



Case Presentation

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- C.D, A previously healthy, physically fit, 43 y.o man.
- Presented to the ER with syncope during intense physical activity: During the 9th Km of a 10K run, the patient felt tired and then lost consciousness.



Syncope in the athletic patient

- Neuro-Cardiogenic (Vasovagal syncope, Orthostatic). Mostly after exercise
 - Exercise-associated Collapse
 - Exertional Heat Stroke
 - Exercise Associated Hyponatremia
- Cardiogenic
 - Structural
 - electrical



- Patient denies palpitations or chest pain
- Denies family history of sudden death or coronary disease.
- Denies substance abuse

On arrival to the ER

- HR=114, Temp (PO)-36.9°C.
- Confused
- Otherwise normal physical exam

PH - general		7.322
PCO2 - general (mmHg)		44.0
PO2 - general (mmHg)		27.9
Saturation, O2 - general (%)		49.4
HCO3 - general (mmol/l)		22.3
Base Excess - general (mmol/l)		-3.8
Sodium (mmol/l)		142.2
Potassium (mmol/l)		3.76
Calcium, Ionized (mmol/l)	1.00-1.20	1.09
Hemoglobin (g/dL)		14.0
Hematocrit (%)		46.1
Glucose (mg/dL)	70-110	116.0
Lactate (mg/dL)	6-18	75

CBC		
WBC (K/microL)	4-10.8	9.28
RBC (M/microL)	4.4-5.9	5.35
HGB (g/dl)	13.5-17.5	15.15
HCT (%)	39.8-52.2	46.31
MCV (fL)	80.5-99.7	86.57
MCH (pg)	26-32	28.3
MCHC (g/dl)	32-36	32.7
RDW (%)	10.9-15.7	12.68
PLT (K/microL)	130-440	279
MPV (fL)	6.5-11.1	9.80
PCT (%)	0.15-0.32	0.27
NEUTRO% (%)	40-74	50.0
LYMPHO% (%)	20-40	44.0 ↑
MONO% (%)	4.7-12.5	2.5 ↓
EOS% (%)	0-7	3.3
BASO% (%)	0-1.5	0.3
Nucleated RBC% (%)	0-0.001	0.0
NEUTRO abs. (K/microL)	1.8-7.7	4.64
LYMPHO abs. (K/microL)	1-4.8	4.08
MONO abs. (K/microL)	0.2-1.0	0.23
EOS abs. (K/microL)	0-0.6	0.31
BASO abs. (K/microL)	0-0.2	0.03
Nucleated RBC abs. (K/microL)	0-0.001	0.00

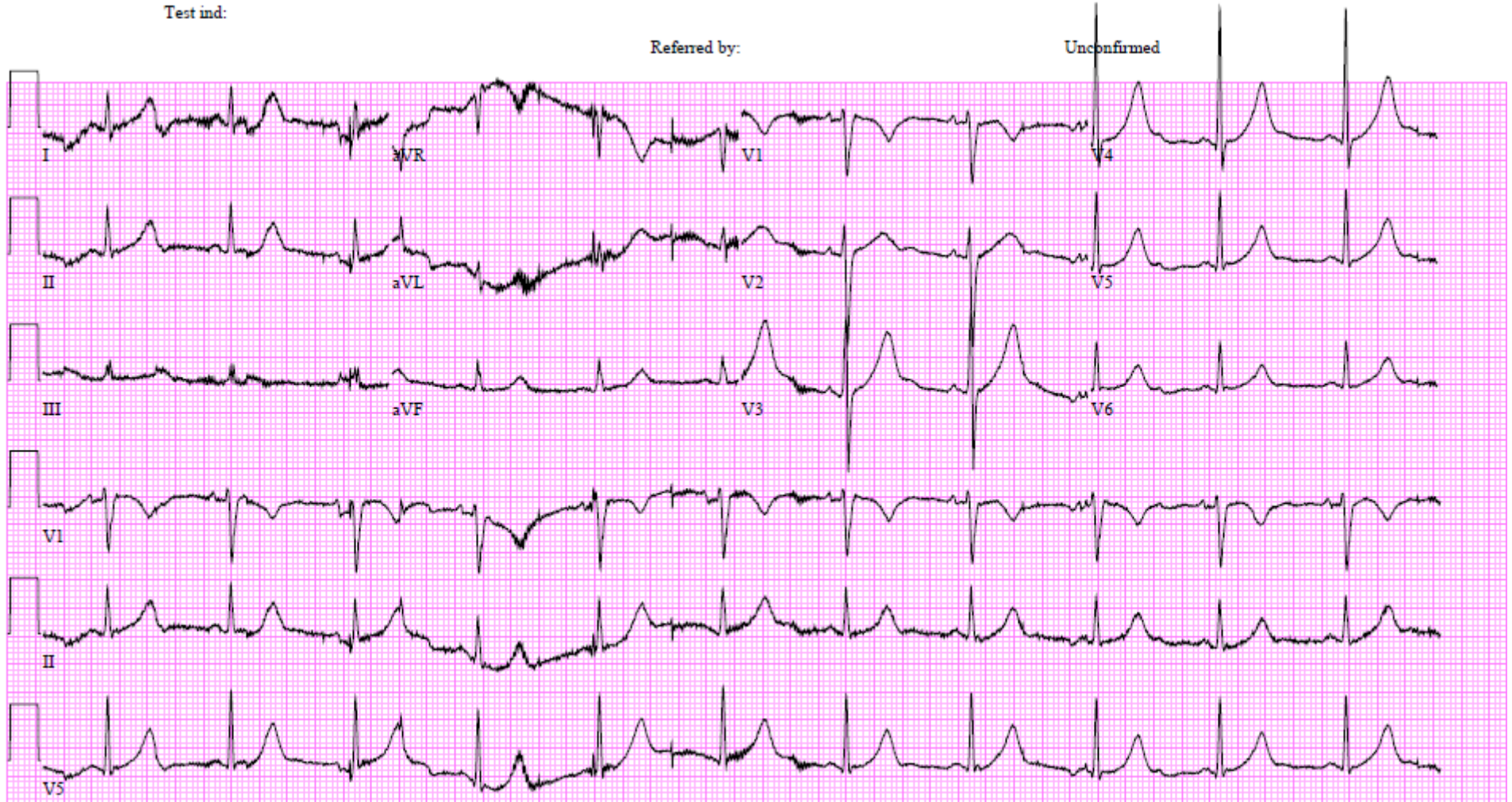
PT (%)	75-135	105
INR	0.80-1.20	0.96
ביוכימיה בדם		
Glucose -Blood (mg/dl) 📄	70-110	107 📄
Urea -Blood (mg/dl)	15-45	32
Sodium -Blood (meg/l)	136-148	140
Potassium -Blood (meg/l)	3.5-5.2	4.1
Lipemia		Normal
Icterus		Normal
Hemolysis		Normal
Creatinine -Blood (mg/dl)	0.8-1.2	1.71 ↑
Estimated Glomerular Filtration Rate (MDRD) (ml/min/1.73m) 📄	60	44 📄
Bilirubin -Blood, total (mg/dl) 📄	0.1-1.1	0.55
Bilirubin -Blood, direct (mg/dl)	0.0-0.3	0.11
SGOT (AST) -Blood (IU/l) 📄	7-40	49 ↑
SGPT (ALT) -Blood (IU/l) 📄	7-45	33
Alkaline Phosphatase -Blood (IU/l)	45-115	89
gamma GT -Blood (IU/l) 📄	10-49	26
Osmolality (calc.) (mOsm/KgH2O)	275-295	291
Troponin-I (micg/l) 📄	<0.02-0.07	0.115 📄
CPK -Blood, total (IU/l)	0-190	558 ↑
CPK-MB (IU/l)	0-25	30.4 ↑
CK-MB% (%)	0-6	5.4
Amylase -Blood (IU/l)	20-90	73
C-Reactive protein (HS) (mg/l)	<0.08-5	1.08



Test ind:

Referred by:

Unconfirmed



Day 2

PH, V	7.32-7.43	7.373	
PCO2, V (mmHg)	41-55	36.7	↓
PO2 (mmHg)		67.2	
Saturation, O2 (%)		93.7	
HCO3 (mmol/l)	22-27	20.9	↓
Base Excess (mmol/l)		-3.7	
Sodium (meq/l)	136-148	141	
Potassium (meq/l)	3.5-5.2	3.6	
Calcium, Ionized (mmol/l)	1.00-1.20	0.72	↓
Glucose (mg/dl)	70-110	108	
Lactate (mg/dl)	6-18	25	↑
COHb (%)	1-2	1.0	
Methemoglobin (%)	0.5-1.3	0.6	

PT (%)	75-135	62	↓
INR	0.80-1.20	1.33	↑
PTT (sec.)	24-38	33	
Fibrinogen (mg/dl)	200-400	158	↓
Thrombin time (sec.)	13.0-18.0	19	↑
Di-Dimer (ng/ml)	<150-250	1479	

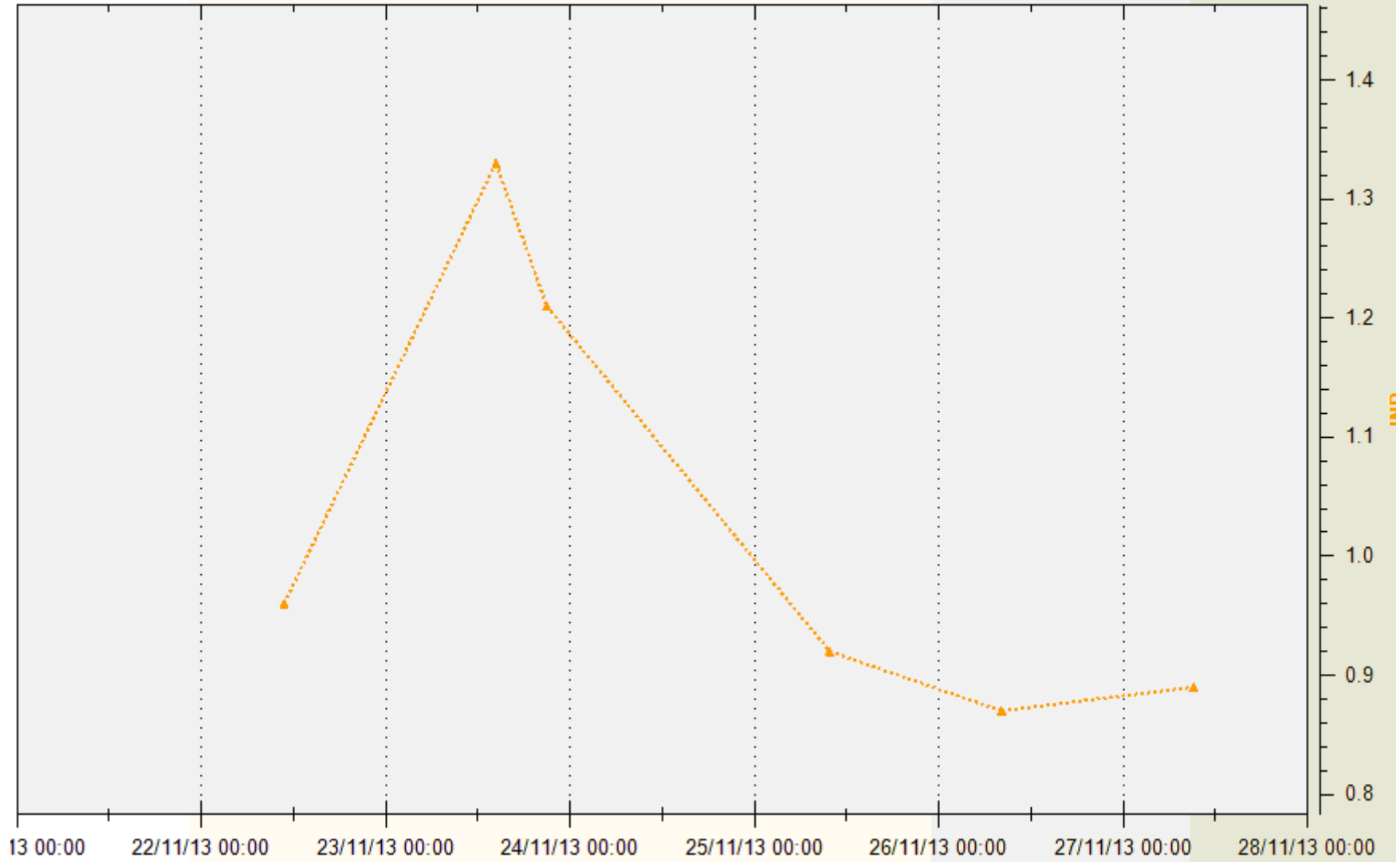
WBC (K/microL)	4-10.8	6.57	
RBC (M/microL)	4.4-5.9	4.53	
HGB (g/dl)	13.5-17.5	12.76	↓
HCT (%)	39.8-52.2	38.76	↓
MCV (fL)	80.5-99.7	85.50	
MCH (pg)	26-32	28.2	
MCHC (g/dl)	32-36	32.9	
RDW (%)	10.9-15.7	13.74	
PLT (K/microL)	130-440	131	
MPV (fL)	6.5-11.1	9.13	
PCT (%)	0.15-0.32	0.12	↓
NEUTRO% (%)	40-74	73.3	
LYMPHO% (%)	20-40	18.9	↓
MONO% (%)	4.7-12.5	6.5	
EOS% (%)	0-7	0.7	
BASO% (%)	0-1.5	0.6	
Nucleated RBC% (%)	0-0.001	0.0	
NEUTRO abs. (K/microL)	1.8-7.7	4.82	
LYMPHO abs. (K/microL)	1-4.8	1.24	
MONO abs. (K/microL)	0.2-1.0	0.42	
EOS abs. (K/microL)	0-0.6	0.04	
BASO abs. (K/microL)	0-0.2	0.04	
Nucleated RBC abs. (K/microL)	0-0.001	0.00	

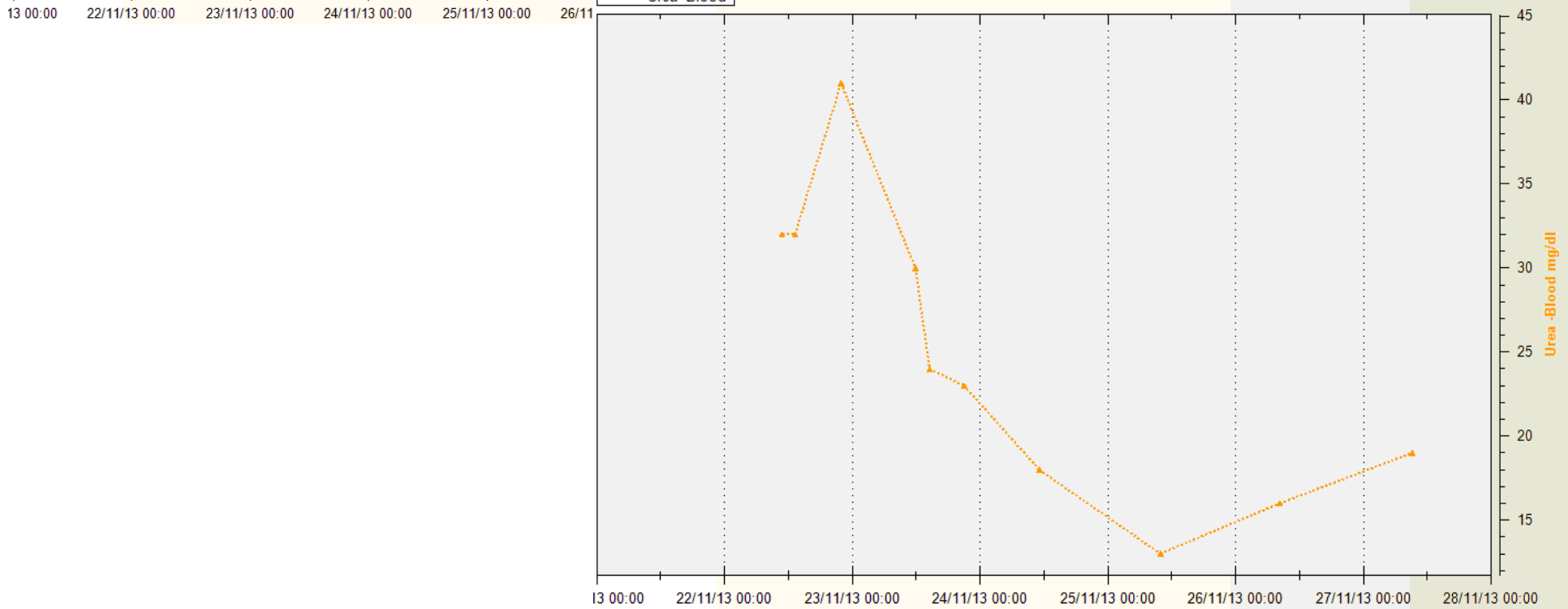
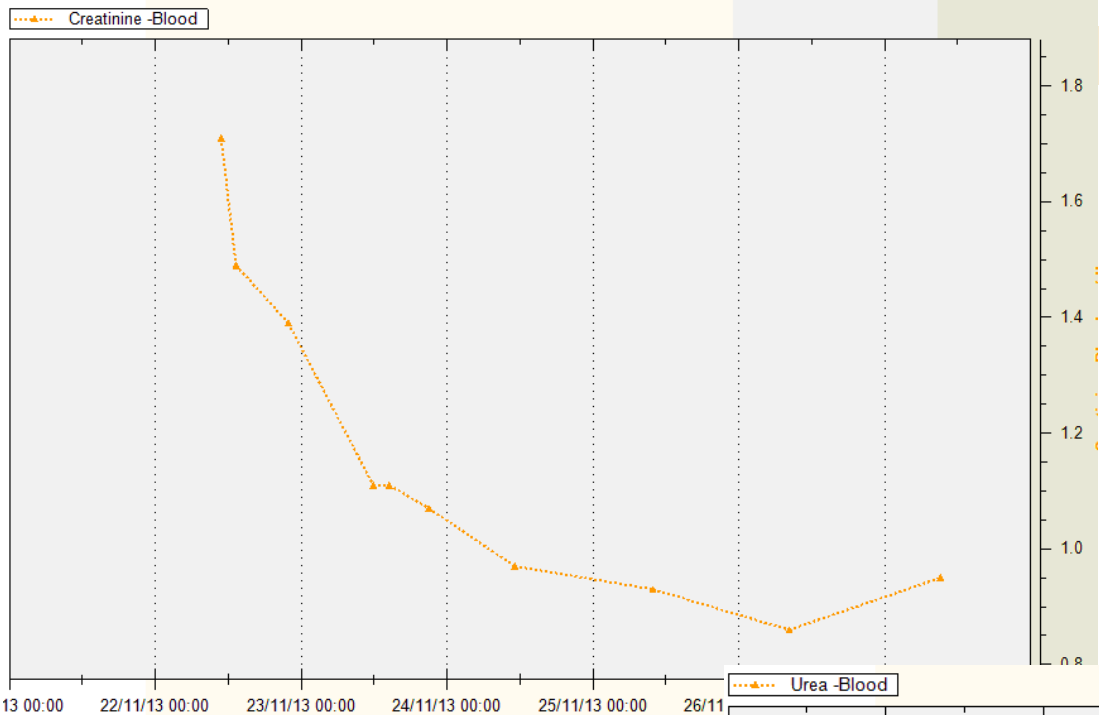
Hemolysis		Normal
Urea -Blood (mg/dl)	15-45	30
Creatinine -Blood (mg/dl)	0.8-1.2	1.11
Glucose -Blood (mg/dl) 📄	70-110	100 📄
Potassium -Blood (meq/l)	3.5-5.2	4.1
Sodium -Blood (meq/l)	136-148	138
Chloride -Blood (meq/l)	98-110	112 ↑
Calcium -Blood, total (mg/dl)	8.1-10.4	7.4 ↓
Phosphorus -Blood (mg/dl) 📄	2-4	1.40 ↓
Magnesium -Blood (mg/dl)	1.9-2.7	2.00
Uric acid -Blood (mg/dl)	3.5-7.2	7.4 ↑
Bilirubin -Blood, total (mg/dl) 📄	0.1-1.1	0.46
Bilirubin -Blood, direct (mg/dl)	0.0-0.3	
SGOT (AST) -Blood (IU/l) 📄	7-40	1016 📄 ↑
SGPT (ALT) -Blood (IU/l) 📄	7-45	1005 📄 ↑
LDH -Blood (IU/l)	100-260	1143 ↑
Alkaline Phosphatase -Blood (IU/l)	45-115	64
gamma GT -Blood (IU/l) 📄	10-49	
Protein -Blood, total (g/dl)	6.5-8.2	5.1 ↓
Albumin -Blood (g/dl)	3.6-5.5	3.2 ↓
Estimated Globulin -Blood (g/dl)	2.3-3.5	1.90 ↓
Osmolality (calc.) (mOsm/KgH2O)	275-295	286
Troponin-I (micg/l) 📄	<0.02-0.07	0.162
CPK -Blood, total (IU/l)	0-190	5792 ↑
CPK-MB (IU/l)	0-25	85.1
CK-MB% (%)	0-6	1.5
Amylase -Blood (IU/l)	20-90	
C-Reactive protein (HS) (mg/l)	<0.08-5	5.63

Normal Echocardiography



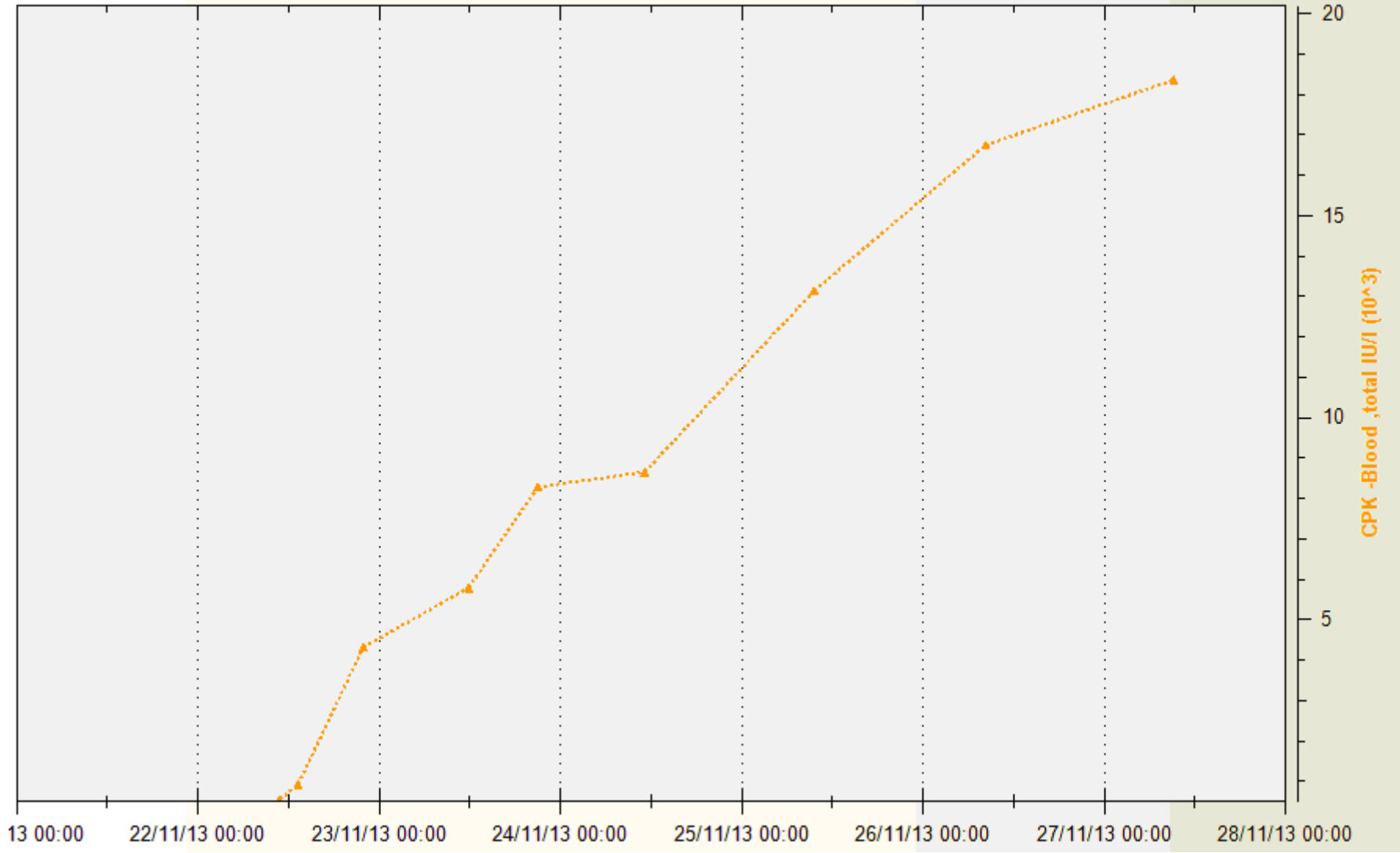
INR





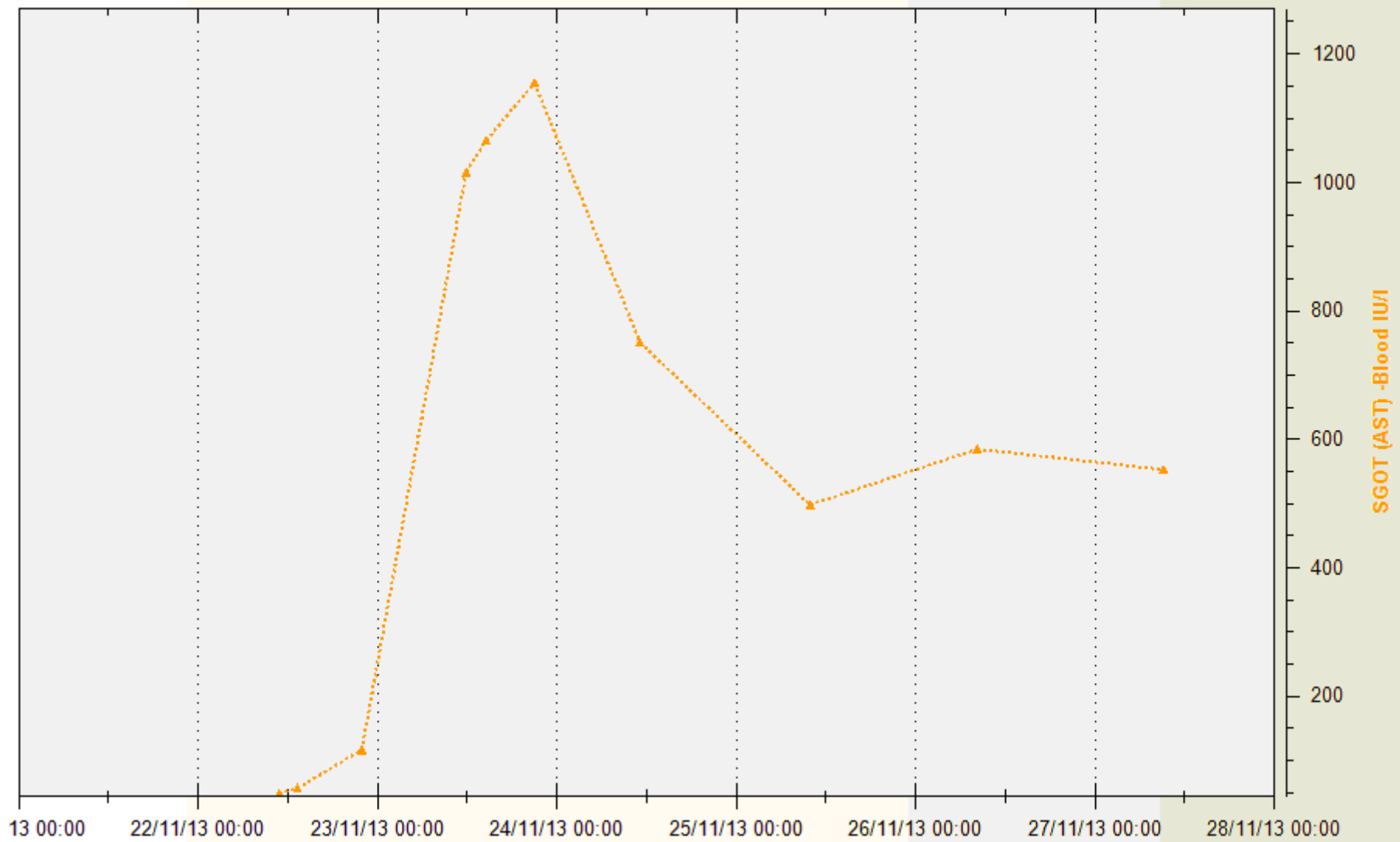


CPK -Blood ,total





---▲--- SGOT (AST) -Blood





Dx?



Exertional Heat Stroke

- Oral temperature 15 minutes after collapse
– 38.6°C
- Classic natural history



Table I. Definition and characterisation of heat stroke from 1967 to 2002

Original publication (year)	T _c (°C)	CNS dysfunction	Organ failure	DIC	Hot and dry skin	Cardiovascular changes	Others
Shibolet et al. ^[34] (1967)	Hyperthermia	Yes	Yes				Systemic disorder
Clowes and O'Donnel ^[41] (1974)	>41	Yes			Yes		Sweat glands still active
Shvartz et al. ^[42] (1977)	Elevated		Yes	Yes			
Shapiro et al. ^[43] (1979)	Elevated	Yes	Yes	Yes			
Costrini et al. ^[44] (1979)	>40	Coma, delirium		Yes		Hypotension, tachycardia	Hyperventilation
Anderson et al. ^[40] (1983)	Hyperthermia	Coma, delirium, convulsion					
Bouchama et al. ^[8] (1993)			Yes	Yes			
Knochel and Reed ^[45] (1994)	>40	Coma, delirium, convulsion			Yes		
CDC (US) ^[46] (1995)	≥40.6 ^a						
Barrow and Clark ^[47] (1998)	≥40.5	Yes					
Yaquub and Al Deeb ^[48] (1998)	≥40	Coma	Yes				Rhabdomyolysis
Samarasinghe ^[49] (2001)	>40	Delirium, coma, agitation,			Yes		
Bouchama and Knochel ^[5] (2002)	Hyperthermia	Encephalopathy	Yes				Inflammatory response



Heat stroke- the three phases of clinical manifestations

- **1. The acute phase - Collapse**
 - CNS disturbances
 - Gastrointestinal dysfunction
 - Respiratory distress
- **2. Hematologic and enzymatic**
 - Hematologic disorders
 - Organ dysfunction
- **3. Late organ dysfunction/failure**
 - Renal & hepatic dysfunction



Phase I – the acute phase, collapse

- Coma
- Stupor
- Delirium
- Irritability & aggressiveness
- Seizures (60-70%)

CNS

- Diarrhea
- Vomiting

Gastrointestinal

- Respiratory alkalosis (masked by metabolic acidosis)
- ARDS

Respiratory



Phase II – hematologic and enzymatic

- Peaks usually at 24-48 hours after the collapse
- Leukocytosis
- Clotting dysfunction
- DIC
- CPK, ALT, AST ↓



Phase III - late organ dysfunction

- **Appears in severe heat stroke**
- **Last for days-weeks or until death from multi organ failure**
- **Fever ?**
- **Disturbance in renal and hepatic function**
- **Fulminant Hepatic failure**
 - High bilirubin levels**
 - High levels of transaminases**
- **Acute renal failure**
 - Brown urine**
 - Oliguria/unuria**



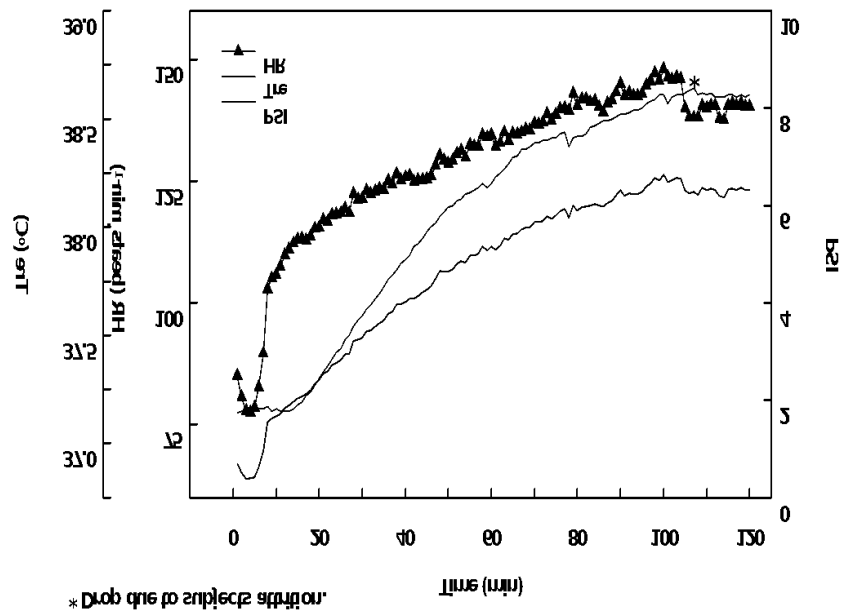
treatment and recurrence

(HTT) Heat Tolerance Test

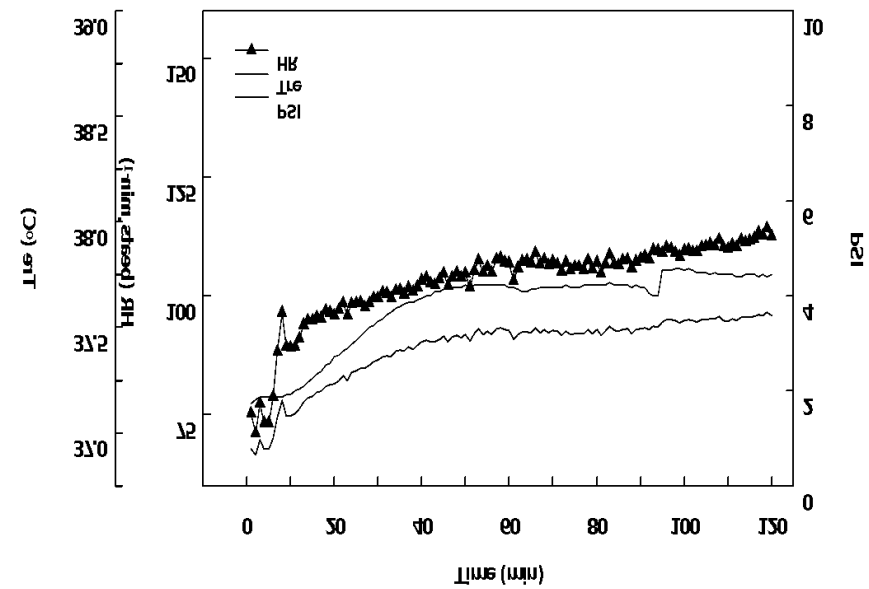


Heat tolerance test

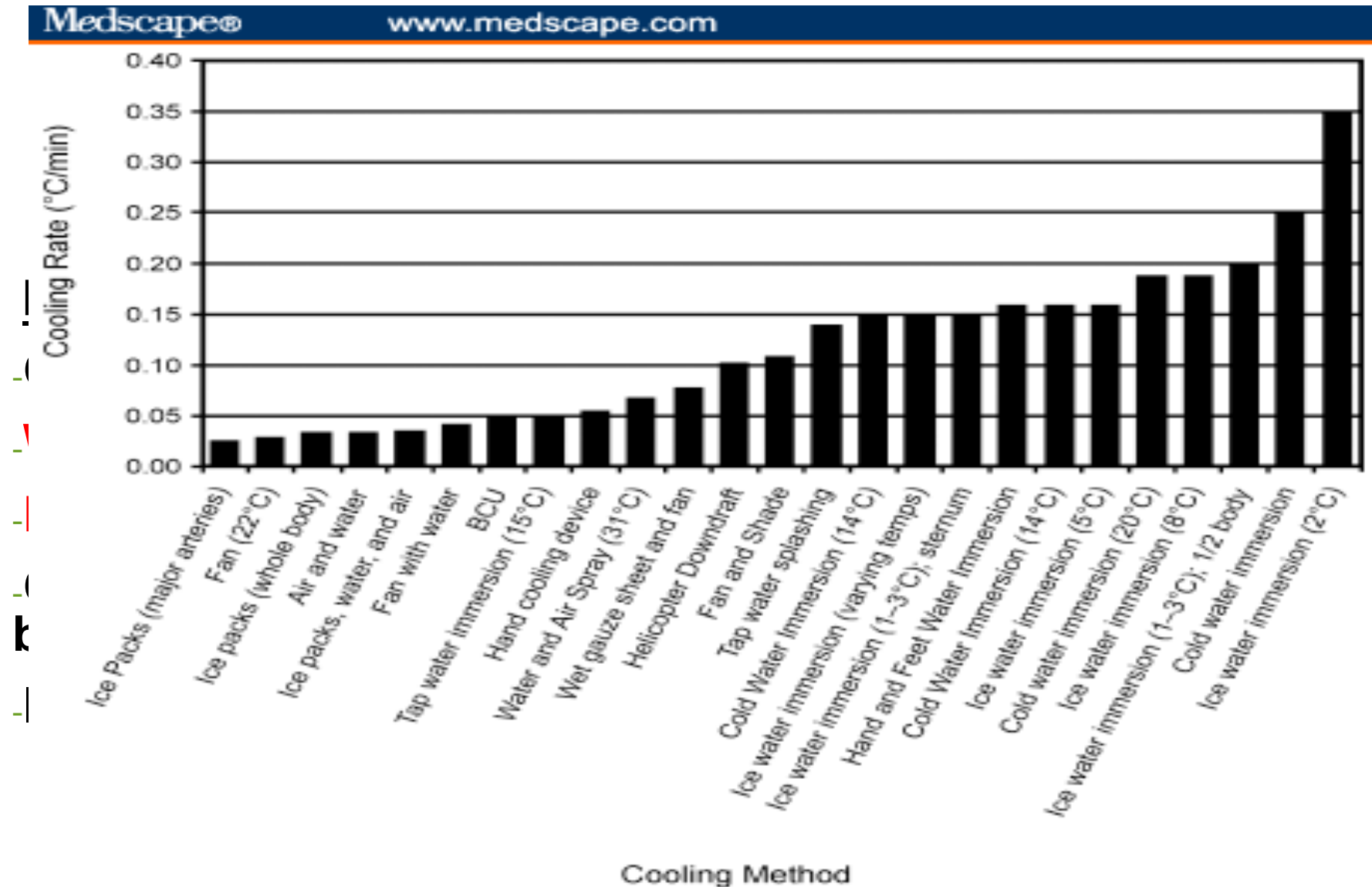
Heat intolerance



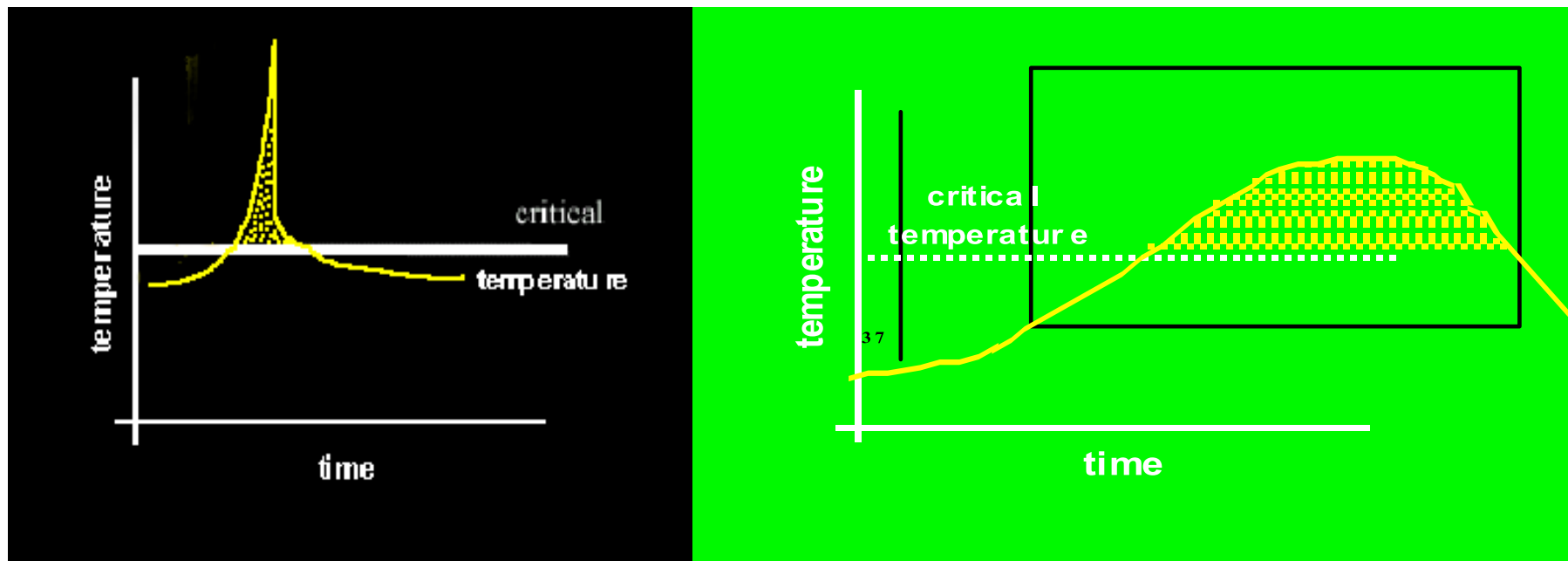
Heat tolerance



Treatment



Temperature - duration area



Thank You

