

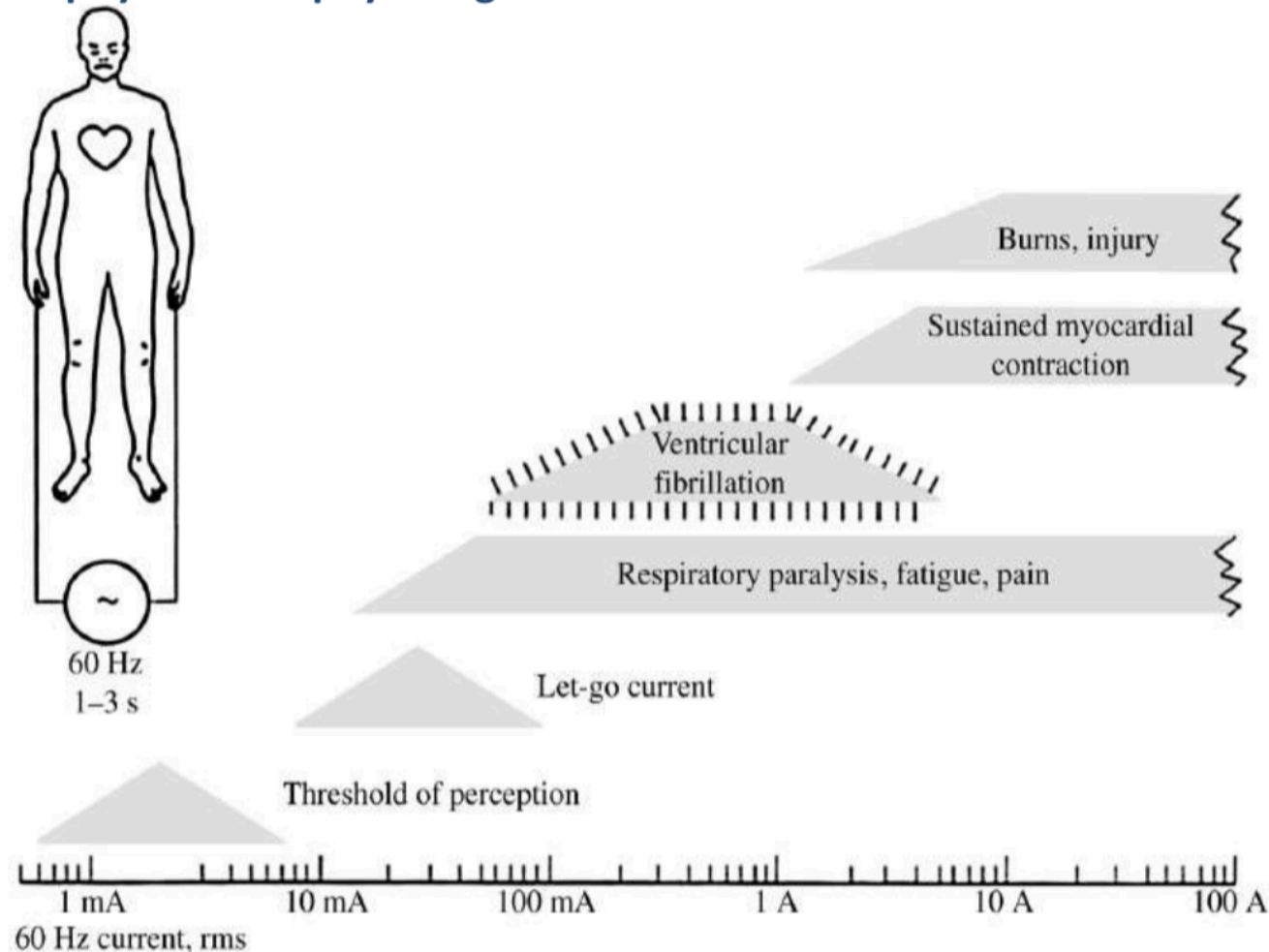


Choque Eletrico

Aquiles



psychophysical and physiological effects of electrical current in humans:-



Adaptado
de
**ELECTRICAL
SAFETY**

By: Yassir Eltayeb
Ali Hassan

Threshold of perception = the minimal current that an individual can detect.

This threshold varies considerably among individuals and with the measurement conditions (wet or dry skin)

Thresholds for dc current range from 2 to 10 mA, and slight warming of the skin is perceived (realized)

Let-go current:-

Is defined as the maximal current at which the subject can withdraw voluntarily.

Involuntary contractions of muscles or reflex withdrawals is occur

The minimal threshold for the let-go current is 6 mA

Respiratory paralysis, pain, and fatigue:-

- respiratory arrest has been observed at 18 to 22mA
- Strong involuntary contractions of the muscles and stimulation of the nerves can be painful and cause fatigue if there is long exposure.

Ventricular fibrillation



Ventricular fibrillation:-

Is a rapid and disorganized cardiac rhythm.

If the magnitude of the current is sufficient to excite only part of the heart muscle and disrupted the heart rate

The heart rate can rise to 300 beats/min

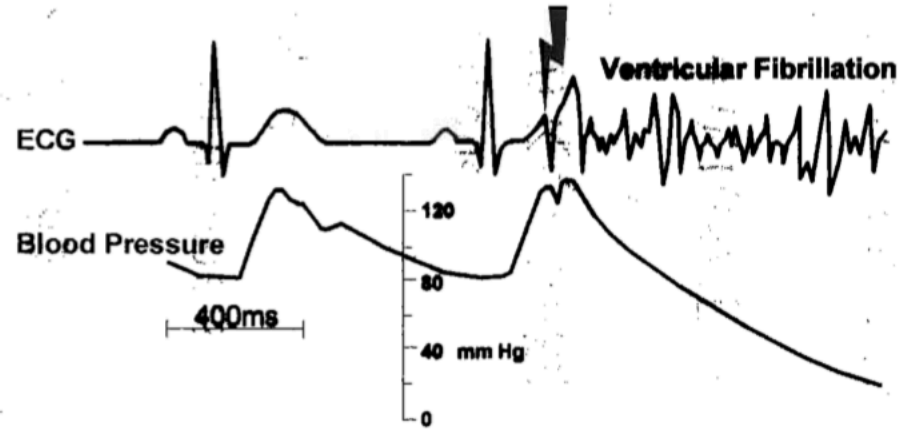
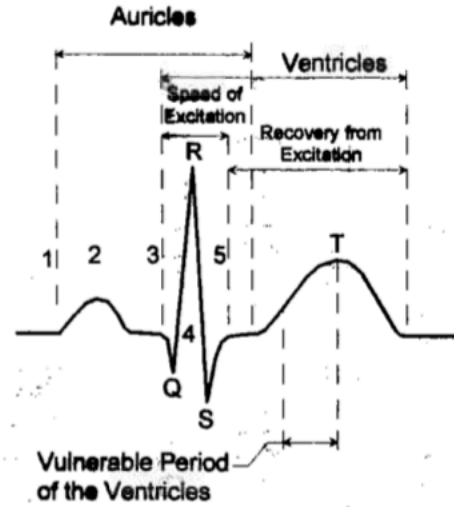
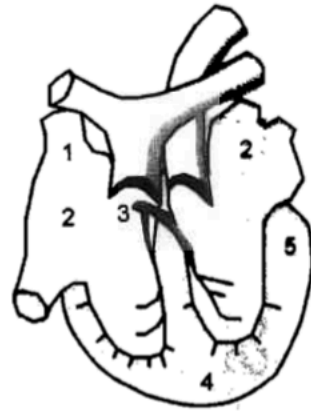
The **fibrillation** does not stop when the current that triggered it is removed.

Ventricular fibrillation is the major cause of death due to electric shock.

The threshold for ventricular fibrillation for an average-sized human varies from about 75 to 400 mA

Normal rhythmic activity returns only if a brief high-current pulse from a defibrillator is applied to depolarize all the cells of the heart muscle the cells relax together, a normal rhythm usually returns

Effects of Current on Heart Beat

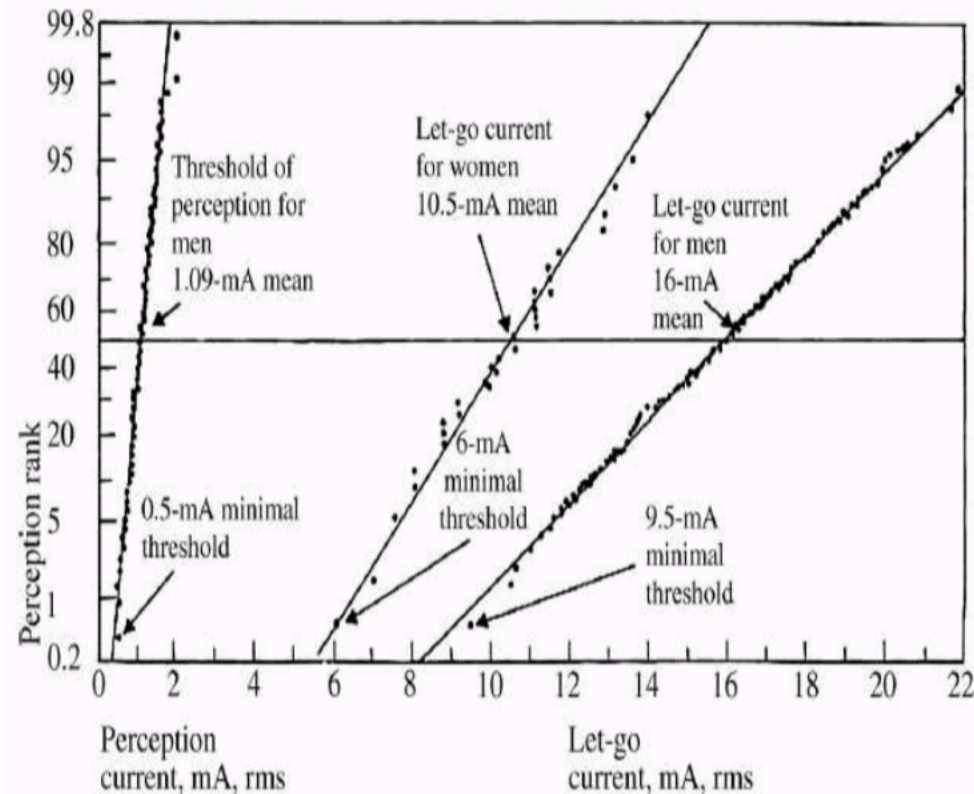


INFLUÊNCIA DA CORRENTE

I (m A)		REAÇÃO FISIOLÓGICA	CONSEQUÊNCIA	SALVAMENTO	RESULTADO FINAL MAIS PROVÁVEL
C.A.	C.C.				
ATE 25	ATE 80	1 mA (C.A)-Limiar da sensação/sens. de formigamento 5-15 mA(C.A)-Contração muscular 15-25 mA(C.A)-Contr.Violenta Impossib. de soltar o eletrodo. Prob. Respiratório	Se a corrente for próxima 25 mA --- pode haver Asfixia e conseq. Morte Aparente.	RESPIRAÇÃO ARTIFICIAL	RESTABELECIMENTO
25-80	80-300	- Sensação In suportável - Contrações Violentas - Asfixia	MORTE APARENTE	RESPIRAÇÃO ARTIFICIAL	RESTABELECIMENTO
>80	>300	- Asfixia Imediata - Fibrilação Ventric. - Alteração Musculares (Químicas). - Queimaduras	MORTE APARENTE	- RESPIRAÇÃO ARTIFICIAL - MASSAGEM CARDÍACA	CASO LEVADO AO HOSP. E FEITO A DESFIBRILAÇÃO -- RESTABELECIMENTO
CORRENTE DA ORDEM DE AMPÈRES		- Queimaduras (Efeito Térmico). - Necrose dos tecidos - Fibrilação Ventric. - Asfixia Imediata - Danos posteriores Resultado do Produto da Eletrolise	- MORTE APARENTE - DEPENDENDO DA EXTENSÃO DAS QUEIMADURAS, SE QUELAS OU MORTE	- RESPIRAÇÃO ARTIFICIAL - MASSAGEM CARDÍACA - TRATAMENTO HOSPITALAR	- HOSPITAL - DESFIBRILAÇÃO - RECUPERAÇÃO DIFÍCIL - ATROFIA MUSCULAR - OUTROS DANOS

Efeito da Corrente no Corpo Humano

Threshold and let-go variability



For men:-

The mean value for the threshold of perception is 1.1 mA.

let-go currents of 16 mA

For women:-

the estimated mean is 0.7 mA.

The minimal threshold of perception is 500 mA.

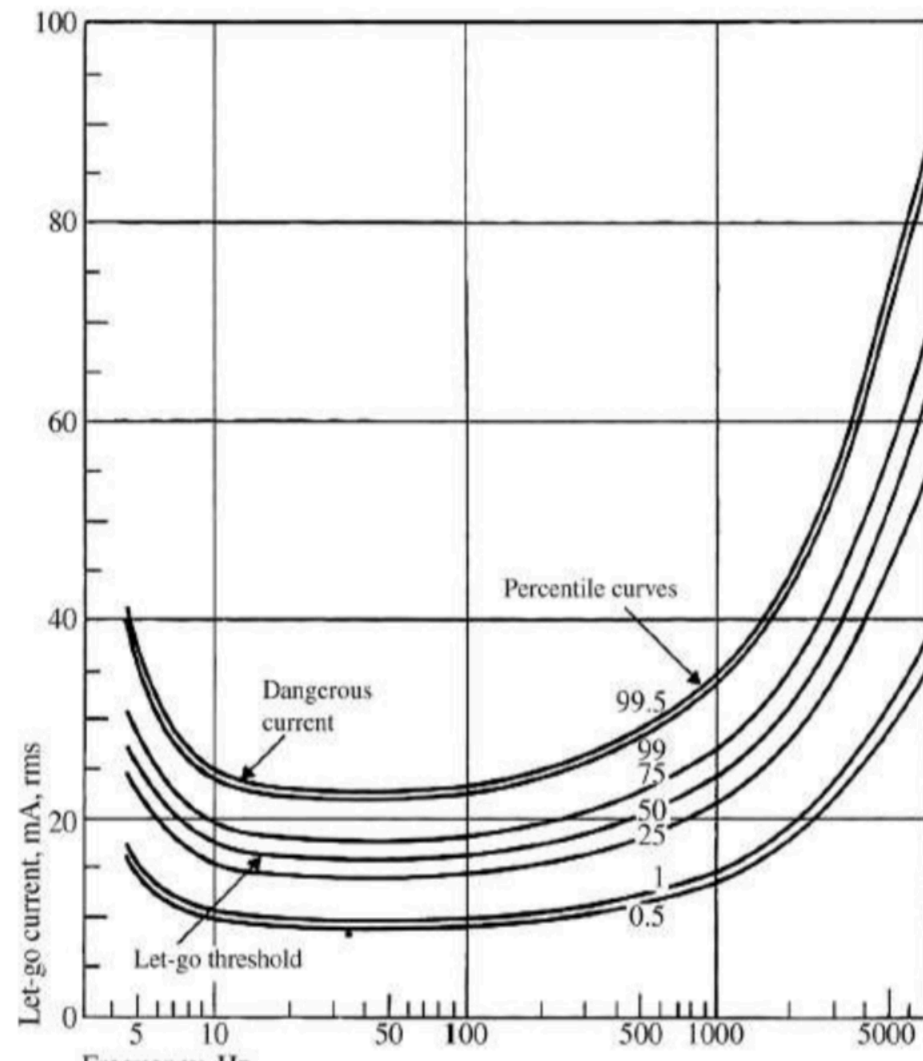
let-go currents of 10.5 mA

let-go current versus frequency of the current

The **minimal let-go currents** occur for commercial power-line frequencies of 50 to 60 Hz

For frequencies **below 10 Hz**, **let-go currents rise**, probably because the muscles can partially relax during part of each cycle

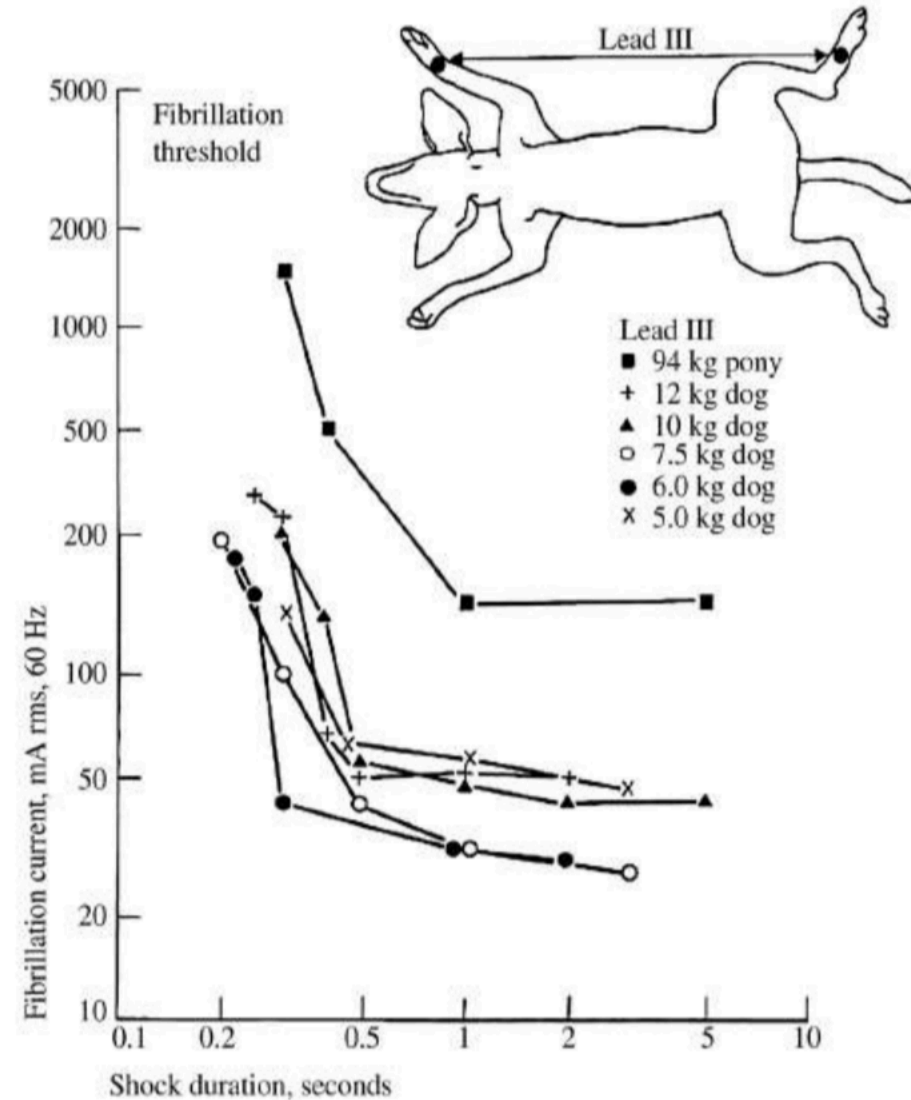
At frequencies **above several hundred hertz**, the **let-go currents rise again**.



Let-go current versus frequency

Body weight and fibrillation, duration of the current

Several studies using animals of various sizes have shown that the fibrillation threshold increases with body weight. Fibrillating current increases from 50 mA rms for 6 kg dogs to 130 mA rms for 24 kg dogs.

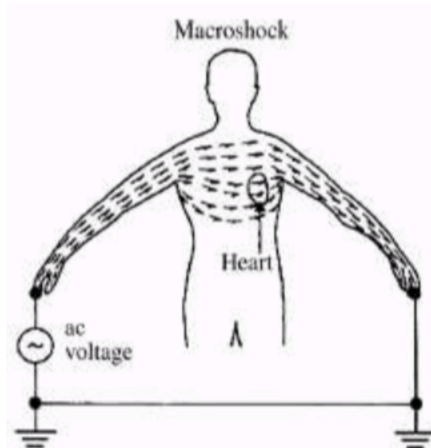


Point of entry (macroshock and microshock)

Macroshock:-

When current is applied at two points on the surface of the body, only a **small fraction** of the total current flows through the heart (macroshock).

The **magnitude of current** needed to fibrillate the heart is far greater when the current is **applied on the surface** of the **body** than it would be if the current were **applied directly to the heart**



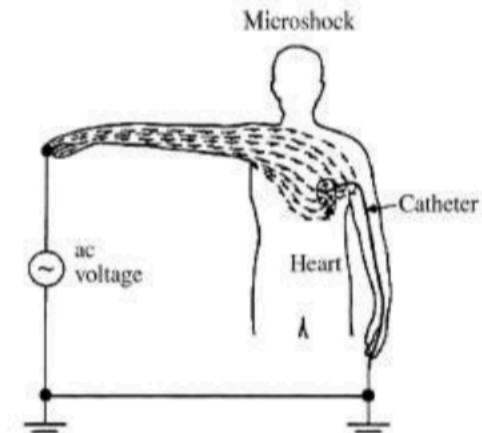
Microshock:-

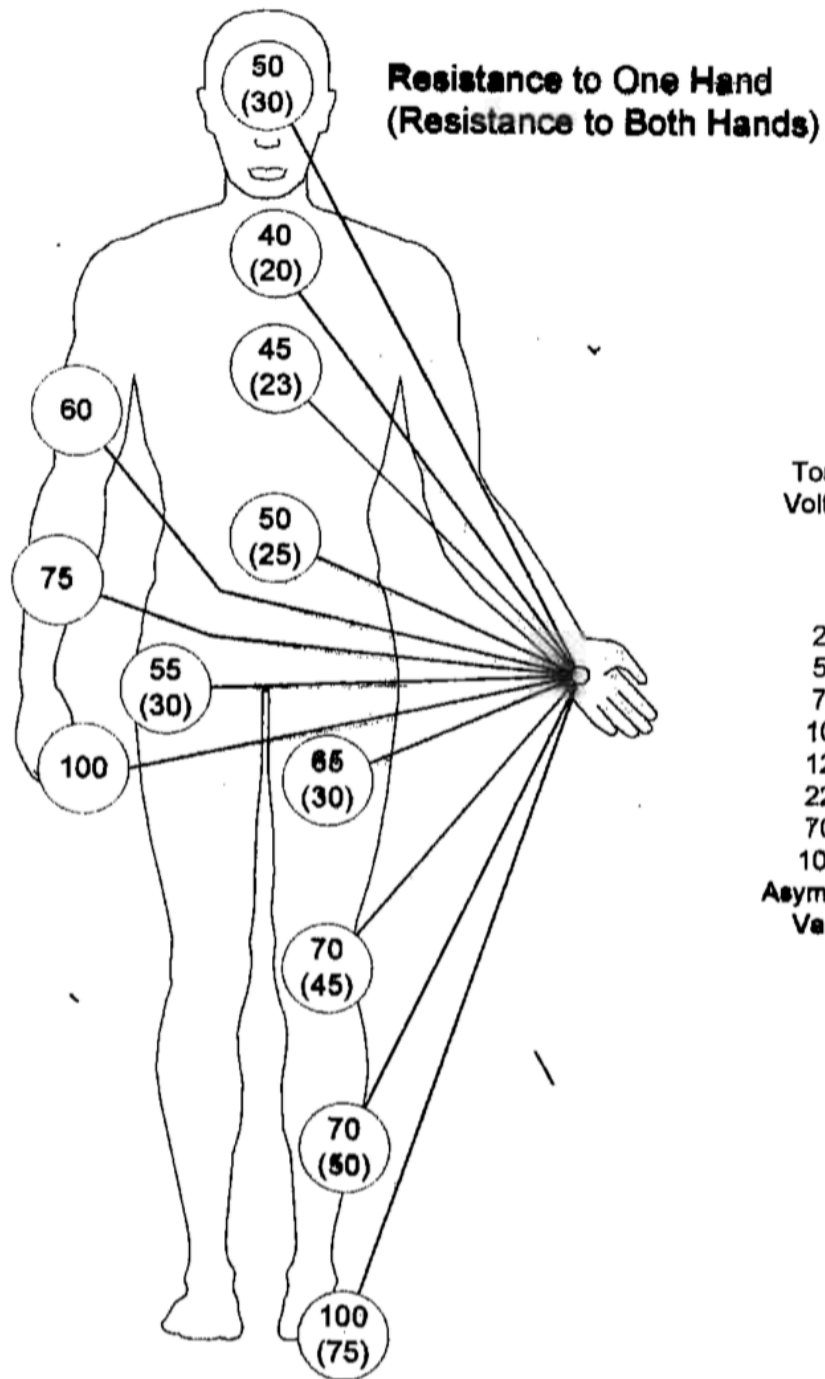
All the current applied through an **intracardiac catheter** flows through the heart

small currents called microshocks can induce Ventricle fibrillation

Current of about **20 μA** can cause microshock .

The widely accepted **safety limit** to prevent microshocks is **10 mA**.



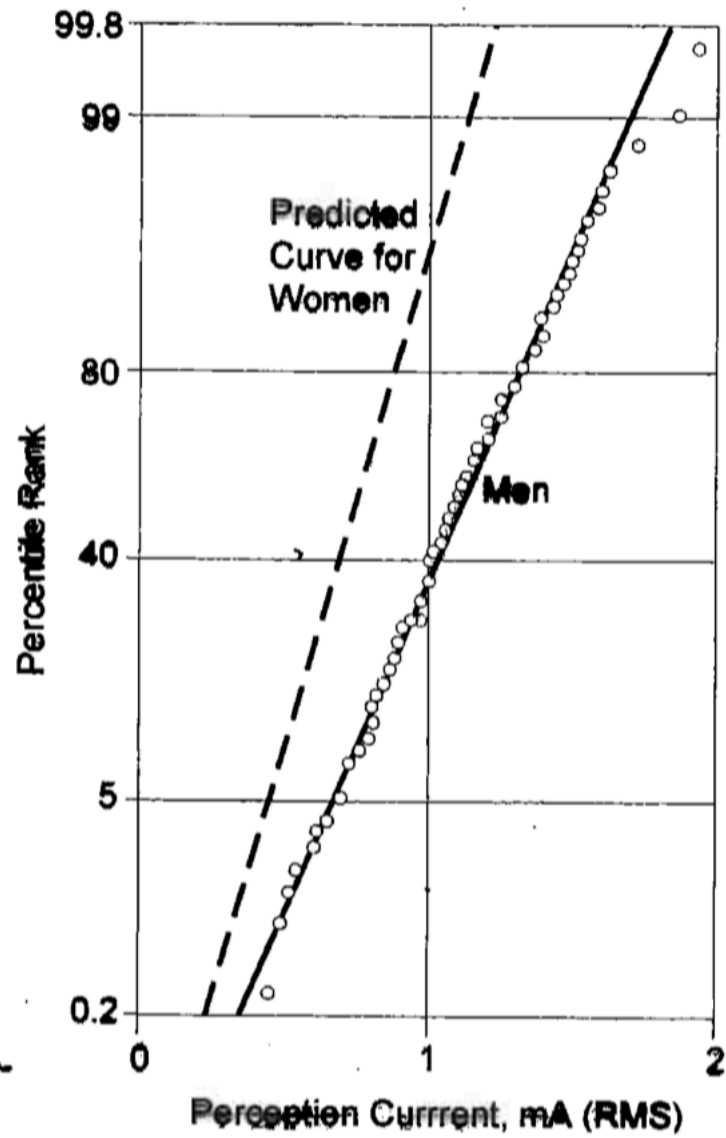


Body Impedance

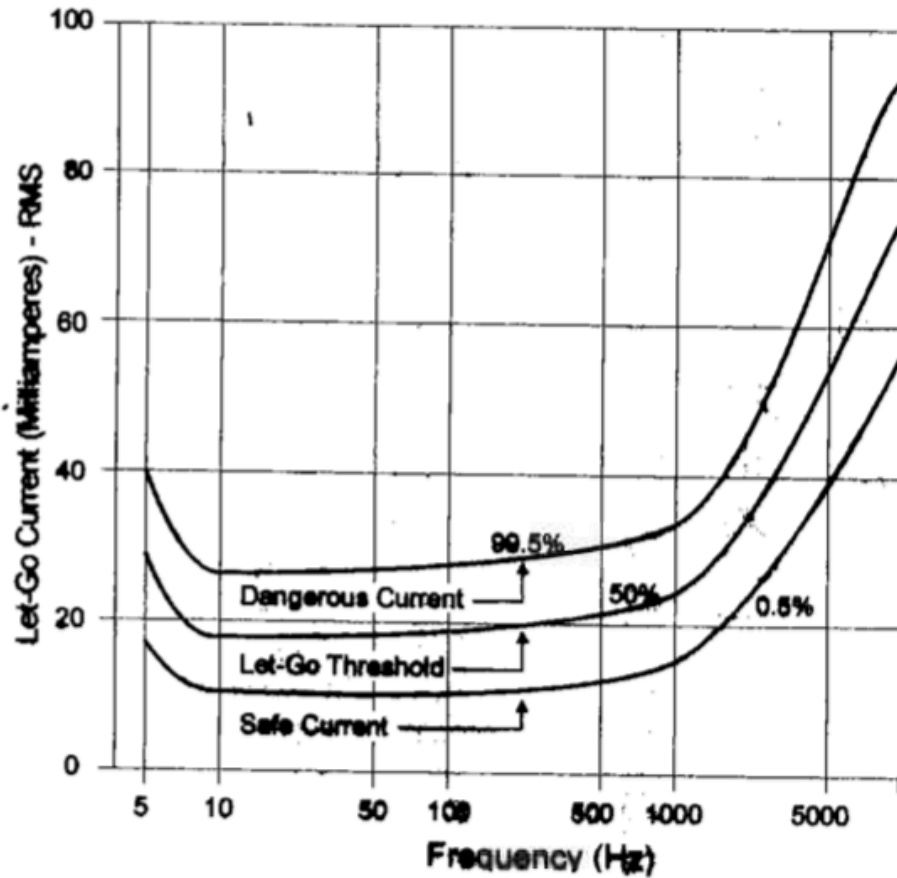
Values for the total body impedance (Ω) that are not exceeded for a percentage (percentile rank) of

Touch Voltage	5% of the population	50% of the population	95% of the population
25	1750	3250	6100
50	1450	2625	4375
75	1250	2200	3500
100	1200	1875	3200
125	1125	1625	2875
220	1000	1350	2125
700	750	1100	1550
1000	700	1050	1500
Asymptotic Value	650	750	850

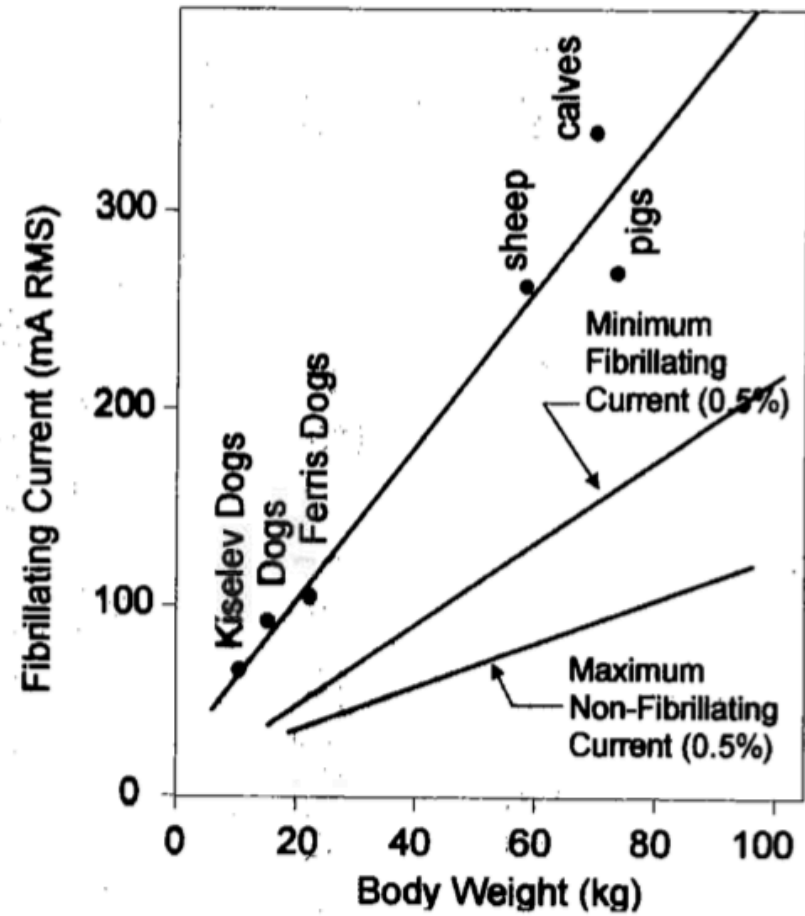
Perception Current



Let-Go Current



Ventricular Fibrillation



Limites de Corrente Corpo Humano

- Dalziel - testes com animais
- $I = K/T^{1/2}$ - $K = S_b^{1/2}$
 - $0,03 < T < 3$ s
 - S_b - energia do choque
- $I = 0,116/ T^{1/2}$ - 50 Kg - 50/60 Hz - 99,5%
- 1961 - 70 Kg - $I = 0,165/ T^{1/2}$ - 99,5%
- 1968 - Dalziel - $I = 0,157/ T^{1/2}$