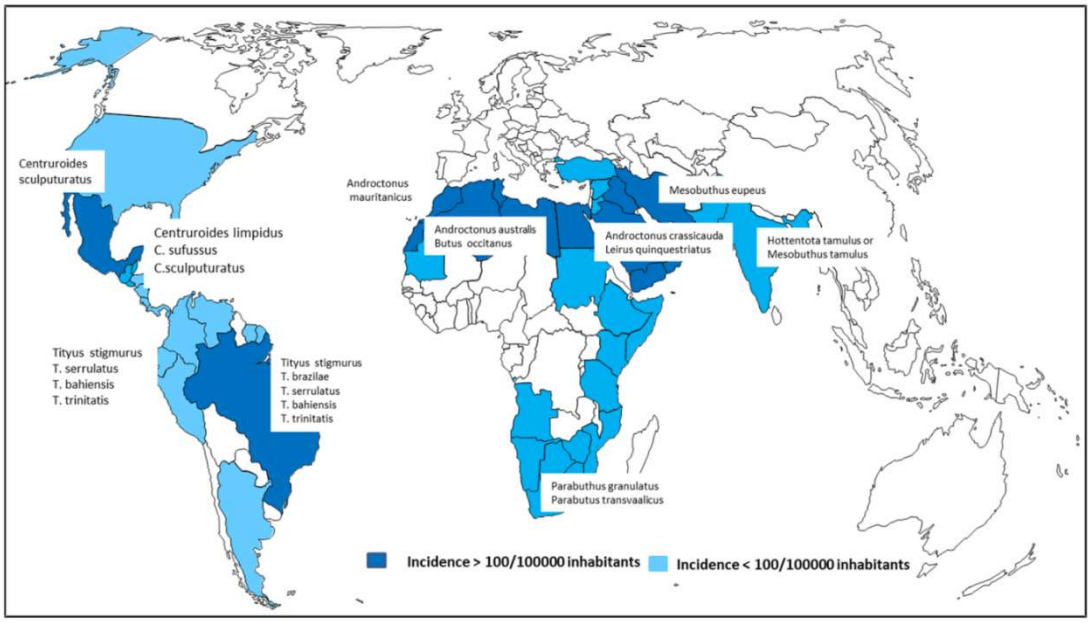


Figure 65 : Distribution and incidence in the world according to scorpion species. [25]

Scorpion envenomation is a major concern in many sub-Saharan African countries, including Morocco, Algeria, Tunisia, Egypt, Sudan, Nigeria, and South Africa. [26]

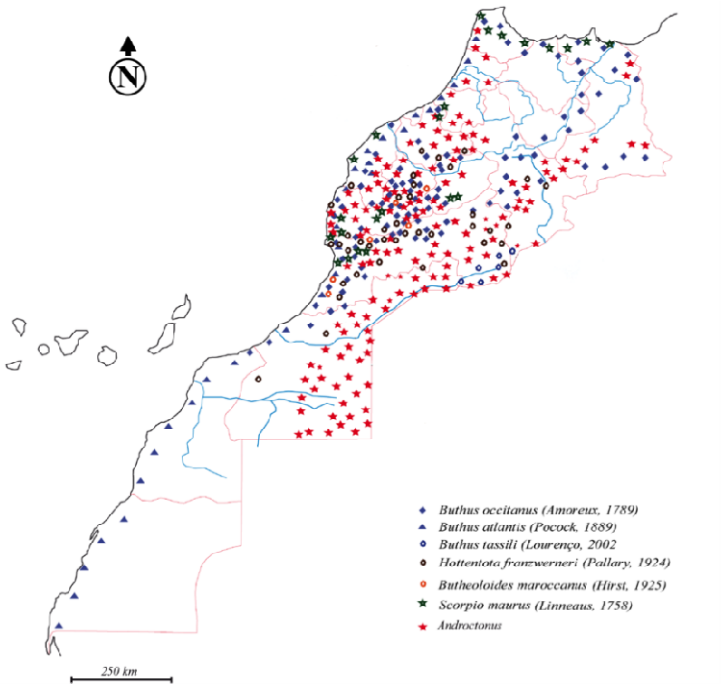


Figure 66 : Mapping of some scorpion species in Morocco. [4]

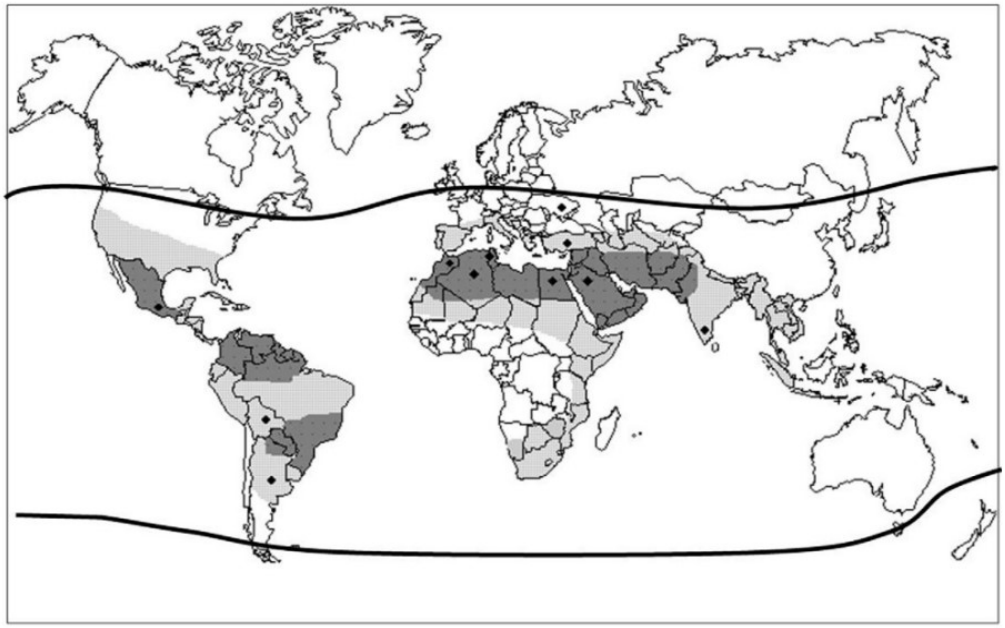


Figure 67 : Geographical origins of experts, in relation with scorpion envenomation incidence areas in the world (per 100 000 inhabitants): within limits of distribution (top and bottom curve lines), >100 (dark grey); 1-100 (light grey); <1 (white). Adapted from Chippaux. [27]

4. The venom :

Scorpion venom is highly heterogeneous and antigenic. The components of venom are complex and specific to each species. It contains proteinaceous and non proteinaceous components such as mucopolysaccharides, oligopeptides, nucleotides, biogenic amines (serotonin, histamine), protease inhibitors, amino acids, and other organic compounds with low enzymatic activity. Several toxins and additional elements have been identified notably cardiotoxins and neurotoxins. The predominance of each of the components is related to the type of scorpion involved. [28]

The pharmacokinetic properties of the venom include a rapid distribution with a half-life of 4 to 7 minutes, maximum peak at 35 to 45 minutes and a long elimination half-life of 4 to 13 hours. [29]

After intravenous injection, the maximum concentration is reached after 15 minutes (liver, lung, and heart). [29]

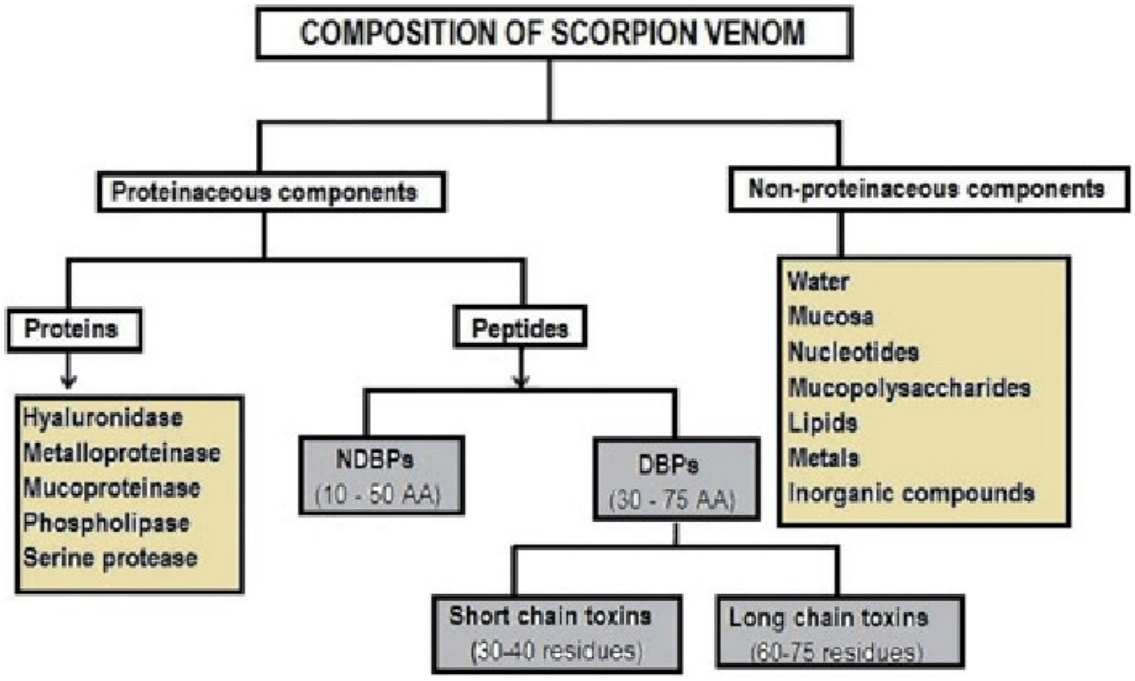


Figure 68 : Composition of Scorpion Venom [30]

In total, scorpion venom is characterized by rapid diffusion throughout the body. It has a high toxic power that is responsible for numerous multi-organ failures.

5. Pathophysiology of envenomation:

Statistics show that out of 100 scorpion sting patients, less than 10 are envenomated (90% Cold Sting). [31]

After a subcutaneous injection, venom appears very rapidly in the bloodstream. It then gradually decreases to become undetectable after 8 to 9 hours, due to predominantly renal elimination (45%). Toxins concentrate preferentially in the viscera, particularly the lungs, kidneys, and liver. [29]

Scorpion venom acts on three levels [32] :

1. Direct toxic action (causing a significant increase in the levels of transaminases, lactate dehydrogenase, alkaline phosphatase, and creatine kinase).
2. Action on the nervous system (massive release of neurotransmitters such as catecholamines, acetylcholine, glutamate, and GABA, prolonged depolarization of the membranes.).
3. Systemic inflammatory reaction (Mobilization and activation of inflammation cells, release of inflammation mediators, dysfunction of endothelial cells)

Systemic effects are the consequence of the release of acetylcholine and catecholamines and excessive inflammatory response.

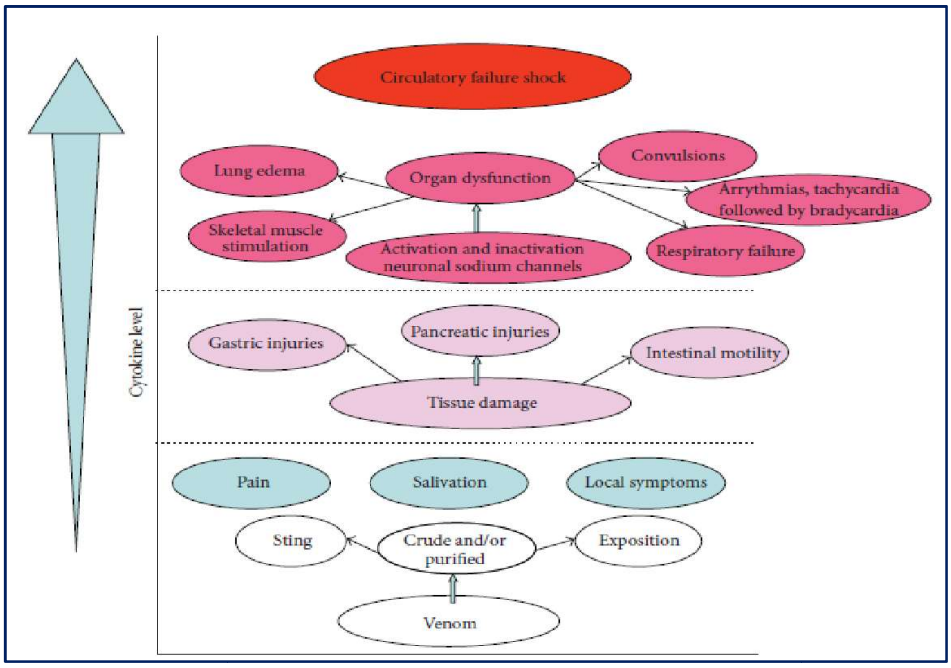


Figure 69 : Effect of scorpion envenoming on cytokine production [33]

6. Climatology and Study Area :

Similarly to what is reported in the literature [23], scorpion stings are recognized as a limited health issue in Morocco both in terms of time (between the months of May and November) and space (affecting the central-southern regions).

The major part of Morocco is characterized by a hot and dry climate, especially during the summer months. Scorpions are ectothermic creatures, which means they rely on external heat to regulate their body temperature. High temperatures make them more active and increase their ability to hunt and reproduce.

Morocco experiences a Mediterranean climate along its coastal areas, with mild, wet winters and hot, dry summers. The interior regions have more of a continental climate with greater temperature extremes. The Atlas Mountains play a significant role in influencing the climate patterns in the country.

7. Therapeutic management of a scorpion envenomation :

The identification of epidemiological indicators and the establishment of a rational approach based on scientific evidence have greatly contributed to the significant reduction in the number of deaths.

According to the recommendations of the CAPM [35], it is important to emphasize that patients classified as Class I should be carried out on an outpatient basis in any healthcare facility (clinic, health center, hospital...). While keeping in mind the vulnerability and high risk of adverse outcomes in the pediatric population. This management requires symptomatic treatment of local signs and monitoring until a post-sting time (PST) of 4 hours :

- Paracetamol:

  Child: 60 to 80 mg/kg/24h in 4 doses,

  Adult: 3g/24h in 3 doses

- Anesthetic cream containing lidocaine and prilocaine:

Apply a thick layer of cream to the site of the sting and cover with a bandage (delayed action time between 1 hour and 1 hour 30 minutes).

If unavailable, apply an ice pack locally.

The temperature, pulse, blood pressure, respiratory rate, and level of consciousness must be monitored continuously, at a minimum interval of every 30 minutes, until a post-sting time (PST) of 4 hours to rule out potential envenomation.

On the other hand, poisoned patients (Classes II and III), who exhibit at least one sign of severity or vital distress, should be stabilized and immediately transferred to an intensive care unit for further management. The treatment should be initiated regardless of the receiving healthcare facility.

Therapeutic management primarily relies on symptomatic treatment focused on the management of cardiovascular involvement and must adjust according to the patient's clinical condition.

Monitoring should focus on blood pressure, heart rate and rhythm, respiratory rate, level of consciousness, and temperature every 30 minutes until complete and sustained disappearance of general symptoms.

The treatment involves :

- Insertion of urinary and gastric catheters
- Careful vascular filling with saline solution at 9‰: Children: 5 ml/kg to be infused over 30 minutes under control of blood pressure, central venous pressure (CVP), or echocardiography.
- Infusion of basic ratio of 5% dextrose in saline solution with electrolytes
- Symptomatic treatment of local and general symptoms.

Treatment of neurological distress:

➢ In case of seizures:

Diazepam for children, administered intrarectally (0.5 mg/kg, not exceeding 10 mg per injection), orally (0.1 to 0.2 mg/kg), or intravenously (0.05 to 0.1 mg/kg).

➢ In case of agitation:

Midazolam via slow intravenous infusion, repeat if needed (Child: 0.1 to 0.3 mg/kg).

➢ In case of neuromuscular incoordination:

Bolus intravenous Midazolam at a dose of 0.05 to 0.1 mg/kg, followed by a continuous infusion of 0.1 mg/kg/h. Doses should be adjusted to maintain sedation with respiratory support.

Treatment of cardiac distress:

➢ In case of hypertension:

Generally, hypertension is infrequent and short-lived. It should be tolerated unless there's added visceral decompensation.

In cases of threatening hypertension (added visceral failure), administer an antihypertensive such as Nicardipine as an IV bolus of 1 to 2 mg, repeated every 5 to 10 minutes or continuously through a syringe pump at a rate of 1 to 4 mg/h.

➢ In case of shock state (hypotension, tachycardia):

Dobutamine: One 250 mg ampule diluted in 50 ml of 9‰ saline via a syringe pump for peripheral administration. Begin with an average dose of 7 µg/kg/min, increasing in increments of 2 µg every 15 minutes until clinical stabilization (shock sign disappearance), normalization of blood pressure, respiratory rate, and diuresis > 0.5 ml/kg/h. Do not exceed 20 µg/kg/min.

Reduction of Dobutamine should also be gradual, in increments of 2 µg/kg/min every 15 minutes, after a sustained hemodynamic stabilization (24 to 48 hours).

When the dose reaches 4 µg/kg/min, Dobutamine can be discontinued

Treatment of respiratory distress or coma:

➢ Artificial ventilation: Only be performed after the failure of non-invasive ventilation with high-concentration 100% oxygen, persistent SpO2 < 90%, and/or clinical signs of respiratory or neurological distress (Glasgow < 9/15).

➢ Sedation: Once the patient is on a ventilator, continuous sedation should be maintained through a syringe pump using Midazolam (Child: 0.025 to 0.05 mg/kg/h) and Fentanyl (1 to 2 µg/kg/h).

The use of anti-scorpion venom serum (ASVS) treatment remains controversial.

Serotherapy :

Studies conducted by the poison control center [34] have shown that the serotherapy used in the public health system is not only ineffective but also provides false security for the patient.

Patients receiving this treatment in healthcare centers are reassured and therefore not subjected to monitoring. Consequently, its use is not recommended, especially due to the inability to administer it promptly to a large population.

Paraclinical examinations:

They should in no way delay the therapeutic management of the patient. [35]

Biological assessment :

- Complete blood count
- Blood ionogram (Na+, K+, Ca++, proteins)
- Blood glucose (and/or Dextrostix)
- Renal assessment (blood urea, creatinine)
- CRP, CPK, Troponin, BNP, blood gas analysis

Radiological assessment :

- Chest X-ray (at the patient's bedside)
- ECG
- Echocardiogram, cardiothoracic CT scan

And if possible: cerebral CT scan, transcranial Doppler.

8. Prevention

The CAPM has developed a national strategy to combat scorpion stings and envenomations (PES) in order to reduce morbidity and mortality rates. [36]

Several prevention campaigns are organized to prevent scorpion stings and to enhance the management of victims who have been stung before arriving at a healthcare facility.

The monthly report, as an information system, is one of the main components of the strategy to fight against scorpion stings and envenomations, allowing the monitoring of various morbidity and mortality indicators related to this issue.

Prevention involves encouraging the population to raise predator poultry for scorpions, seal all gaps and holes in walls, smooth the walls, weed and maintain the surroundings of their homes to reduce scorpion access. They are advised to wear closed and high shoes and take precautions before touching stones, wood, etc.

II. Epidemiological data :

1. Frequency :

The annual number of scorpion stings exceeds 1.2 million worldwide, resulting in over 3250 deaths. [3] In Morocco, overall mortality due to scorpion envenomation is higher compared to international data. [37]

According to the observation of the study of Rebahi and all [38], the average annual recruitment was 96 severely envenomed children per year. In our study, an average of 123 patients per year were admitted for severe envenomation.

Table LXIV : Evolution of scorpion sting cases and envenomations in children under 15 years old, CAPM, 1999-2017. [39]

Year	Cases	Percentage of children <15 years
1999	1179	38,59
2000	3339	27,49
2001	15559	30,41
2002	17815	32,07
2003	23199	29,62
2004	24 917	29,91
2005	25 651	29,32
2006	31 483	27,65
2009	29 802	24,91
2010	28 371	25,31
2011	27 456	26,17
2012	24 942	28
2013	25 067	27,5
2014	24 033	26,87
2015	27 397	25,76
2016	25 675	24,75
2017	29 944	25,29

The number of scorpion sting cases shows some fluctuations over the years. Our data align with those of national studies to the extent that we observe a slight increase in the number of cases in 2017, whether during our study or at the national level.

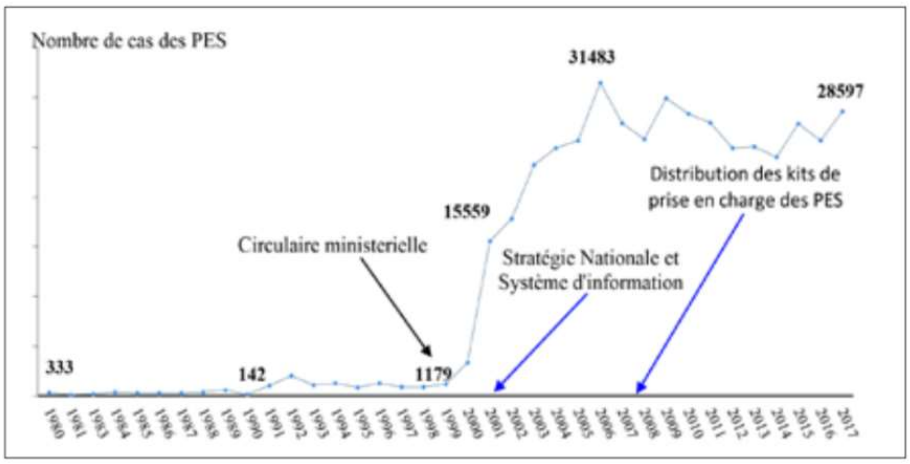


Figure 70 : Evolution of reported scorpion stings and envenomations over the years, CAPM, 1980-2017. [39]

2. Age :

The average age during our study was 6.11 years, ranging from 1 month and 3 weeks to 16 years. The mean age of individuals with a poor outcome was 4.32 years (±3.43), while for survivors without sequelae, it was 6.22 years (±4.01).

Research conducted by Krifi et al. (1998) [45] and Farsky et al. (1997) [46] has firmly established a correlation between young age and the severity of clinical symptoms after scorpion envenomation. This is what we also observe in our study.

The average ages in the different series of literature:

Table LXV: Comparison of the age according to the literature

	Data
Our series	6.11 years
Mohamad and all. [37]	5 years
Dehghankhalili and all. [40]	5.75 years ± 4.54
Tunç and all. [41]	7.64 years ± 4.04
Caglar and all. [42]	4 years
Rachid and all. [43]	5 years
Bosnak and all. [44]	7.7 2.8 years

It appears that scorpion envenomation can occur at any age, and the frequency among children could be attributed to their negligent behavior and adventurous and curious nature at this age group, partially explaining the obtained result.

Children are generally more vulnerable to scorpion stings due to several factors:

1. Children have smaller body sizes compared to adults, which means that the same amount of venom from a scorpion sting can have a relatively greater impact on them. Additionally, their immune systems are still immature and developing and may not respond as effectively to counteract the effects of scorpion venom.
2. Children often have a natural curiosity and may be less aware of potential dangers. They may unknowingly approach or provoke a scorpion, increasing the likelihood of getting stung. Their active and exploratory behavior can put them at a higher risk of encounters with scorpions.

3. Young children may not have sufficient knowledge or experience to identify and avoid scorpion habitats or recognize the signs of a potential threat. They may not understand the importance of taking precautions or seeking immediate medical help after a sting.
4. Children's bodies may respond differently to scorpion venom compared to adults. The venom can affect their developing organs and systems more severely, potentially leading to complications such as respiratory distress or cardiovascular problems.

3. Weight :

The mean weight was 20.7 kg, encompassing a range of values from 1 kg to 70 kg.

In our study, body weight does not appear to be a significant factor in determining the outcome of the envenomation.

Certain studies, notably the one conducted by Tunç and al. [41], have hypothesized a more severe condition if there is a low body weight, potentially due to the higher amount of toxins exposed per kilogram.

The work published by Dudin and al. [47] demonstrates that the severity of the symptoms and signs was not related to weight, which is consistent with our observations.

4. Gender :

A higher prevalence of males was observed, resulting in a male-to-female sex ratio of 1.31. There is no correlation between gender and scorpion type with the occurrence of poor outcome.

Table LXVI : Comparison of the gender according to the literature

	Female	Male
Our series	43.2%	56.8%
Mohamad and al. [37]	62.17%	37.87%
Dehghankhalili and al. [40]	40.5%	59.5%
Tunç and all.	56.9%	43.1%

Boys typically display higher levels of physical activity and risk-taking behaviors compared to girls, which can contribute to more impulsive and adventurous behaviors.

Boys tend to engage in more rough and active play, which can increase the chances of accidents and injuries. They may also be more prone to engaging in behaviors that involve climbing, jumping, and exploring their physical environment.

These generalizations may not apply to every individual or circumstance, as there can be significant variation within each gender.

5. Geographical origin :

In our study, a significant proportion of cases originated from rural environments. El Haouz province stands out as having the highest incidence of envenomation cases, followed by Chichaoua and Marrakech.

Rebahi and al.'s study confirms that 30% came of children in their study were from the Al Haouz region, followed by Chichaoua, Rehamna, Marrakech, El Kelaa and Essaouira (24%, 19%, 15%, 10% and 2% respectively). [38]

Table LXVII : Comparison of the distribution of origin according to the literature

Rural Origin	Percentage (in %)
Our series	71.6%
Tunç and al. [41]	65.3%
These Dr CHAJA, 2020	85%
Rebahi and al. [38]	74%

Scorpion stings mainly occur in rural areas since scorpions usually inhabit desert and arid environments. This poses a limit to early management in a resuscitation setting, thus worsening the prognosis.

A higher percentage of survivors without sequelae had a rural origin compared to those with a poor outcome. Our data align with those of national studies as well as international studies.

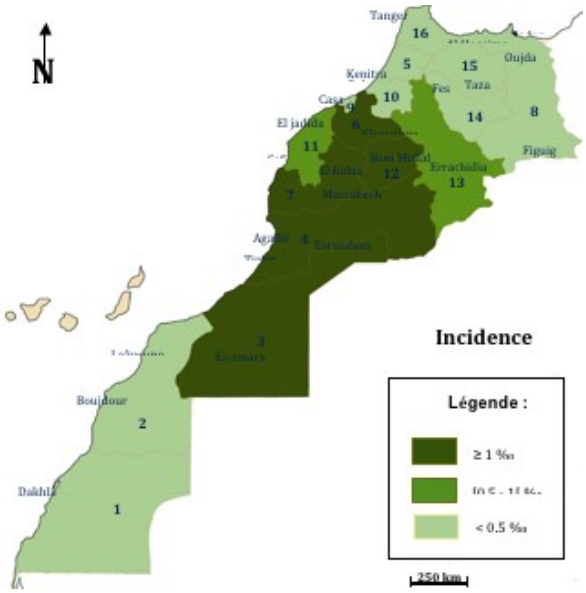


Figure 71 : Synthetic map of the Incidence by regions between 2001 and 2007 [4]

6. Sting site :

A vast majority of envenomations occurred following a solitary sting (97.3%). Lower and upper extremities exhibited a higher frequency of stings, whereas the trunk surface and gluteal region demonstrated the lowest occurrence rates.

There is a slight inclination towards stings occurring more frequently on the right side.

Thus, our findings align with the literature data. Stings are primarily located in the distal parts of the limbs. In our series, 81.50% of the stings were located at the extremities.

In Dr. ZITOUNI's series [51], 91.52% of the bites were located at the level of the extremities. The same goes for Dr. MELLOUK [48], where 90% of the cases showed bites at the level of the extremities. This is also the case in Dr. Rebahi and al, which indicates that stings were most frequently located in the extremities, with 54.8% occurring on the hands or feet.

The sting site does not seem to play a significant role in determining the outcomes of the envenomation

Scorpion stings generally occur accidentally (scorpion hidden in shoes or bags) or due to carelessness (lifting a stone, putting a hand in a crevice, during field plowing, walking barefoot). Indeed, scorpions have a fearful and non-aggressive nature and only sting when they feel threatened. [23]

7. Season/Month :

The majority of envenomations took place during the summer months and were recorded in July and August, which is consistent with the findings in medical literature [53], highlighting the need for health authorities to intensify their efforts during this summer period.

Compared with meteorological data, we notice a potential correlation between rising temperatures, reduced precipitation, and the incidence of scorpion stings. [54]

In fact, if we refer to the number of stings that led to envenomation in our study, it appears that the years correspond to those with the most extreme temperatures. Especially in 2017, where we observe a peak in temperature corresponding to a peak in envenomation.

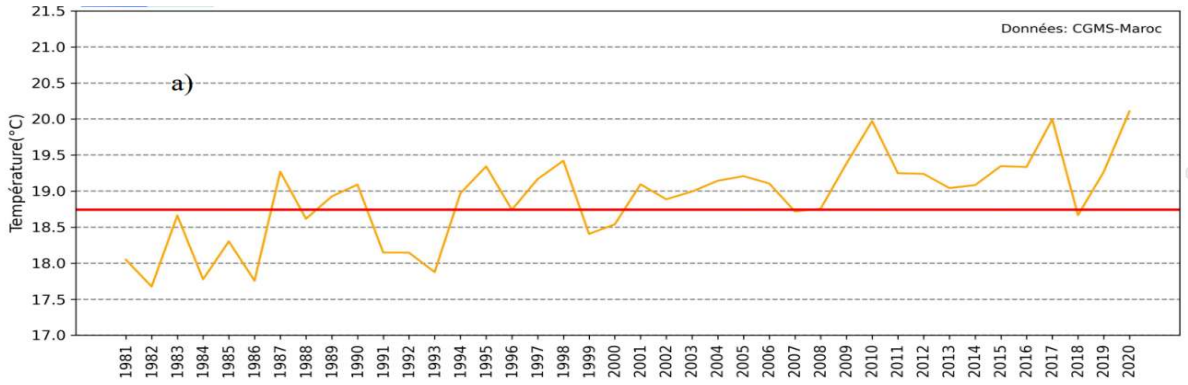


Figure 72: Annual average of the mean temperature at the national level. [55]

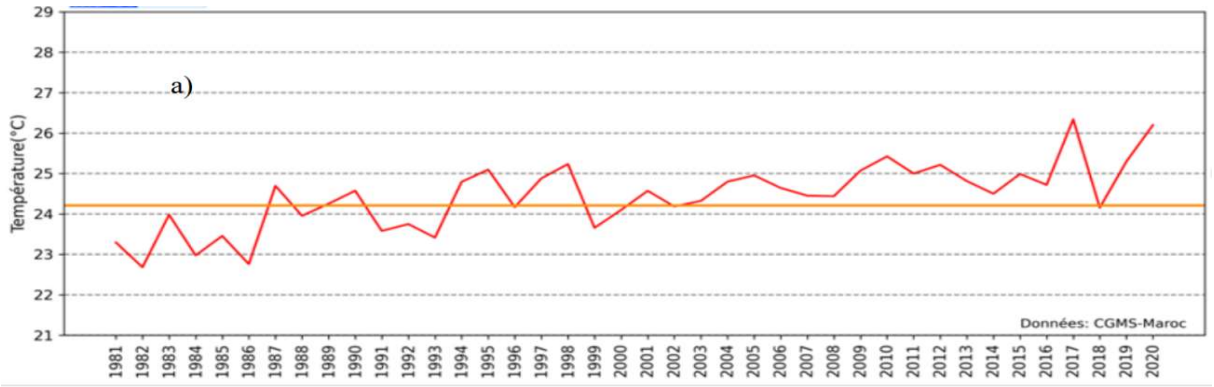


Figure 73: Annual average of the maximum temperature at the national level. [55]

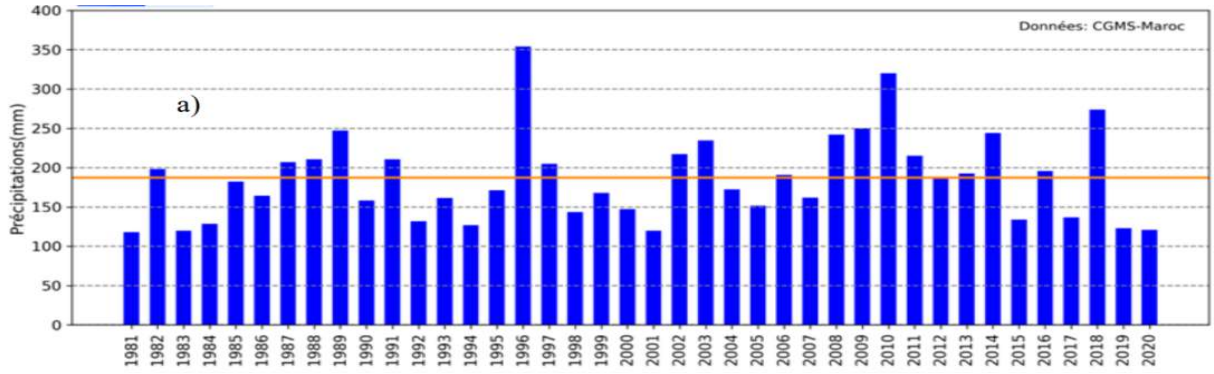


Figure 74 : Annual cumulative precipitation at the national level. [55]

8. Time of sting :

Entomological data reports that scorpions are species with nocturnal habits that awaken at dusk, with a peak of activity between 9 PM and midnight. [54] This corroborates our deductions, which show a nocturnal incidence peak between 6 PM and 6 AM.

Table LXVIII : Comparison of the time of sting time according to the literature

		Percentage of nocturnal time of sting
National Data	Our series	71.2%
	Rebahi and al.	78.4%
	Dr Chaja series	57.5%
	Dr Mellouk series	61%
	Dr Azziz series	76%
	Dr Zitouni series	66.5 %
International Data	Rachid and al.	75%
	Dehghankhalili and al.	53.7%

9. Post-sting time :

The mean post-sting time for deceased children is significantly higher than that of survivors, with a statistically significant difference ($p<0.001$).

The average time post-sting was 277 minutes, with a range from 10 minutes to 61 hours.

All authors agree that the Time to Presentation (TPP) is a decisive factor in patient management. [23]

Table LXIX : Comparison of the post-sting time according to the literature

Study	Total	Minimum	Maximum
Our series	277 min	10 min	61 hours
Rachid and all.	295 min	10 min	25 hours
Dr Chaja series	180 min	30 min	8 hours
Dr Azziz series	108.8 min	40 min	5 hours

The TPP corresponds to the interval between the time of the sting and the time of admission to the ICU, and it proves to be a prognostic element that reflects the patient's condition upon admission. It is important for patient monitoring, therapeutic decision-making, and ruling out potential envenomation.

Moreover, TPP1 and TPP2 are important indicators for assessing patient responsiveness and early medical management. A short TPP1 and a rapid TPP2 are generally desirable as they allow for prompt initiation of appropriate therapeutic measures and reduce potential complications associated with scorpion stings. [5]

The prolongation of the post-sting time can be explained by :

- The geographical distance of certain provinces that lack healthcare facilities
- Delays in transferring victims
- Insufficient awareness among parents regarding this danger, especially considering that initial symptoms motivating consultation may be absent.

Hence, there is a need to intensify efforts to minimize the post-sting time and raise awareness among medical and paramedical personnel about the importance of prompt management.

10. Causal agent :

The diagnosis of scorpion stings is rarely a problem as the scorpions are most often seen by the victim or his entourage.

However, the scorpion species remained unidentified in the majority of cases.

Indeed, the scorpion species is a parameter that could not be properly analyzed in our study due to a lack of usable data.

We must keep in mind that a black scorpion is not necessarily of the species Androctonus Mauritanicus.

11. Sting location :

The majority of stings predominantly occur within confined spaces, particularly within the household environment.

Our study proves that a child is about 4.53 times more likely to get stung at home than outdoors. This prevalence of scorpion stings occurring at home has also been reported in other studies. [49,50,52,56]

Table LXX : Comparison of the sting location according to the literature

Study	Percentage of sting occurred at home/ indoor environment
Our series	81.9%
Dr Azziz series	67%
Dr Chaja series	57.5%

It's likely due to the nocturnal frequency and the domestic nature of scorpions, which prefer to live in habitats in search of moisture. [54]

III. Management :

1. Preadmission management :

The majority of patients initially sought consultation at a level 2 primary healthcare facility.

Among the patients admitted, the majority (40.0%) were transferred without proper regulation, while only 23.0% were appropriately referred and regulated from a regional training facility, 23.0% of children were referred by other healthcare facilities.

In our study, the regulation of their transfer is not determining factors for death.

Our series showed that 55.9% of children received Dobutamine before their admission to the Intensive Care Unit (ICU). The early administration of Dobutamine in our study is comparable to the observations made by Rachid and colleagues, which reported 47%.

None of the envenomed children has been given antivenom.

In our study, most of the patients were referred to us without their optimal condition being ensured. As a result, we observed several anomalies, including:

- Non-functional vascular access (displaced or bent due to patient agitation, or even detached due to excessive sweating).
- Blocked or torn infusion sets.
- Inconsistent and discontinuous administration of Dobutamine.

In the face of a sting, we should avoid any manipulation or application of products, and the child should be transported as quickly as possible to a healthcare facility. [35]

Particular attention should be given to this stage of patient management, as it remains crucial for improving patient prognosis.

Furthermore, we noted that patient triage is inadequate. Parents often bring their children directly to the university hospital without following the hierarchical structure of healthcare facilities.

Ideally, regional hospitals should coordinate with the triage center, which obtains approval from the pediatric intensive care unit and authorizes the transfer of patients who have been appropriately stabilized. [35]

A national strategy to combat this scourge was established in 1999 and updated in 2013, with the main objective of reducing the morbidity and mortality caused by this scourge. [6]

In some regions, particularly rural or underserved areas, limited access to healthcare facilities and trained medical professionals can hinder timely and appropriate treatment for scorpion envenomation. This lack of access can increase the risk of complications and mortality.

2. Length of stay :

The duration of hospitalization ranged from 1 hour to 1134 hours (47,25 days), with a median of 27 hours and 30 minutes. This is consistent with the literature data.

Table LXXI : Comparison of length of stay according to the literature

	Study	Lengh of stay (in hours)
National Data	Our series	27 hours and 30 min
	Achour (El Kelâa) [57]	33 hours and 36 min
	El fattach (Fès) [58]	55 hours and 12 min
	Nekkal (El Kelâa) [59]	31 hours
	Dr Azziz (Tiznit) [50]	24 hours
	Dr Zitouni (El Kelâa) [51]	48 hours
International Data	Bahloul (Tunisia) [60]	69 hours and 36 min
	Ganesh (India) [61]	48 hours
	Çağlar (Turkey) [42]	48 hours
	Rachid and al.	48 hours

Once the 24-hour mark has been surpassed, the risk of decompensation is generally no longer present, and the vital prognosis is no longer at stake. The same observation has already been reported by other studies. [58,62]

IV. Clinical data :

The scorpion sting resulted in a large spectrum of symptoms and signs.

1. Local signs :

The local signs most commonly encountered are listed in order of frequency : sting puncture (75.2%) , pain/swarm (32.8%), local redness (25.5%), local swelling (24.8%).

The Tunisian study by Bouaziz et al. indicates that no local inflammatory signs were observed in any patients. However, it should be noted that unlike the scorpions present in Morocco, Tunisian scorpions do not cause local signs. [52

Our results align with Dehghankhalili and al. [40]'s observations where it mentions that the most common local signs among the patients were pain (37.3%), erythema (34.2%), edema (33.9%), and cyanosis (16.8%).

These signs are typically localized to the area where the scorpion stung the individual. Here are some common local signs typically reported in the literature [60]:

1. Pain: Pain is a common local sign of scorpion envenomation. The severity of pain can vary depending on the species of scorpion and individual sensitivity.
2. Redness and Swelling: The area around the sting site may become red and swollen. This localized inflammation is a typical response to the venom.
3. Localized Numbness or Tingling: Some individuals may experience numbness or tingling at the site of the sting. This sensation may be caused by the action of the venom on nerve endings.
4. Warmth or Heat: The sting site can feel warm or hot to the touch. This localized increase in temperature is often a result of the inflammatory response.
5. Itching or Pruritus: Itching or a sensation of skin irritation may occur at the sting site.

Local signs begin to diminish after one hour and then fade away within a period of a few hours to 24 hours. [48]

2. Vital parameters :

In our study, the most frequently observed vital parameter disorders are: tachycardia (37.11%), tachypnea (21.1%), hypertension (43.26%), hypothermia (14.3%).

According to Dehghankhalili et al. study [40] tachypnea was usual among patients with a rate of 87.0%. Although tachycardia was a common symptom 58.9%, bradycardia was rare (1.2%). Most of the victims had normal blood pressure. Hypotension was also seen in some of the patients, but hypertension was approximately rare. Fever was seen in a few patients (3.9%). Temperature was mostly normal. These are the same observations that we describe in our study.

The patients in our study have an average body temperature of 37.8 ± 1.1 C ranging from 35 C to 42 C. In the study of Bouaziz and al. where the body temperature was measured for 1197 patients, it was on average 37.0 Celsius ranged from 32.8 to 42.2 Celsius. [52]

3. General signs :

In our study, the frequently reported clinical signs were: vomiting (85.85%), excessive sweating (84.96%), priapism (34.77%), tachycardia (31.84%), and abdominal pain (31.46%).

According to Dehghankhalili and al. [40] the most common presenting symptom was vomiting in 67.4%. This is also the case for Rachid and al. [43] where vomiting was present for 83% of the case. As well as the Bahloul et al. [60] study reported that gastro-intestinal manifestations, dominated by vomiting, were present in 72% of the patient.These statements align with the result of our study

On the contrary, for the study of Caglar and al. [42] the most common systemic finding was cold extremities (41.5%). Along the same lines, Bosnak and al. [44] cold extremities and tachycardia were the most frequently seen clinical findings (38.4% for both).

In the study of Rebahi and all. [38] bivariate analysis indicated that hyperthermia, episodes of diarrhea, tachycardia [...] signs of respiratory distress were significantly correlated with mortality. On multivariate analysis, diarrhea, respiratory distress, and GCS 3-9 were found to be independent risk factors for mortality in our patient population.

This is not entirely consistent with our study, where only diarrhea is a significant prognostic factor for a poor outcome.

Priapism is a very important sign to look for in boys and has significant diagnostic value. [23]

Table LXXII : Comparative analysis of priapism presence according to the literature.

	Priapism
Our series	34,23%
Rachid and all. [43]	72%
Mohamad and all [37]	50.7%
Bosnak and all. [44]	25.7%

* Note that the ratio was calculated on the total number of males only (excluding the female population).

General signs refer to the systemic or whole-body effects that occur as a result of the scorpion's venom spreading throughout the body. These signs involve various organ systems and can vary in severity depending on factors such as the species of scorpion and the amount of venom injected. Here are some common general signs described in the literature [36] :

1. Cardiovascular Symptoms: Scorpion venom can affect the cardiovascular system, leading to symptoms such as an irregular or rapid heartbeat (tachycardia), high or low blood pressure, and changes in heart rhythm.
2. Respiratory Symptoms: Some scorpion venoms can affect the respiratory system, causing symptoms such as difficulty breathing, shortness of breath, wheezing, or respiratory distress.
3. Neurological Symptoms: Scorpion venom can impact the nervous system, leading to neurological signs such as muscle twitching, jerking movements, restlessness, agitation, confusion, and even seizures.
4. Gastrointestinal Symptoms: Scorpion envenomation may result in gastrointestinal symptoms such as abdominal pain, nausea, vomiting, and diarrhea.
5. Sweating and Salivation: Increased sweating and excessive salivation (drooling) are common general signs observed in scorpion envenomation.
6. Systemic Inflammation: Scorpion venom can trigger a systemic inflammatory response, leading to symptoms such as fever, generalized swelling, and malaise.

4. Severity class :

The hierarchy of the patient's clinical condition guides the therapeutic approach and holds significant prognostic value. It is based on a well-conducted medical history and a thorough and precise clinical examination.

Table LXXIII : Distribution of envenomation grades upon admission according to the literature

		Grade II at admission	Grade III at admission
National Data	Our series	41.9%	57.4%
	Dr Chaja (Marrakech) [49]	65%	35%
	Dr Azziz (Tiznit) [50]	47%	12%
	Dr Zitouni (El Kelâa) [51]	54%	9%
International Data	Caglar and all. [42]	ND	34.1%
	Mohamad and all. [37]	10.8%	53.2%
	Bosnak and all. [44]	61.5%	38.5%
	Rachid and all. [43]	ND	39%

Table LXXIV : Type of vital distress observed upon admission according to the literature.

	Cardiovascular	Respiratory	Neurologic
Our series	56.8%	9.15%	8.8%
Mohamad and all. [37]	46.8%	33.3%	22.8%
Rachid and all. [43]	25%	27%	21%

4.1. Cardiac :

In our study, the most frequently found cardiovascular signs are coldness of extremities (63.88%), followed by prolonged capillary refill time at 10.7%. Mottling was observed in only 3.3% of the cases.

In the Bosnak series, predominant signs involving the cardiovascular system were tachycardia (36.5%), dyspnea (23.0%), and paleness (15.3%).

Hypertension (7.6%) and hypotension (3.8%) were rare on admission to our hospital. On the other hand, there were also manifestations of cholinergic stimulation, including excessive sweating (32.6%) and vomiting (3.8%).

The cardiovascular response following envenomation occurs in two phases: an initial peripheral vascular phase characterized by the massive release of catecholamines and other vasoconstrictive peptides, followed by a second phase involving structural and morphological changes that impair myocardial performance. [66]

Simultaneously, left ventricular filling pressures begin to rise, favoring the development of pulmonary edema, which is characteristic of severe forms of scorpion envenomation. Often, scorpion envenomation stops at this stage and does not progress to cardiogenic shock. In some cases, a cardiogenic phase gradually develops, marked by the occurrence of cardiogenic shock. This is related to a myocardial pathology whose nature is still debated.

The transient increase in systemic arterial pressure is often not captured in the patient's medical history as it is ephemeral and occurs early after the sting, well before the patient's initial consultation. [68]

Several clinical studies have documented an early and massive elevation in circulating catecholamine levels, attributing it to most of the characteristic hemodynamic disturbances in severe cases of scorpion envenomation. [33]

Scorpion-induced cardiomyopathy has three characteristics that make it unique [67] :

- Severity
- Biventricular involvement
- Reversibility.

4.2. Respiratory :

The venom, through its action on the central nervous system and/or on the cardiovascular system, leads to respiratory failure. [69]

Boşnak et al. found that 9.6% of the cases had pulmonary edema [44], while 36.45% are recorded in our study. For Bouaziz and al. Five hundred eighty-five patients (61.5%) had a pulmonary edema, while 195 patients (20.5%) had a cardiogenic shock. [52]

The pathogenesis of pulmonary edema during scorpion envenomation is complex, involving systemic hypertension and left ventricular dysfunction. Recent studies have documented the hemodynamic nature of the latter during scorpion envenomation, highlighting the elevation of left ventricular filling pressures. [69]

4.3. Neurological :

Our study counted 141 patients who presented neurologic distress at the initial assessment (8.8%). Among the cases, altered levels of consciousness were the most prevalent, followed by stupor, seizures and coma was noted in 16 cases.

Strabismus was observed in 15 cases.

Scorpion venoms contain excitatory neurotoxins that affect nerve signal transmission. These toxins target ion channels in neurons, leading to an excessive influx of ions such as sodium or calcium. This results in depolarization of nerve cells, causing sustained and repetitive firing of action potentials. The excessive neuronal activity can lead to hyperexcitability, muscle spasms, seizures, and other neurological symptoms. [70]

Scorpion venom may inhibit the release of inhibitory neurotransmitters such as gamma-aminobutyric acid (GABA), which normally dampens neuronal activity. By reducing the inhibitory control, the venom can promote neuronal excitability and contribute to neurological symptoms. [71]

Scorpion venom can disrupt the autonomic nervous system, which regulates involuntary bodily functions. It may cause excessive sympathetic (fight-or-flight) or parasympathetic (rest-and-digest) activity, leading to imbalances in heart rate, blood pressure, sweating, and other autonomic responses.

This dysregulation can contribute to cardiovascular instability and other neurological manifestations. [70]

Some scorpion venoms have direct toxic effects on nerve cells. The venom components can damage neuronal membranes, impair ion channel function, or interfere with intracellular signaling pathways. This direct neurotoxicity can lead to neuronal dysfunction, loss of synaptic connections, and cellular damage in the central nervous system. [70]

Some studies have shown that scorpion envenomation can trigger an inflammatory response in the nervous system. The venom-induced release of pro-inflammatory molecules and immune cell activation can contribute to tissue damage, edema (swelling), and the recruitment of additional immune cells. This inflammatory cascade can exacerbate neurological symptoms and contribute to tissue injury. [72]

5. Digestive Disorders:

At the gastric level, the venom induces a significant release of histamine and acetylcholine, resulting in increased acidity and pepsin secretion. Scorpion envenomation can indeed lead to various digestive disorders due to the effects of venom on the gastrointestinal system. [73]

- Scorpion venom can cause severe abdominal pain as a direct effect or secondary to systemic disturbances. The pain may be localized to the sting site or spread throughout the abdomen.

- Envenomation by certain scorpion species can induce nausea and vomiting. This can be a result of the direct action of venom on the gastrointestinal tract or as a response to systemic effects.
- Some individuals may experience diarrhea after scorpion envenomation. The venom can disrupt normal bowel function, leading to increased motility and loose stools. Diarrhea can contribute to dehydration if not managed properly.
- Scorpion venom can stimulate excessive salivation in some cases. This excessive production of saliva can result in drooling.
- In severe cases, scorpion envenomation can lead to gastrointestinal bleeding. This can occur due to the disruption of blood clotting mechanisms or direct damage to blood vessels in the digestive system.

V. Biological disturbances :

In our study leukocyte, thrombocyte values and glucose levels were markedly increased in the poor outcome group. Indeed, the analysis reveals significant differences in leukocyte count, platelet count, and urea levels between survivors without sequelae and those with a poor outcome.

The biological disturbances usually observed during scorpion envenomation are represented by leukocytosis, hyperglycemia, hyperuricemia, and non-specific electrolyte imbalances. From a hydroelectrolytic perspective, we typically encounter hyponatremia, hypocalcemia, hypokalemia accompanying severe scorpion envenomation.

Table LXV : Biological disturbances compared to the literature data.

	Our series	Rachid and al.	Bouaziz and al.
Leukocytosis	63.8%	ND	80%
Thrombocytosis	36.5%	27%	ND
Hyperglycemia	15.86%	31%	39%
Uremia	10.1%	20%	10.7%
Hypocalcemia	11.5%	19%	ND
Hypokalemia	16.1%	42%	11.4%
Hyponatremia	3.7%	13%	ND

Hemoglobin, white blood cell count, aspartate aminotransferase, alanine aminotransferase, and creatine phosphokinase levels were higher in severely envenomed children compared to levels in those with mild-moderate stings. [33,45,77]

Table LXVI : Biological disturbances compared to the literature data.

	Our series	Gokay and all	Bosnak and all	Bouaziz and all
WBC	17.3 ± 8.08	14.34 ± 8.3	11.9 ± 4.8	17.4 ± 7.8
Hb, g/dL	12.8 ± 1.86	12.31 ± 1.34	12.5 ± 1.2	12.8 2.10
Htc (%)	37.4 ± 4.91	36.46 ± 3.78	37 ± 3.4	ND
Platelet (103/mL)	384 ± 163	353.11 ± 131	326.2 ± 88.4	ND
Glucose (mg/dL)	147 ± 78	ND	122 ± 52	205 ± 102
Troponin I, ng/mL	97.27	0.15 ± 1.00	ND	ND
Urea mg/dL	58 ± 21	11.99 ± 4.35	28.4 ± 8.6	43 ± 19
Creatinine,mg/dL	0.432	0.44 ± 0.17	0.4 ± 0.1	0.97
ALT (IU/L)	28,5	ND	21.1 ± 6.5	38 ± 38.6
AST (IU/L)	59,9	ND	35 ± 11	73.6 ± 102.7
CPK (IU/L)	324	ND	321 ± 247	597 ± 1006
Na (mEq/L)	142 ± 8.75	ND	136.7 ± 3.7	140.49 ± 5.8
Cl (mEq/L)	105 ± 5.66	ND	104 ± 3.9	ND
K (mEq/L)	579 ± 3.16	ND	4.2 ± 0.5	4.15 ± 0.65
Ca (mEq/L)	5.0	ND	9.8 ± 0.6	ND

Blood Gas Analysis :

Similarly to our study, The Bouaziz and al. study describe metabolic acidosis as a frequent event. Experimental studies conducted on animals (rats and pigs) demonstrated that the scorpion toxin led to a consistent decrease in blood pH over time. [78]

Peaks of hypercapnia and hypoxemia were observed at the 30-minute mark, followed by a return to normal values by the 60-minute mark. Remarkably, there was a significant reduction in blood bicarbonate levels at 60 minutes, and negative base-excess values increased progressively over time, becoming particularly evident at the 60-minute mark. [78]

Table LXVII : Blood gas analysis compared to the literature data

	Our series	Bouaziz and al.
pH	7.34 ± 0.143	7.34 ± 0.10
PaO2 (mmHg)	88,40 ± 55.07	135 ± 80
PCO2 (mmHg)	22,12 ± 5.15	35 ± 9
HCO3 (mmol/l)	20,16 ± 4.70	18.8 ± 5.2

Troponin :

When it was conducted, the troponin level was elevated in 48.9% of the cases.

Some studies have focused on the diagnostic significance of cardiac biomarkers in scorpion stings. While elevated levels of troponin serve as a diagnostic criterion for myocarditis, it doesn't always signify myocardial dysfunction. Several studies have examined the sensitivity of troponin levels in predicting cardiac dysfunction using echocardiography as a reference. [67]

While some suggest excellent sensitivity and specificity of troponin in detecting cardiac dysfunction in cases of scorpion envenomation. Generally, the presence of myocardial dysfunction and the severity of envenomation are well correlated with troponin levels, making it a valuable screening tool. It seems that troponin also has a better diagnostic value than clinical examination or ECG alone in identifying patients at risk of cardiac distress. [75]

VI. Paraclinical anomalies:

1. EKG :

The EKG performed on 146 patients revealed anomalies in 15.75% of the case. The most frequent ECG patterns after sinus tachycardia were ventricular extrasystole, complete arrhythmia due to atrial fibrillation and atrial flutter.

Studies reported abnormal EKG findings in cases without cardiac dysfunction, this suggests either the venom itself or its subsequent substance release or autonomic excitation can affect cardiac electrical conduction even in the absence of clinically-evident myocarditis. As the result of conduction disturbances, life-threatening arrhythmias such as right or left bundle branch block atrioventricular can occur and cause deaths. [67]

EKG in isolation seems to be neither a sensitive nor specific tool to diagnose scorpion-related myocarditis. However, it is still a valuable tool to detect life-threatening arrhythmias and can help the diagnosis of myocarditis when combined with other diagnostic criteria. [66]

2. Transthoracic echocardiogram :

Echocardiographic findings are among the diagnostic criteria of clinical myocarditis, and as expected, typical changes are present in the reported literature, most notably hypokinesia and reduced ejection fraction and abnormal ITV. [75]

Certains studies have documented normal echocardiography despite the presence of clinical manifestations of heart failure. This provides support for the hypothesis that pulmonary edema, which is usually regarded as a classic sign of congestive heart failure, may sometimes be of non-cardiac origin in scorpion envenomation. [67]

Moreover, we also found echocardiographic changes in the absence of clinical evidence of myocarditis. This illustrates that scorpion myocarditis can sometimes be subclinical. It appears in Fereidooni and all. findings that out of 50 patients with normal echocardiography performed within 3 hours of hospital admission, none had developed any abnormality in repeat echocardiography upon follow-up. [66]

This underscores echocardiography as an excellent diagnostic and prognostic tool.

VII. Evolution :

We observed good evolution in the majority of cases, 78 children died during their hospitalization, and 8 survived with comorbidities.

Despite the severity of the clinical presentation, the overall prognosis is generally favorable with improvement in neurological function, regression of general and digestive symptoms, as well as stabilization of hemodynamic and respiratory status.

Table LXVIII : Patient evolution compared to the literature data.

		Survival without sequelae	Poor outcome
National Data	Our series	94.60%	5.40%
	Dr Zitouni (El Kelaa)	97.5%	2.6%
	Dr Chaja (Marrakech)	95%	5%
	Dr Azziz (Tiznit)	98.89%	1.11%.
International Data	Bouaziz and all. (Tunisia)	92.5%	7.5%
	Mohamad and all. (Egypt)	55.8%	44.2%
	Ismail Lotfy (Egypt)	82.89%	17.11%
	Bahloul (Tunisia)	91.1%	8.9%
	Uluğ (Turkey)	99%	1%

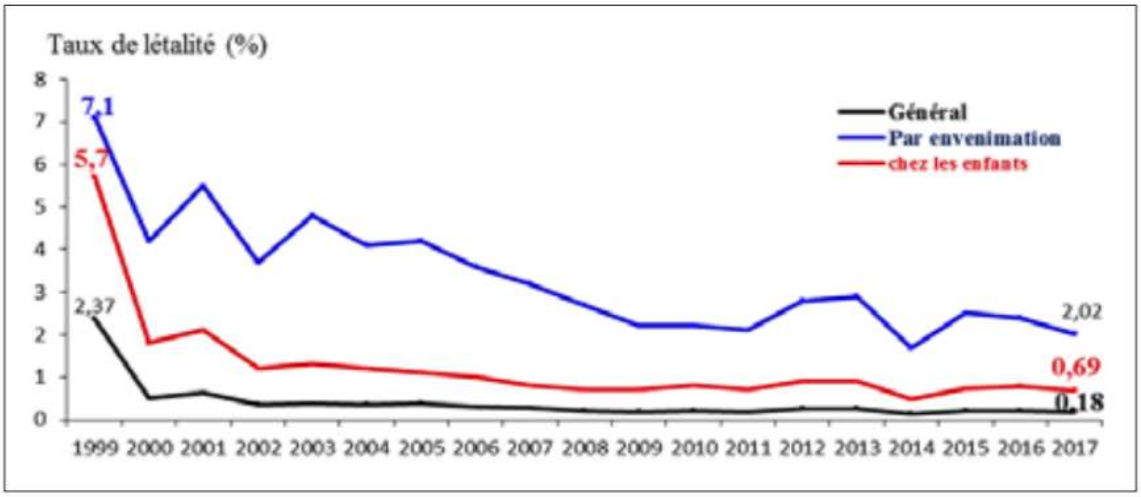


Figure 75 : Evolution of overall and specific fatality rates due to scorpion stings and envenomations between 1999 and 2017. [31]

VIII. Mortality rate:

1. Causes of morbimortality :

In our study, mortality was primarily attributed to cardio-circulatory failure, which aligns with the literature findings. Indeed, cardiogenic shock and pulmonary edema are the leading causes of death after scorpion envenomation. [69]

Cardiovascular Collapse:

Some scorpion venoms contain potent neurotoxins that can affect the cardiovascular system. These toxins can lead to disturbances in heart rhythm, increased heart rate (tachycardia), and fluctuations in blood pressure. Severe cardiovascular effects can result in cardiac arrhythmias, cardiac arrest, or cardiovascular collapse, leading to death. [63]

- **Respiratory Failure:**

Certain scorpion venoms can cause respiratory distress and impair lung function. The venom-induced inflammation, pulmonary edema (fluid accumulation in the lungs), or respiratory muscle paralysis can compromise oxygen exchange and lead to respiratory failure. Inability to maintain adequate breathing and oxygenation can be fatal if not promptly treated. [33]

- **Neurological Complications:**

Scorpion venoms often target the nervous system, affecting nerve signal transmission. Severe neurological complications such as seizures, brain damage, or cerebral edema (swelling of the brain) can occur in some cases. These complications can have life-threatening consequences. [76]

- **Systemic Organ Failure:**

In severe cases, scorpion envenomation can lead to multi-organ dysfunction. The venom's toxic effects on various organ systems, such as the liver, kidneys, or gastrointestinal tract, can result in organ failure. The failure of vital organs can ultimately lead to death. [33]

2. Multivariate analysis:

Our multivariate analysis found the following factors to be correlated with a poor outcome:

- Age less than 6 years (OR = 2.804).
- Rural origin (OR = 3.65)
- Delayed time to admission (OR = 1.02)
- Early Administration of dobutamine (OR = 0.625)
- Class III envenomation at admission (OR = 4.14).
- Acute Pulmonary edema (OR = 5.00).
- Tachypnea (OR = 1.57)
- Pulse Oxygen Saturation / Hypoxemia (OR = 3.39)
- Priapism (OR = 2.25)
- Diarrhea (OR = 1.42).
- Cardiovascular distress (OR = 6.17).
- Neurological distress (OR = 4.92).
- Respiratory distress (OR = 1.07).
- Leukocytosis (OR = 2.31).
- Thrombocytosis (OR = 1.25).
- Uremia (OR = 9.47).
- Elevated Alanine Aminotransferase (OR = 3.94)
- Elevated Aspartate Aminotransferase (OR = 1.67)

- Hyperglycemia (OR = 1.75).
- Elevated Troponin (OR = 9.02).
- Metabolic Acidosis (OR = 7.00).
- ECG rhythm disturbance (OR = 1.60)
- Abnormal Time-velocity integral (OR = 2.35)
- Placement of a central arterial line (OR = 3.89)
- Administration of dobutamine for more than 24h (OR = 1.37)

Conclusion

Scorpionism in Morocco, with its high mortality rate for children under 15, exhibits a significant cardiac tropism, making prevention strategies and early management crucial factors that greatly influence the prognosis.

Our study highlights the significant public health concern posed by scorpion stings in North Africa, particularly in Morocco. The high incidence and mortality rates, especially among children under 15 years old, underscore the urgency of addressing this issue.

The study identified several risk factors associated with poor outcomes, including age less than 6 years, rural origin, Class III envenomation at admission, the presence of acute pulmonary edema, hypoxemia, priapism, the presence of vital distress upon admission, leukocytosis, uremia, elevated Alanine Aminotransferase, elevated troponin levels, metabolic acidosis, abnormal Time-velocity integral, and the placement of a central arterial line.

Other factors with a minimal impact on the outcome have been highlighted, including delayed admission time, tachypnea, diarrhea, thrombocytosis, hyperglycemia, Elevated Aspartate Aminotransferase, ECG rhythm disturbance, and the administration of dobutamine for more than 24h.

Early administration of dobutamine is a factor associated with a reduced risk of poor clinical outcomes.

To mitigate the health impact of scorpion stings, it is essential to raise awareness, implement preventive measures (such as ensuring proper housing construction to reduce scorpion entry) and improve access to healthcare services.

Annex

ANNEX 1 : Fiche d'exploitation - Envenimations scorpioniques [Version française]

IP : ……

A- Dermographie :

Date de naissance (J/M/A): …/…/… Sexe : □ F □ M Poids (Kg) : ……

Localité/ Région: …….. □ Urbain □ Rural

Province: □ Marrakech □ Chichaoua □ Al Haouz □ El Kelâa De Sraghna □ Essaouira

□ Rehamna □ Safi □ Youssoufia □ Autre (à préciser) : ……

Régulation :

□ Transfert avec régulation □ Transfert sans régulation

□ Consultation d'emblée aux urgences du CHU

Si référé : □ Avec dobutamine □ Sans dobutamine

B- Antécédents :

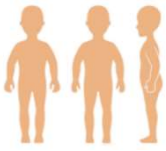
□ Cardiopathie □ Asthme □ Atopie □ Pneumopathie □ Neuropathie □ Envenimation scorpionique antérieure Si oui, Date : …/…/…… □ Cas similaire dans la famille/ fratrie

□ Autre (à préciser) : ……

C- Informations sur la piqûre de scorpion :

Nombre de piqûre : □ 1 □ 2 □ 3 □ 4 et plus

Siège : □ Membre supérieur □ Membre inférieur □ Tronc □ Tête et cou



Autre (à préciser) : …… Latéralité : □ Gauche □ Droit

Date et heure de la piqûre : …/…/…… à …H…

Temps post piqûre primaire en minutes (TPP1) : …….

Temps post piqûre secondaire en minutes (TPP2) : …….

Scorpion identifié □ Oui □ Non Si oui, coloration : □ Noir □ Jaune

Lieu où a eu lieu la piqûre: □ En intérieur □ En extérieur

D- Prise en charge avant l'admission en réanimation :

Traitement avant la première consultation :

□ Incision et scarification □ Succion □ Pose d'un garrot □ Recours aux moyens traditionnels □ Cryothérapie

Traitement lors de la première consultation en milieu médicalisé (centre de santé ou hôpital régional):

Oxygénothérapie : □ Lunettes □ Masque nasale à haute concentration □
Ventilation artificielle Si oui, □ VNI □ VM

Si VNI, interface : □ CPAP □ BiPAP

Abord vasculaire : Voie veineuse périphérique (VVP) □ Oui □ Non Si oui, nombre : □ 1 □ 2

Traitements médicamenteux:

□ Dobutamine Si cochée, en perfusion □ ou en Seringue Auto Pousseuse (SAP) □

□Corticothérapie □ Calcithérapie □ Antibiotiques □ Antiulcéreux □ SAT (Sérum Antitétanique)

□ Anesthésiques locaux □ Anti-émétiques □ Benzodiazépine □ Antipyrétique □ Insuline

□ Antihypertenseurs
Autre (à préciser): ……

E- A l'admission en réanimation pédiatrique :

A l'admission, la classe d'envenimation est : □ Classe I □ Classe II □ Classe III

Signes locaux : □ Douleur □ Fourmillement □ Engourdissement □ Rougeur □ Œdème
□ Traces cutanées de piqûre

Signes généraux : □ Fièvre □ Hypothermie □ Hypersudation □ Frissons □ Vomissements
□ Diarrhée □ Douleurs abdominales □ HTA □ Ballonnement abdominal
□ Hypersalivation □ Tachycardie □ Priapisme □ Agitation
□ Autres (à préciser) :…….

Détresse vitale : Cardiovasculaire (DVC) :

□ Bruit de galop □ Marbrures □ Froideur des extrémités
□ TRC>3 sec □ Hypotension □ Pouls filant

Détresse vitale : Respiratoire (DVR) :

□Râles crépitants □Tachypnée □Bradypnée □Cyanose
□Encombrement trachéobronchique □SDL □Arrêt respiratoire

Détresse vitale : Neurologique (DVN) :

□ Convulsions □ Irritabilité □ Obnubilation □ Désorientation temporo-spatiale
□Confusion □Nystagmus □ Strabisme □Troubles de vigilance □ Coma

Si indiqué, GCS :…/15

Signes vitaux :

TA: …../….. mmHg Température: …… °C FC: …… bpm FR: ……. cpm

SpO^2 à l'air ambiant :… % Glycémie : ……. g/L

Gazométrie :

Ph : ……. PCO2 : ……. PO2 : ……. HCO3- : ……

Lactates : …… Calcium ionisé : ……. Origine : ……..

Bilan biologique à l'admission :

	A l'admission
GB	……..10^3/ul
Hb	…….. g/dl
Ht	…….. %
Plq	……10^3/ul
Na+	
K+	
Cl	

Ca2+ Urée	*Valeur : …….. Hypocalcémie : □ Oui □ Non*
Créatinine Protidémie	
Albumine Troponines	*Valeur : …….. (soit ….. x la normale)*
BNP ASAT/ALAT	
CPK Lipase	
Amylase	

Bilan radiologique :

	Si fait, résultats :
Électrocardiogramme □ Fait □ Non fait **Radiographie Standard Thorax** □ Fait □ Non fait	Trouble du rythme ? □ Oui □ Non Trouble de repolarisation ? □ Oui □ Non Autre (à préciser) : …….. Signes d'OAP ? □ Oui □ Non -Cardiomégalie, syndrome alvéolaire, lignes de Kerley B, aspect en aile de papillon..
Echographie transthoracique □ Fait □ Non fait	Fraction d'éjection (FE): ….. Intégrale Temps Vitesse sous aortique (ITV) : ……

TDM cérébrale □ Fait □ Non fait	Ischémie cérébrale ? □ Oui □ Non Hémorragie ? □ Oui □ Non Oedème cérébrale ? □ Oui □ Non Autre (à préciser) : ……..
IRM cérébrale □ Fait □ Non fait	Ischémie cérébrale ? □ Oui □ Non Hémorragie ? □ Oui □ Non Oedème cérébrale ? □ Oui □ Non Autre (à préciser) : ……..

F- Prise en charge à l'admission en réanimation :

Oxygénothérapie : □ Oui □ Non

Si oui, □ Lunettes □ Masque nasale à haute concentration

□ Assistance ventilatoire non invasive :

Si cochée, □ Casque de Ventilation (Helmet) □ Total Face □ Masque naso-buccal

Si VNI, interface : □ CPAP □ BiPAP

□ Assistance ventilatoire invasive : □ Oui □ Non

Abord vasculaire :

Voie veineuse périphérique (VVP) □ Oui □ Non Si oui, nombre : □ 1 □ 2 Voie veineuse centrale (VVC) □ Oui □ Non

Cathéter central □ Oui □ Non

Sonde naso-gastrique : □ Oui □ Non

Sondage vésical : □ Oui □ Non Si sexe masculin, étui pénien □ Oui □ Non

Traitements médicamenteux :

□ Corticothérapie □ Calcithérapie □ Antibiotiques □ Antiulcéreux □ SAT □ Anesthésiques locaux □ Anti-émétiques □ Benzodiazépine □ Antipyrétique □ Insuline □ Diurétique □ Amiodarone □ Antihypertenseurs

Autre (à préciser): ……

	Date et heure d'administration	Dose Durée d'administration
Dobutamine en SAP		□ 7,5Ɣ/kg/min □ 10 Ɣ/kg/min □ 15 Ɣ/kg/min
Adrénaline		
Noradrénaline		
Milrinone		

G- Evolution :

☐ Survie ☐ Transfert en milieu de soin non intensif ☐ Décès

Durée totale du séjour en réanimation (en heure) : ……..

A - Favorable : ☐ Sortie avec retour à domicile

B - Complications précoces (en deça des 36 premières heures)

☐ *Passage d'un d'une envenimation classe II à classe III*

 Détresse cardiovasculaire : □ Choc cardiogénique □ Trouble du rythme grave

□ Choc distributif □ Arrêt cardiaque

 Détresse respiratoire : □ OAP □ Arrêt respiratoire □ Inhalation □ SDRA

 Détresse neurologique : □ État de mal épileptique □ Coma □ HTIC

☐ *Recours aux drogues :* □ Noradrénaline □ Adrénaline □ Milrinone

☐ *Recours à la ventilation mécanique invasive* □ Oui □ Non

Si oui en préciser la durée (heure): ……h

☐ *Recours à la sédation* □ Oui □ Non Si oui en préciser la durée (min): ……min

□ Midazolam □ Fentanyl □agents bloquants neuromusculaires

☐ *Recours à la cardioversion* □ Oui □ Non

C - Complications tardives (au delà des 36 premières heures)

Infections nosocomiales □ Oui □ Non

Si oui, préciser :

Date du prélèvement : …/…/… à …H…

Nature du prélèvement :

□ Pus □ ECBU □ Cathéters □ Hémocultures

□ Prélèvements respiratoires □ Liquide céphalo-rachidien □ Biopsie

□ liquide d'ascite □ Autre (à préciser) : ……

Site infectieux :

□ Pneumopathies □ Bactériémies □ Infections suppurées □ Infections urinaires □ Autres : ……..

Espèce bactérienne isolée : ……

Antibiogramme :

Défaillance multiviscérale

□ Défaillance hémodynamique □ Défaillance respiratoire □ Défaillance rénale □ Défaillance hépatique □ Défaillance hématologique □ Encéphalopathie Autre (à préciser) : ……..

D - Survie et comorbidités après survenue d'une complication

Trachéotomie : □ Oui □ Non

Séquelles neurologiques : □ Oui □ Non

Si oui, préciser si : □ Handicap modéré □ Handicap sévère □ État végétatif

ANNEX 2 : Operating Sheet - Scorpion Envenomation [English Version]

IP: .....

A- Demography:

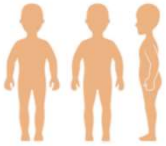
Date of Birth (D/M/Y): .../.../... Gender: □ F □ M Weight (Kg): .....
Location/Region: ..... □ Urban □ Rural
Province:
□ Marrakech □ Chichaoua □ Al Haouz □ El Kelâa De Sraghna □ Essaouira
□ Rehamna □ Safi □ Youssoufia □ Other (specify): .....
Regulation:
□ Transfer with regulation □ Transfer without regulation
□ Immediate consultation at the emergency department of the university hospital
If referred: □ With dobutamine □ Without dobutamine

B- Medical History:

□ Heart disease □ Asthma □ Atopy □ Lung disease □ Neuropathy
□ Previous scorpion envenomation If yes, Date: .../.../.....
□ Similar case in the family/siblings
□ Other (specify): .....

C- Information about the scorpion sting:

Number of stings: □ 1 □ 2 □ 3 □ 4 or more
Site: □ Upper limb □ Lower limb □ Trunk □ Head and neck
Other (specify): ..... Laterality: □ Left □ Right
Date and time of the sting: .../.../..... at ...H...
Primary post-sting time in minutes (TPP1): .....
Secondary post-sting time in minutes (TPP2): .....
Identified scorpion □ Yes □ No If yes, color: □ Black □ Yellow
Location of the sting: □ Indoors □ Outdoors



D- Management before admission to the intensive care unit

Treatment before the initial consultation:
□ Incision and scarification □ Suction □ Application of a tourniquet
□ Use of traditional methods □ Cryotherapy
Treatment during the initial consultation in a medical facility (health center or regional hospital):
Oxygen therapy: □ Nasal cannula □ High-concentration nasal mask
□ Artificial ventilation If yes, □ NIV □ MV
If NIV, interface: □ CPAP □ BiPAP
Vascular access: Peripheral venous line (PVL) □ Yes □ No

If yes, number: □ 1 □ 2

Medication treatments:
□ Dobutamine If checked, by infusion □ or Syringe Auto Pusher (SAP) □
□ Corticosteroids □ Calcium therapy □ Antibiotics □ Antiulcer drugs
□ SAT □ Local anesthetics □ Antiemetics □ Benzodiazepine
□ Antipyretics □ Insulin
□ Antihypertensives Other (specify): .....

E- Admission to the pediatric intensive care unit:

Upon admission, the envenomation class is: □ Class I □ Class II □ Class III
Local signs:
□ Pain □ Tingling □ Numbness □ Redness □ Swelling □ Skin marks from the sting

General signs: □ Fever □ Hypothermia □ Excessive sweating □ Chills □ Vomiting □ Diarrhea
□ Abdominal pain □ Hypertension □ Abdominal bloating □ Excessive salivation □ Tachycardia □ Priapism
□ Agitation □ Other (please specify):.....

Life-threatening distress: Cardiovascular (CVD):
□ Gallop sound □ Mottling □ Cold extremities □ CRT>3 sec □ Hypotension □ Thready pulse

Life-threatening distress: Respiratory (RVD):
□ Crackling rales □ Tachypnea □ Bradypnea □ Cyanosis
□ Tracheobronchial congestion □ SDL (Sudden Death-Like) □ Respiratory arrest

Life-threatening distress: Neurological (NV):

□ Convulsions □ Irritability □ Clouding of consciousness □ Temporo-spatial disorientation □ Confusion
□ Nystagmus □ Strabismus □ Altered level of consciousness □ Coma If checked, GCS: .../15

Vital signs:
BP: ...../..... mmHg Temperature: ..... °C HR: ..... bpm
RR: ..... breaths per minute SpO2: ...% at room air Glycemia: ..... g/L
Blood gas analysis:
pH: ..... PCO2: ..... PO2: ..... HCO3-: .....
Lactate: ..... Ionized calcium: ..... Origin: .....
Laboratory findings at admission:

	Upon admission
WBC	……..10^3/ul
Hemoglobin	…….. g/dl
Hematocrit	…….. %
Platelet count	……10^3/ul
Na+	
K+	
Cl	
Ca2+	*Value: ..... Hypocalcemia: □ Yes □ No*
Urea	
Creatinine	
Total Protein	

Albumin	
Troponins Value	*Value : …….. (….. x the normal range)*
BNP	
ASAT/ALAT	
CPK	
Lipase	
Amylase	

Radiological assessment:

	If done, results:
Electrocardiogram □ Done □ Not done **Chest X-ray** □ Done □ Not done	Arrhythmia? □ Yes □ No Repolarization disorder? □ Yes □ No Other (please specify): ..... Signs of pulmonary edema? □ Yes □ No -Cardiomegaly, alveolar syndrome, Kerley B lines, butterfly-wing appearance.
Transthoracic echocardiogram □ Done □ Not done	Ejection fraction (EF): ..... Time-velocity integral (TVI): .....

Brain CT scan □ Done □ Not done	Cerebral ischemia? □ Yes □ No Hemorrhage? □ Yes □ No Cerebral edema? □ Yes □ No Other (please specify): .....
Brain MRI □ Done □ Not done	Cerebral ischemia? □ Yes □ No Hemorrhage? □ Yes □ No Cerebral edema? □ Yes □ No Other (please specify): .....

F- Initial management in the intensive care unit

Oxygen therapy: □ Yes □ No
If yes, □ Nasal Cannula □ High-flow Nasal Cannula Mask
□ Non-invasive Ventilatory Support:
If checked, □ Ventilation Helmet □ Total Face Mask □ Naso-buccal Mask
If NIV, interface: □ CPAP □ BiPAP □ Invasive Ventilatory Support: □ Yes □ No
Vascular Access:
Peripheral Venous Line (PVL) □ Yes □ No
If yes, number: □ 1 □ 2
Central Venous Line (CVL) □ Yes □ No
Central Catheter □ Yes □ No
Naso-gastric Tube: □ Yes □ No
Urinary Catheterization: □ Yes □ No If male, penile sheath □ Yes □ No
Medications:
□ Corticosteroids □ Calcium Therapy □ Antibiotics □ Antiulcer drugs □ Oxygen Therapy □ Local Anesthetics □ Antiemetics □ Benzodiazepines □ Antipyretics □ Insulin □ Diuretics □ Amiodarone □ Antihypertensives
Other (please specify): ……

	Date and time of administration	Dose Administration Duration
Dobutamine in SAP		□ 7,5Ɣ/kg/min □ 10 Ɣ/kg/min □ 15 Ɣ/kg/min
Adrenaline		
Noradrenaline		
Milrinone		

G- Evolution :

☐Survival ☐Transfer to non-intensive care setting ☐Death
Total duration of stay in the ICU (in hours): ……..

A - Favorable outcome: ☐Discharged with return home

B - Early complications (within the first 36 hours) :
☐Progression from Class II to Class III envenomation
 Cardiovascular distress: □ Cardiogenic shock □ Severe arrhythmia □ Distributive shock □ Cardiac arrest
 Respiratory distress: □ Pulmonary edema □ Respiratory arrest
□ Inhalation □ ARDS
 Neurological distress: □ Status epilepticus □ Coma □ Increased intracranial pressure (ICP)
☐Use of drugs:
□ Noradrenaline □ Adrenaline □ Milrinone
☐Use of invasive mechanical ventilation □ Yes □ No
If yes, specify duration (hours): ……h
☐Use of sedation □ Yes □ No
If yes, specify duration (minutes): ……min
□ Midazolam □ Fentanyl □ Neuromuscular blockers
☐Use of cardioversion □ Yes □ No

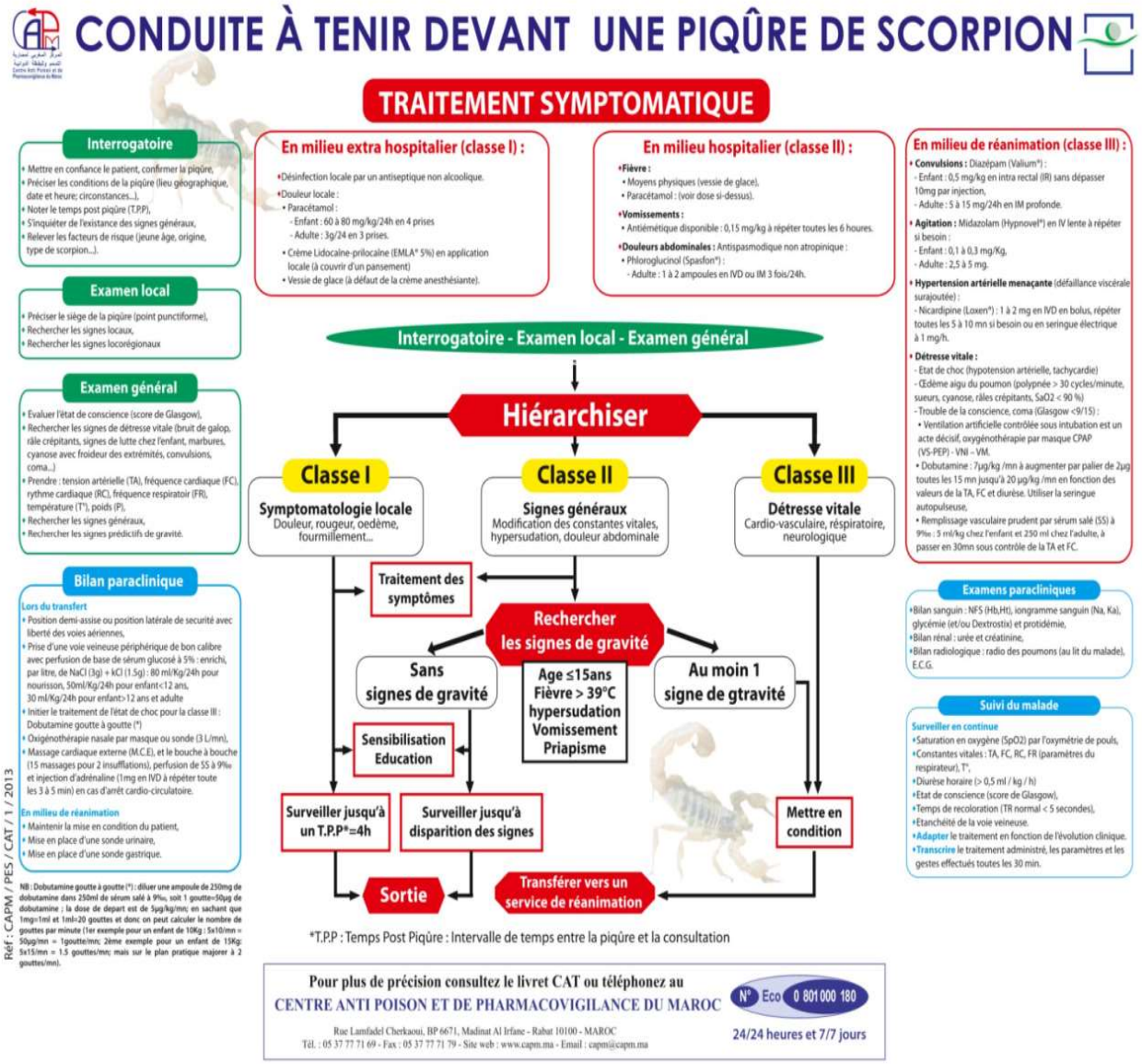
C - Late complications (beyond the first 36 hours) :
Nosocomial infections □ Yes □ No
If yes, specify:

Date of sampling: …/…/… at …H…
Nature of the sample:
□ Pus □ Urine culture □ Catheters □ Blood cultures
□ Respiratory samples □ Cerebrospinal fluid □ Biopsy
□ Ascitic fluid □ Other (please specify): ……
Site of infection:
□ Pneumonia □ Bacteremia □ Suppurative infections □ Urinary infections □ Others: …….
Isolated bacterial species: …….
Antibiogram:

Multi-organ failure
□ Hemodynamic failure □ Respiratory failure □ Renal failure □ Hepatic failure □ Hematological failure □ Encephalopathy Other (please specify): ……..

D - Survival and comorbidities after the occurrence of a complication :
Tracheostomy: □ Yes □ No
Neurological sequelae: □ Yes □ No
If yes, specify if: □ Moderate disability □ Severe disability □ Vegetative state

ANNEX 3 :


CONDUITE À TENIR DEVANT UNE PIQÛRE DE SCORPION
TRAITEMENT SYMPTOMATIQUE
Interrogatoire
• Mettre en confiance le patient, confirmer la piqûre,
• Préciser les conditions de la piqûre (lieu géographique, date et heure; circonstances...),
• Noter le temps post piqûre (T.P.P),
• S'inquiéter de l'existance des signes généraux,
• Relever les facteurs de risque (jeune âge, origine, type de scorpion...).
Examen local
• Préciser le siège de la piqûre (point punctiforme),
• Rechercher les signes locaux,
• Rechercher les signes locorégionaux
Examen général
• Evaluer l'état de conscience (score de Glasgow),
• Rechercher les signes de détresse vitale (bruit de galop, râle crépitants, signes de lutte chez l'enfant, marbures, cyanose avec froideur des extrémités, convulsions, coma...)
• Prendre : tension artérielle (TA), fréquence cardiaque (FC), rythme cardiaque (RC), fréquence respiratoir (FR), température (T°), poids (P),
• Rechercher les signes généraux,
• Rechercher les signes prédictifs de gravité.
Bilan paraclinique
Lors du transfert
• Position demi-assise ou position latérale de securité avec liberté des voies aériennes,
• Prise d'une voie veineuse périphérique de bon calibre avec perfusion de base de sérum glucosé à 5% : enrichi, par litre, de NaCl (3g) + kCl (1.5g) : 80 ml/Kg/24h pour nourisson, 50ml/Kg/24h pour enfant<12 ans, 30 ml/Kg/24h pour enfant>12 ans et adulte
• Initier le traitement de l'état de choc pour la classe III : Dobutamine goutte à goutte (*)
• Oxigénothérapie nasale par masque ou sonde (3 L/mn),
• Massage cardiaque externe (M.C.E), et le bouche à bouche (15 massages pour 2 insufflations), perfusion de 5S à 9‰ et injection d'adrénaline (1mg en IVD à répéter toute les 3 à 5 min) en cas d'arrêt cardio-circulatoire.
En milieu de réanimation
• Maintenir la mise en condition du patient,
• Mise en place d'une sonde urinaire,
• Mise en place d'une sonde gastrique.
NB : Dobutamine goutte à goutte (*) : diluer une ampoule de 250mg de dobutamine dans 250ml de sérum salé à 9‰, soit 1 goutte=50µg de dobutamine ; la dose de depart est de 5µg/kg/mn; en sachant que 1mg=1ml et 1ml=20 gouttes et donc on peut calculer le nombre de gouttes par minute (1er exemple pour un enfant de 10Kg : 5x10/mn = 50µg/mn = 1goutte/mn; 2ème exemple pour un enfant de 15Kg: 5x15/mn = 1.5 gouttes/mn; mais sur le plan pratique majorer à 2 gouttes/mn).
Réf : CAPM / PES / CAT / 1 / 2013
En milieu extra hospitalier (classe I) :
•Désinfection locale par un antiseptique non alcoolique.
•Douleur locale :
• Paracétamol :
- Enfant : 60 à 80 mg/kg/24h en 4 prises
- Adulte : 3g/24 en 3 prises.
• Crème Lidocaïne-prilocaïne (EMLA® 5%) en application locale (à couvrir d'un pansement)
• Vessie de glace (à défaut de la crème anesthésiante).
En milieu hospitalier (classe II) :
•Fièvre :
• Moyens physiques (vessie de glace),
• Paracétamol : (voir dose si-dessus).
•Vomissements :
• Antiémétique disponible : 0,15 mg/kg à répéter toutes les 6 houres.
•Douleurs abdominales : Antispasmodique non atropinique :
• Phloroglucinol (Spasfon®) :
- Adulte : 1 à 2 ampoules en IVD ou IM 3 fois/24h.
Interrogatoire - Examen local - Examen général
Hiérarchiser
Classe I
Symptomatologie locale
Douleur, rougeur, oedème, fourmillement...
Classe II
Signes généraux
Modification des constantes vitales, hypersudation, douleur abdominale
Classe III
Détresse vitale
Cardio-vasculaire, réspiratoire, neurologique
Traitement des symptômes
Rechercher les signes de gravité
Sans signes de gravité
Age ≤15ans
Fièvre > 39°C
hypersudation
Vomissement
Priapisme
Au moin 1 signe de gtravité
Sensibilisation Education
Surveiller jusqu'à un T.P.P*=4h
Surveiller jusqu'à disparition des signes
Mettre en condition
Sortie
Transférer vers un service de réanimation
*T.P.P : Temps Post Piqûre : Intervalle de temps entre la piqûre et la consultation
En milieu de réanimation (classe III) :
• Convulsions : Diazépam (Valium®) :
- Enfant : 0,5 mg/kg en intra rectal (IR) sans dépasser 10mg par injection,
- Adulte : 5 à 15 mg/24h en IM profonde.
• Agitation : Midazolam (Hypnovel®) en IV lente à répéter si besoin :
- Enfant : 0,1 à 0,3 mg/Kg,
- Adulte : 2,5 à 5 mg.
• Hypertension artérielle menaçante (défaillance viscérale surajoutée) :
- Nicardipine (Loxen®) : 1 à 2 mg en IVD en bolus, répéter toutes les 5 à 10 mn si besoin ou en seringue électrique à 1 mg/h.
• Détresse vitale :
- Etat de choc (hypotension artérielle, tachycardie)
- Œdème aigu du poumon (polypnée > 30 cycles/minute, sueurs, cyanose, râles crépitants, SaO2 < 90 %)
- Trouble de la conscience, coma (Glasgow <9/15) :
• Ventilation artificielle contrôlée sous intubation est un acte décisif, oxygénothérapie par masque CPAP (VS-PEP) - VNI - VM.
• Dobutamine : 7µg/kg /mn à augmenter par palier de 2µg toutes les 15 mn jusqu'à 20 µg/kg /mn en fonction des valeurs de la TA, FC et diurèse. Utiliser la seringue autopulseuse,
• Remplissage vasculaire prudent par sérum salé (5S) à 9‰ : 5 ml/kg chez l'enfant et 250 ml chez l'adulte, à passer en 30mn sous contrôle de la TA et FC.
Examens paracliniques
•Bilan sanguin : NFS (Hb,Ht), iongramme sanguin (Na, Ka), glycémie (et/ou Dextrostix) et protidémie,
•Bilan rénal : urée et créatinine,
•Bilan radiologique : radio des poumons (au lit du malade), E.C.G.
Suivi du malade
Surveiller en continue
•Saturation en oxygène (SpO2) par l'oxymétrie de pouls,
•Constantes vitales : TA, FC, RC, FR (paramètres du respirateur), T°,
•Diurèse horaire (> 0,5 ml / kg / h)
•Etat de conscience (score de Glasgow),
•Temps de recoloration (TR normal < 5 secondes),
•Etanchéité de la voie veineuse.
•Adapter le traitement en fonction de l'évolution clinique.
•Transcrire le traitement administré, les paramètres et les gestes effectués toutes les 30 min.
Pour plus de précision consultez le livret CAT ou téléphonez au
CENTRE ANTI POISON ET DE PHARMACOVIGILANCE DU MAROC
Rue Lamfadel Cherkaoui, BP 6671, Madinat Al Irfane - Rabat 10100 - MAROC
Tél. : 05 37 77 71 69 - Fax : 05 37 77 71 79 - Site web : www.capm.ma - Email : capm@capm.ma
N° Eco 0 801 000 180
24/24 heures et 7/7 jours

ANNEX 4 : Grading Signs and Symptoms of scorpion sting cases

Grade I : Mild envenomation.	Pain and/or paresthesia at the scorpion sting site, tingling, numbness and minor swelling in the skin area encompassing the sting *(local symptoms)* and absence of severe complications
Grade II : Moderate envenomation.	Fever, chills, tremor, excessive sweating, nausea, vomiting, diarrhea, hypertension and priapism *(systemic symptoms +/- locals symptoms)*
Grade III : Severe envenomation.	Severe systemic manifestations, including cardiovascular collapse, severe respiratory distress, or neurological complications.

ANNEX 5 :

ROYAUME DU MAROC
MINISTERE DE LA SANTE

CENTRE ANTI POISON ET DE PHARMACOVIGILANCE DU MAROC (CAPM)

Délégation de:.....
Hôpital: .....
Service d'hospitalisation:.....
N° d'ordre:..... N° d'entrée:.....
(dans le Registre du scorpion)

DOSSIER D'HOSPITALISATION
d'un patient présentant une envenimation scorpionique

MALADE
Nom: ..... Prénom: ..... Sexe: F /__/ M /__/
Age (en années révolues): /__/__/ Poids (en Kg): /__/__/

Piqûre : Siège:..... Date /__/__/__/__/__/__/__/__/ Heure : /__/__/__/__/
Circonscription :.....

Admission : Date /__/__/__/__/__/__/__/__/ Heure : /__/__/__/__/

Malade référé (*) : Oui /__/ Non /__/ (*) : si oui adjoindre la fiche de référence

Antécédents du malade (préciser):.....

CLASSE À L'ADMISSION

Classe II : Signes généraux /__/
/__/ Fièvre
/__/ Hypersudation
/__/ Vomissements
/__/ Douleurs abdominales
/__/ Tachycardie
/__/ Hypertension artérielle (chiffrée à: /)
/__/ Priapisme
/__/ Agitation
/__/ Ballonnement abdominale

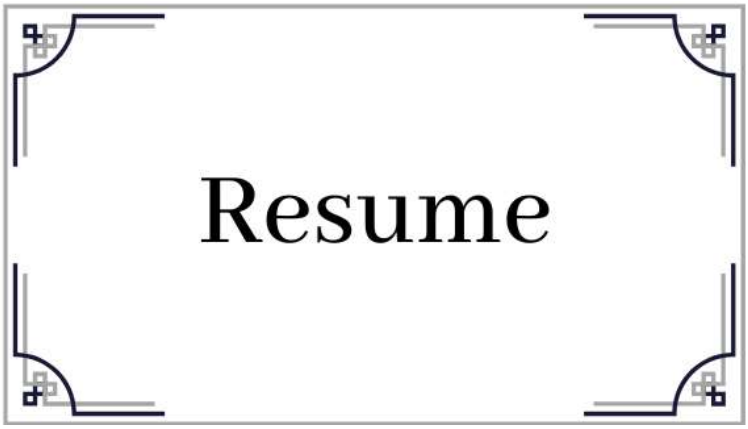
Classe III : Détresse vitale /__/
Cardiovasculaire (DVC) /__/
/__/ Bruit de Galop
/__/ Marbrures
/__/ Cyanose des extrémités
/__/ Tps de Recoloration >3 sec
/__/ Pouls filant
Respiratoire (DVR) /__/
/__/ Râles crépitants
/__/ Tachypnée (cycles/min)
/__/ Signes de lutte (chez l'enfant)
Neurologique (DVN) /__/
/__/ Convulsion
/__/ Coma GLASGOW /__/__/
/__/ Trouble de la vigilance

/__/Autres (préciser):.....
NB: préciser la date et l'heure de la première manifestation clinique

EXAMENS PARA CLINIQUES (voir recto)

EVOLUTION FINALE
FAVORABLE /__/ Date de Sortie: /__/__/__/__/__/__/__/__/ Heure de sortie: /__/__/__/__/
DECES: /__/ Date de décès: /__/__/__/__/__/__/__/__/ Heure du décès: /__/__/__/__/
Séquelles (préciser) :.....

CAPM/SIPESS/F.H1


Resume

Abstract

Scorpion stings constitute a major public health concern. The incidence and mortality associated with scorpion envenomations are worrisome in North Africa, with over 350,000 reported cases and more than 810 deaths annually. This is notably the case in Morocco, where there are over 30,000 cases per year, resulting in a mortality rate of approximately three deaths per 1000 stings. Children under 15 years old are a particularly vulnerable population and exhibit more severe symptoms. Morocco, especially the region of Marrakech Tensift El Haouz, is characterized by a rich diversity of scorpion species.

The objective of this retrospective cross-sectional descriptive study was to provide an epidemiological and clinical description of moderate and severe scorpion envenomation and define predictive factors that may be associated with poor outcomes. The study analyzed patient cases obtained from medical records over a 13-year period (January 2010 to December 2022) at the pediatric intensive care unit at the Children's Hospital of Marrakech, Morocco. A total of 1595 patients admitted for scorpion sting were included in the analysis.

Among them, 914 patients (57.4%) were categorized as grade III, while 670 patients (41.9%) were classified as grade II. Scorpion envenomation was more prevalent in the summer, with 66.34% of patients admitted between June and August. The mean age of the patients was 6.11 ± 4.0 years, ranging from 1 month and 3 weeks to 16 years. During the ICU stay, 1504 patients (94.5%) showed improvement without sequelae, while 78 patients (4.89%) died.

The study identified several risk factors associated with poor outcomes, including age less than 6 years, rural origin, Class III envenomation at admission, the presence of acute pulmonary edema, hypoxemia, priapism, the presence of vital distress upon admission, leukocytosis, uremia, elevated Alanine Aminotransferase, elevated troponin levels, metabolic acidosis, abnormal Time-velocity integral, and the placement of a central arterial line.

Other factors with a minimal impact on the outcome have been highlighted, including delayed admission time, tachypnea, diarrhea, thrombocytosis, hyperglycemia, Elevated Aspartate Aminotransferase, ECG rhythm disturbance, and the administration of dobutamine for more than 24h.

Early administration of dobutamine is a factor associated with a reduced risk of poor clinical outcomes.

In conclusion, our study highlights the significant public health concern posed by scorpion stings in North Africa, particularly in Morocco. The high incidence and mortality rates, especially among children under 15 years old, underscore the urgency of addressing this issue.

Résumé

Les piqûres de scorpion constituent un enjeu majeur de santé publique. L'incidence et la mortalité associées aux envenimations scorpioniques sont préoccupantes en Afrique du Nord, avec plus de 350 000 cas signalés et plus de 810 décès chaque année. C'est notamment le cas au Maroc, où l'on recense plus de 30 000 cas par an, entraînant un taux de mortalité d'environ trois décès pour 1000 piqûres. Les enfants de moins de 15 ans sont une population particulièrement vulnérable et présentent des symptômes plus sévères. Le Maroc, en particulier la région de Marrakech Tensift El Haouz, se caractérise par une grande diversité d'espèces de scorpions.

L'objectif de cette étude rétrospective descriptive transversale était de fournir une description épidémiologique et clinique des envenimations scorpioniques modérées et sévères et de définir les facteurs prédictifs pouvant être associés à de mauvais résultats. L'étude a analysé sur une période de 13 ans (de janvier 2010 à décembre 2022) les patients admis à l'unité de soins intensifs pédiatriques de l'hôpital des enfants de Marrakech, au Maroc. Un total de 1595 patients admis pour une piqûre de scorpion a été inclus pour l'étude.

Parmi eux, 914 patients (57,4 %) ont été classés en grade III, tandis que 670 patients (41,9 %) ont été classés en grade II. Les envenimations scorpioniques étaient plus fréquentes en été, avec 66,34 % des patients admis entre juin et août. L'âge moyen des patients était de 6,11 ± 4,0 ans, allant de 1 mois et 3 semaines à 16 ans. Pendant leur séjour en unité de soins intensifs, 1504 patients (94,5 %) ont montré une amélioration clinique sans comorbidité associée, tandis que 78 patients (4,89 %) sont décédés.

L'étude a identifié plusieurs facteurs de mauvais pronostic, notamment un âge inférieur à 6 ans, une origine rurale, une envenimation de classe III à l'admission, la présence d'un œdème pulmonaire aigu, une hypoxémie, un priapisme, la présence de détresse vitale à l'admission, une hyperleucocytose, une hyperuricémie, une élévation de l'alanine aminotransférase, des taux

élevés de troponine, une acidose métabolique, un intégral temps-vitesse anormal et la mise en place d'une ligne artérielle centrale.

D'autres facteurs ayant un impact minimal sur l'évolution clinique ont été soulignés, notamment le délai d'admission retardé, la tachypnée, la diarrhée, la thrombocytose, l'hyperglycémie, l'élévation de l'aspartate aminotransférase, les perturbations du rythme ECG et l'administration de dobutamine pendant plus de 24 heures.

L'administration précoce de dobutamine est un facteur associé à de meilleurs résultats cliniques.

En conclusion, notre étude met en exergue le problème majeur de santé publique que posent les envenimations scorpioniques au Maroc, et met en évidence des facteurs pronostiques permettant d'adapter au mieux la prise en charge. Les taux élevés d'incidence et de mortalité, en particulier chez les enfants de moins de 15 ans, soulignent l'importance de la mise en place de mesures urgentes et adaptées.

ملخص

لسعات العقرب تمثل تحديًا رئيسيًا في مجال الصحة العامة. إن انتشار ووفيات لسعات العقارب مرتبطة بالتسمم الناجم عنها يثير قلقًا في شمال إفريقيا، حيث يتم الإبلاغ عن أكثر من 350,000 حالة وأكثر من 810 وفيات سنويًا. وهذا ينطبق على وجه الخصوص على المغرب، حيث يُسجّل أكثر من 30,000 حالة سنويًا، مما يؤدي إلى معدل وفيات يصل إلى حوالي ثلاث وفيات لكل 1000 لسعة. الأطفال الذين تقل أعمارهم عن 15 عامًا هم فئة خاضعة للخطر بشكل خاص وتظهر لديهم أعراض أشد شدة. يتميز المغرب، وبخاصة منطقة مراكش تانسيفت الحوز، بتنوع كبير في أنواع العقارب.

دفت هذه الدراسة الوصفية العرضية البائنة إلى تقديم وصف وبائي وسريري لحالات التسمم الناتج عن لدغ العقارب المعتدلة والشديدة، وتحديد العوامل التوقعية التي يمكن أن تكون مرتبطة بنتائج سيئة. تم تحليل الدراسة خلال فترة تصل إلى 13 عامًا (من يناير 2010 إلى ديسمبر 2022) للمرضى الذين تم قبولهم في وحدة العناية المركزة للأطفال في مستشفى أطفال مراكش في المغرب. تم تضمين مجموعة من 1595 مريضًا تم قبولهم بسبب لدغة عقرب للدراسة.

من بينهم، تم تصنيف 914 مريضًا (57.4٪) في الدرجة الثالثة، في حين تم تصنيف 670 مريضًا (41.9٪) في الدرجة الثانية. كانت حالات التسمم بسبب لدغ العقارب أكثر انتشارًا في فصل الصيف، حيث تم قبول 66.34٪ من المرضى بين يونيو وأغسطس. كان متوسط عمر المرضى 6.11 ± 4.0 سنوات، متراوحًا بين شهر و3 أسابيع وحتى 16 عامًا. خلال إقامتهم في وحدة العناية المركزة، أظهر 1504 مريضًا (94.5٪) تحسنًا، في حين توفي 78 مريضًا (4.89٪).

تمكنت الدراسة من تحديد العديد من العوامل التي تؤثر سلبًا على التوقعات، منها العمر الذي يقل عن 6 سنوات، والأصل الريفي، والتسمم من الدرجة الثالثة عند القبول، ووجود انتفاخ في الرئة حاد، وانخفاض في مستوى الأوكسجين في الدم، والتحاميل القضيبية، ووجود حالة تخدير حيوي عند القبول، وارتفاع عدد كريات الدم البيضاء، وارتفاع مستوى اليوريكيميا، وارتفاع إنزيم الألانين أمينوترانسفيريز، وارتفاع مستويات تروبونين، والحموضة الاستقلابية، وتغير في الزمن والسرعة المتكامل ووضع خط مركزي للشريان.

تم التأكيد على عوامل أخرى لها تأثير ضئيل على التطور السريري، بما في ذلك تأخر وقت القبول، وسرعة التنفس، والإسهال، وارتفاع عدد صفائح الدم، وارتفاع مستوى السكر في الدم، وارتفاع إنزيم الأسبارتات أمينوترانسفيريز، واضطرابات في إيقاع القلب بتخطيط القلب (ECG)، وإعطاء الدوبوتامين لمدة تزيد عن 24 ساعة.

إعطاء الدوبوتامين في مراحل مبكرة هو عامل مرتبط بنتائج سريرية أفضل.

في الختام، تسلط دراستنا الضوء على القلق الكبير المتعلق بالصحة العامة الناشئ عن لدغات العقارب في شمال أفريقيا، وبخاصة في المغرب. تعكس معدلات الإصابة والوفاة العالية، وخاصة بين الأطفال دون سن 15 عامًا، على ضرورة اتخاذ إجراءات عاجلة.

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قسم الطبيب

أقْسِم بالله العَظِيم

أن أراقبَ الله في مِهْنَتِي.

وأن أصُونَ حياة الإنسان في كآفّةِ أطوَارهَا في كل الظروف والأحَوال باذلة وسْعِي في إنقاذها مِن الهَلاكِ والمرَضِ والألَم والقَلَق.

وأن أحفَظَ لِلنَاسِ كرَامَتهُم، وأسْتر عَوْرَتهُم، وأكتمَ سِرَّهُمْ.

وأن أكونَ عَلى الدوَام من وسائِل رحمة الله، باذلة رِعَايَتي الطبية للقريب والبعيد،للصالح والطالح، والصديق والعدو.

وأن أثابر على طلب العلم، وأسَخِّرَه لِنَفْعِ الإنْسَان لا لأذَاه.

وأن أُوَقّرَ مَن عَلَّمَني، وأُعَلّمَ مَن يَصْغَرَني، وأكون أختاً لِكُلّ زَميل في المِهنَةِ الطِّبّيَة مُتعَاونِين عَلى البرّ والتقوى.

وأن تكون حياتي مِصْدَاق إيمَاني في سِرّي وَعَلانيَتي،نَقِيَّة مِمّا يُشينهَا تجَاهَ الله وَرَسُولِهِ وَالمؤمِنين.

والله على ما أقول شهيد

كليـــــــــة الـطـب
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MARRAKECH
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UNIVERSITÉ CADI AYYAD

سنة 2023 أطروحة رقم 336

الخصائص الوبائية والسريرية والنتائج لتسمم العقارب الحاد في وحدة الرعاية المركزة للأطفال في مستشفى مراكش الطبي للأطفال: تحليل متعدد المتغيرات لـ 1595 حالة.

الأطروحة

قدمت ونوقشت علانية يوم 2023/09/27

من طرف

السيدة علياء التفالي

المزدادة في 27 يناير 1998 في مراكش

لنيل شهادة الدكتوراه في الطب

الكلمات الأساسية :

عقرب - تسمم - وبائية - أطفال - مغرب - صحة عامة

اللجنة

السيد	ع. هاشمي أستاذ في الإنعاش الطبي	الرئيس
السيد	س. يونس استاذ في التخدير و الإنعاش	المشرف
السيد	م. خلوقي استاذ في التخدير و الإنعاش	الحكام
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