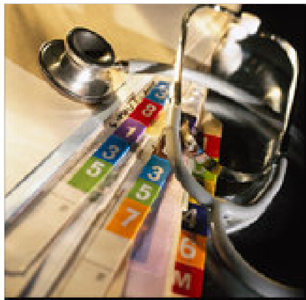


Evaluation of postmortem serum calcium and magnesium levels in relation to the causes of death in forensic autopsy

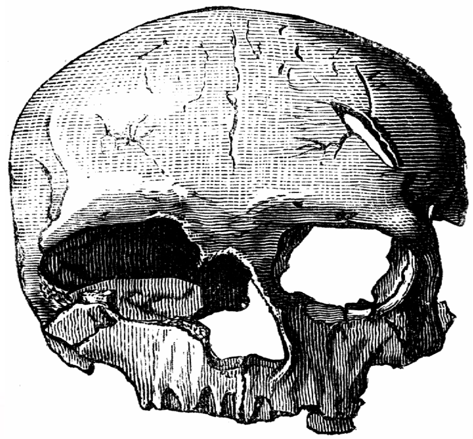
Bao-Li Zhu*, Takaki Ishikawa, Li Quan, Dong-Ri Li, Dong Zhao,Tomomi Michiue, Hitoshi Maeda

Forensic Science International 155 (2005) 18–23

PIYACHAT PROMPECH

52312319

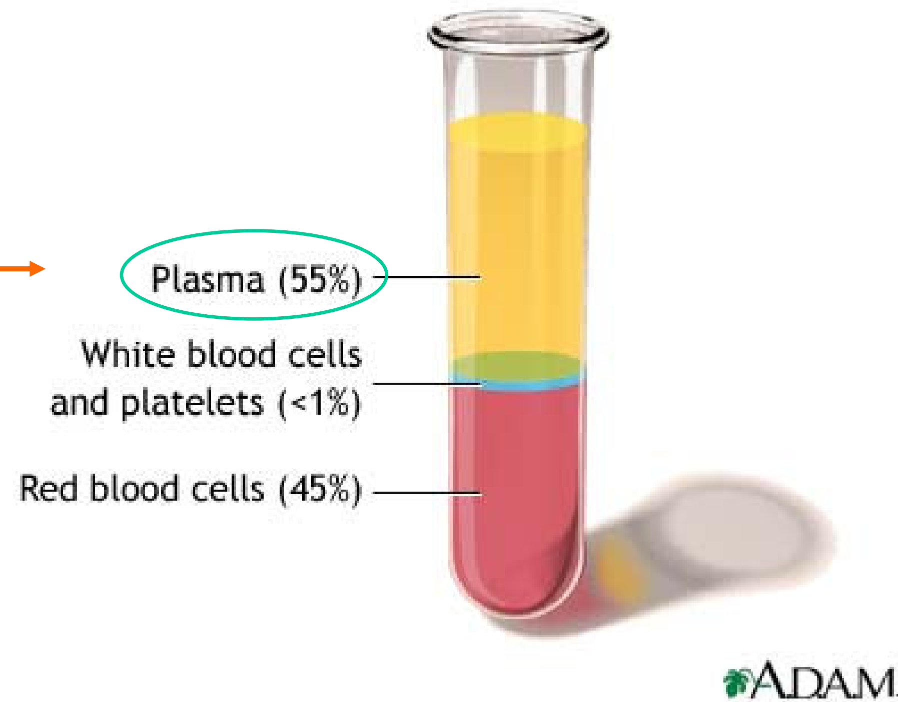
INTRODUCTION



- **Natural death**
- **Unnatural death**
- **Legal death**

INTRODUCTION (Cont.)

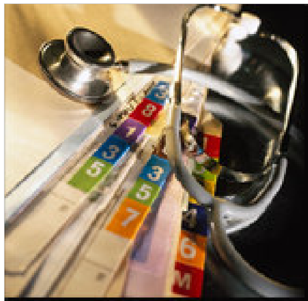
INTRODUCTION (Cont.)



Ions in blood plasma : calcium (Ca), magnesium (Mg) and sodium (Na).

OBJECTIVE

- Examined postmortem serum Calcium (Ca) and Magnesium (Mg) levels in relation to the cause of death

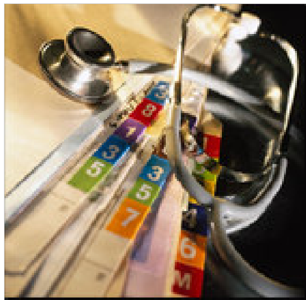


MATERIAL

Case profiles

Cause of death	*n*	Age (years)		Postmortem interval (h) range	BUN (mg/dl)	
		Range	Mean		Range	Mean
Blunt injury	76	2–94	53.2	6–40	5.7–40.3	17.2
Sharp injury	29	22–90	53.5	6–46	1.3–36.7	13.3
Asphyxia	42	2–93	48.9	6–47	7.4–45.8	16.9
Drowning						
Freshwater	11	5–72	42.8	10–34	10.6–20.2	13.9
Saltwater	17	0–70	45.6	7–48	5.8–23.0	14.2
Fire fatality						
COHb < 60%	48	23–89	62.4	6–48	4.0–40.3	16.9
COHb > 60%	31	1–87	55.8	7–39	7.2–31.2	17.9
MA poisoning	8	20–52	38.3	8–34	11.1–112.0	46.5
Delayed death from traumas	37[a]	1–79	57.2	5–32	10.8–114.6	58.8
Acute myocardial infarction/ischemia	61	31–94	65.5	5–36	4.7–42.8	19.9
Total	360	0–94	52.2	5–48	1.3–114.6	22.4

COHb, carboxyhemoglobin concentration; MA, methamphetamine.



MATERIAL (Cont.)

Biochemistry Analyses

Calcium (Ca) & Magnesium (Mg)

Clinical reference serum

ranges were: 8.7–10.1 mg/dl for Ca

1.8–2.6 mg/dl for Mg

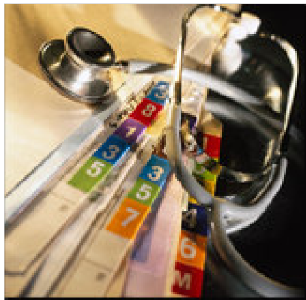
Ortho-cresolphthalein complexome method and Xylidyl blue method

Blood urea nitrogen (BUN)

Clinical reference serum

ranges were: 7-18 mg/dl for BUN

urease-glutamate dehydrogenase method



MATERIAL (Cont.)

Toxicological Analyses

Blood COHb concentration →

CO-Oximeter system

Alcohol analyses →

Head space gas chromatography

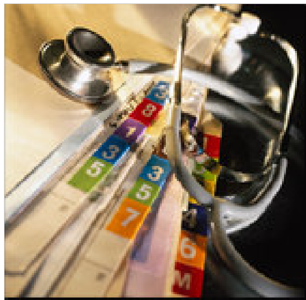
Drug analyses →

Gas chromatography/Mass spectrometry

MATERIAL (Cont.)

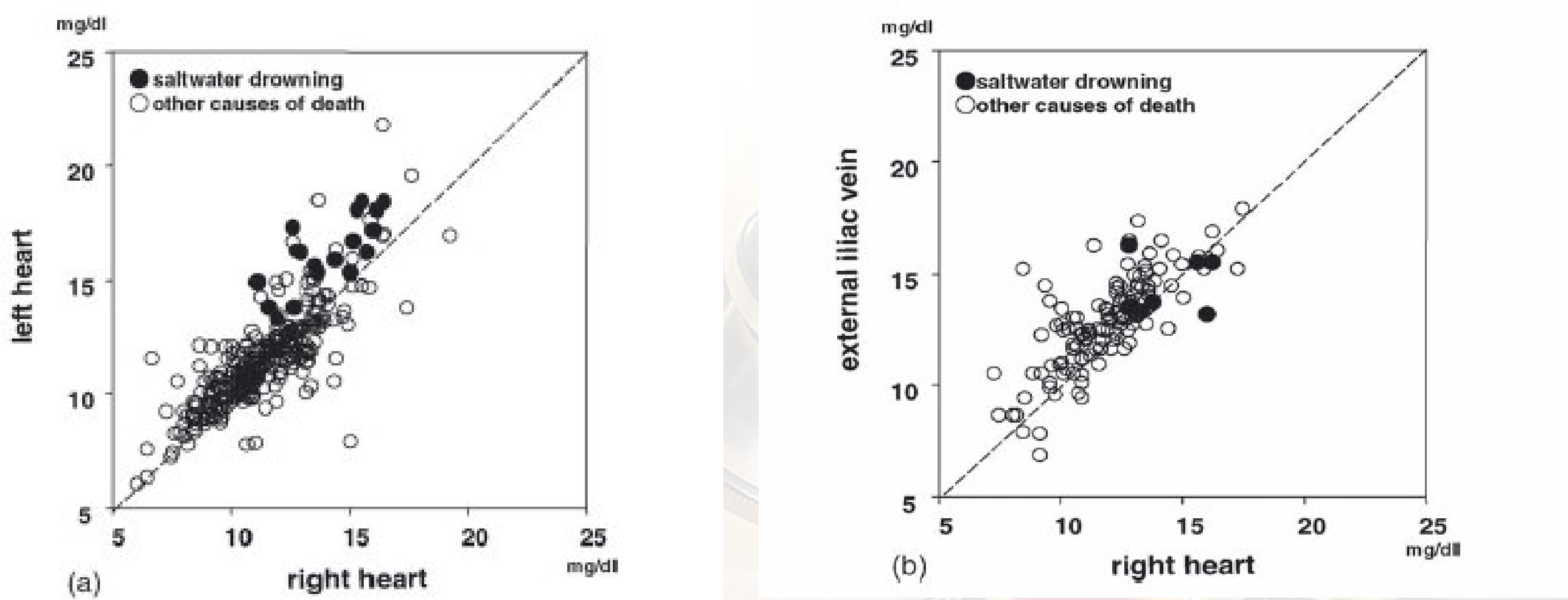
Statistical Analyses

- **Student's t-test**,
- **Nonparametric test (Mann–Whitney U-test)**



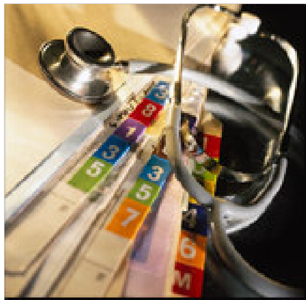
RESULT

3.1 Postmortem stability, topographic distribution, age and gender - dependence



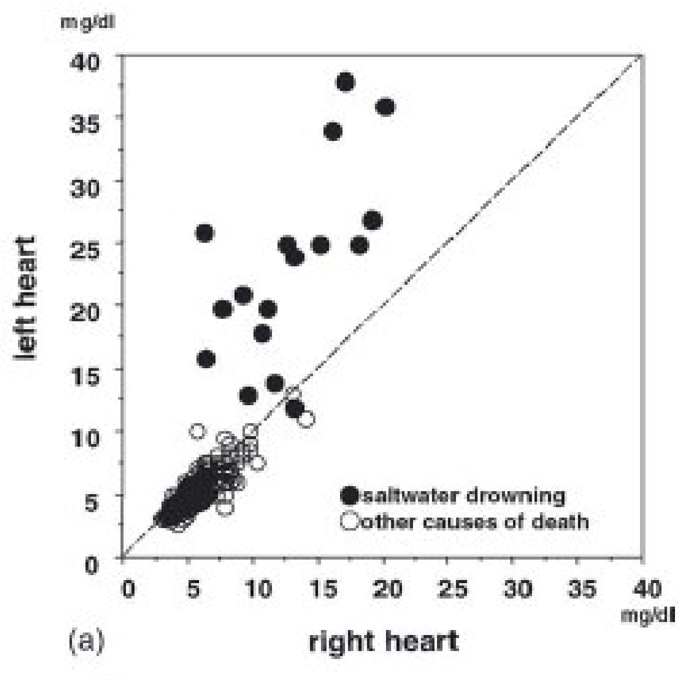
Calcium (Ca)

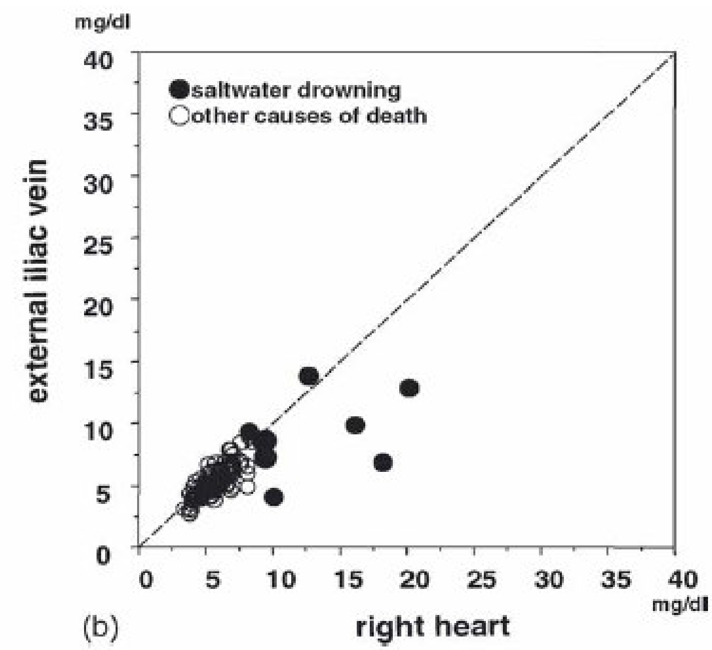
Topographic comparisons of postmortem serum levels.



RESULT (Cont.)

3.1 Postmortem stability, topographic distribution, age and gender - dependence



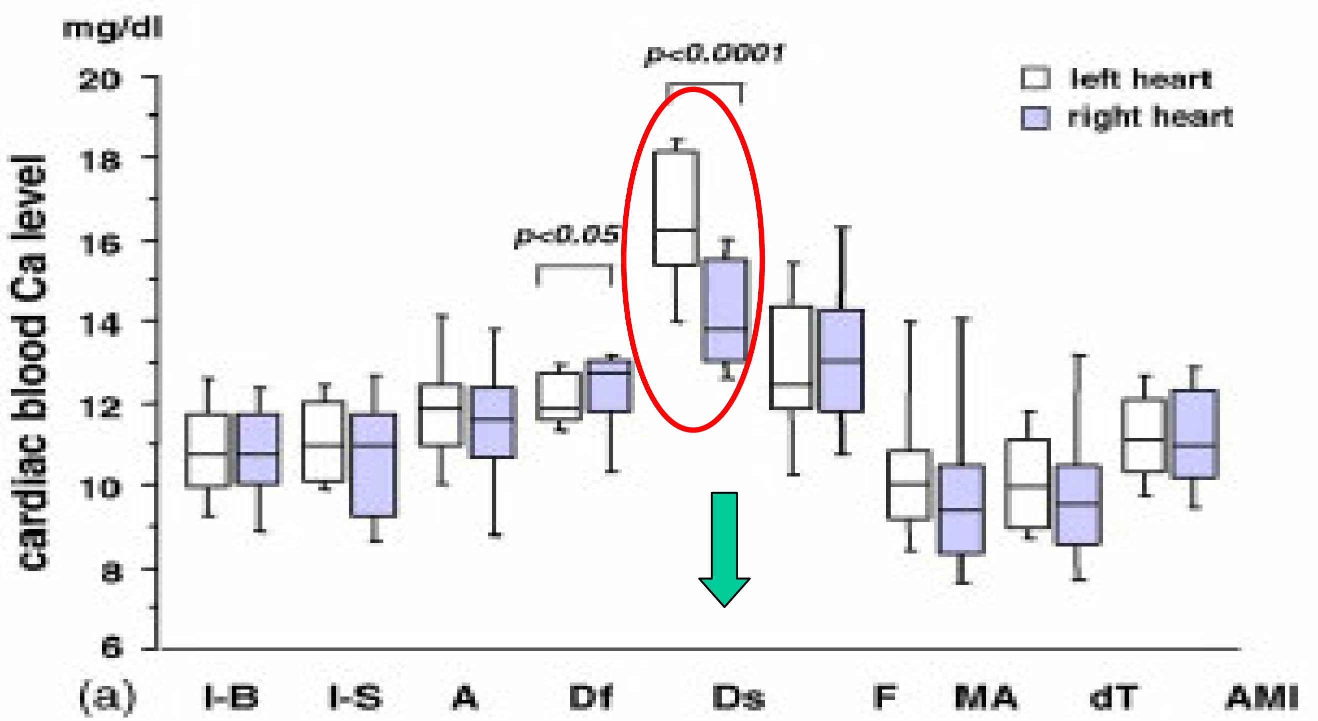


Magnesium (Mg)

Topographic comparisons of postmortem serum levels.

RESULT (Cont.)

3.2 Difference in relation to the causes of death

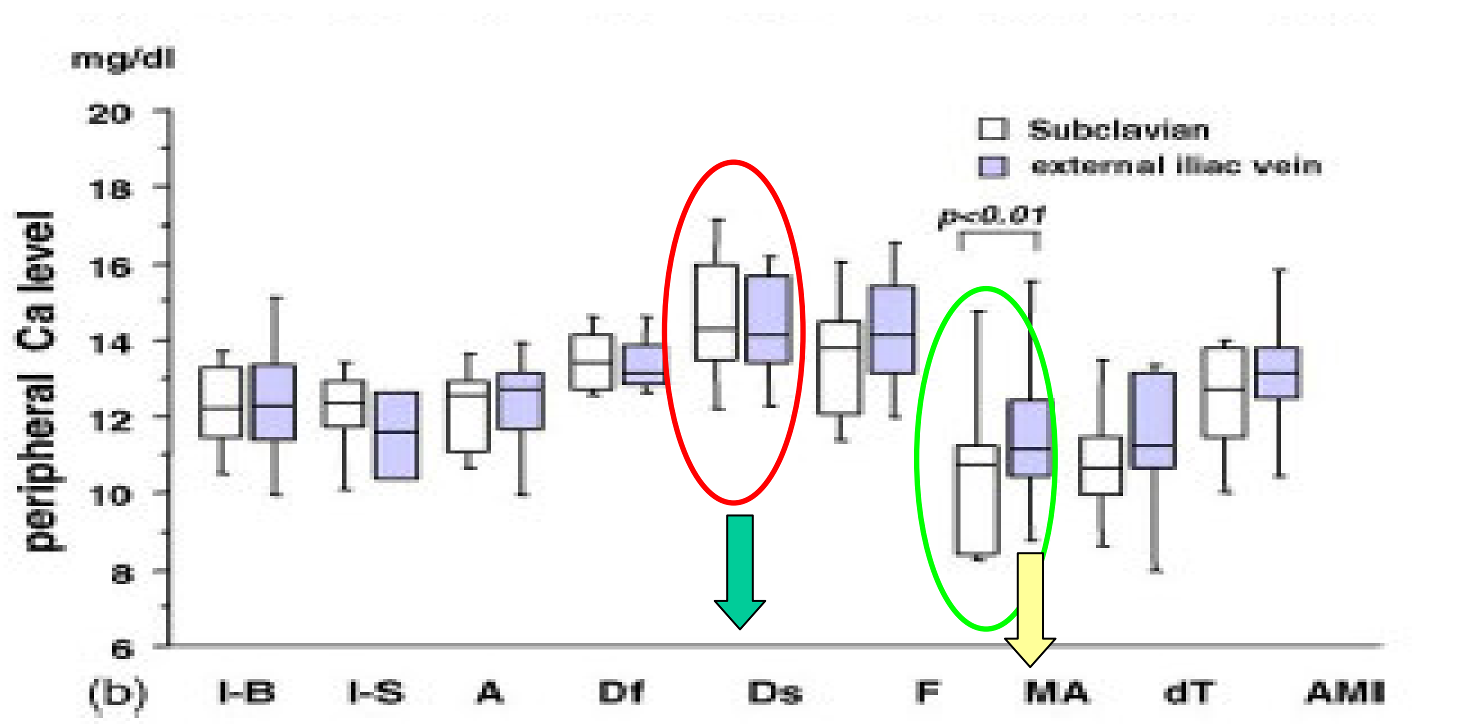


I–B, blunt injury , I–S, sharp injury ,A, mechanical asphyxiation ,Df, freshwater drowning Ds, saltwater drowning, F, fire fatalitie ,MA, fatal methamphetamine poisoning ,dT, delayed traumatic death ,AMI, acute myocardial infarction/ ischemia

Postmortem serum calcium (Ca) levels in the heart blood

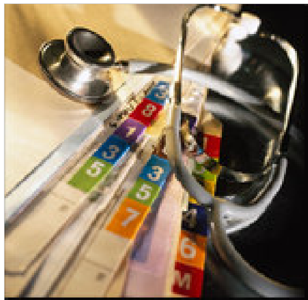
RESULT (Cont.)

3.2 Difference in relation to the causes of death



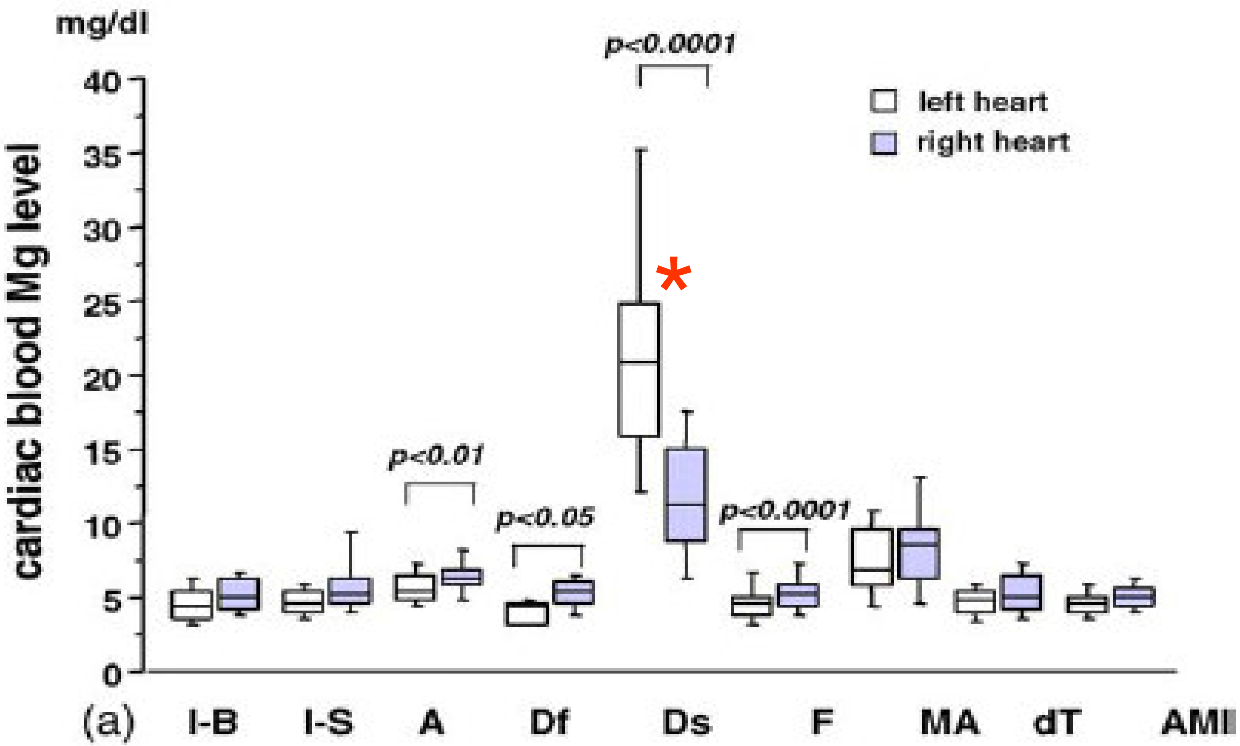
I–B, blunt injury , I–S, sharp injury ,A, mechanical asphyxiation ,Df, freshwater drowning Ds, saltwater drowning, F, fire fatalitie ,MA, fatal methamphetamine poisoning ,dT, delayed traumatic death ,AMI, acute myocardial infarction/ ischemia

Postmortem serum calcium (Ca) levels in peripheral blood



RESULT (Cont.)

3.2 Difference in relation to the causes of death

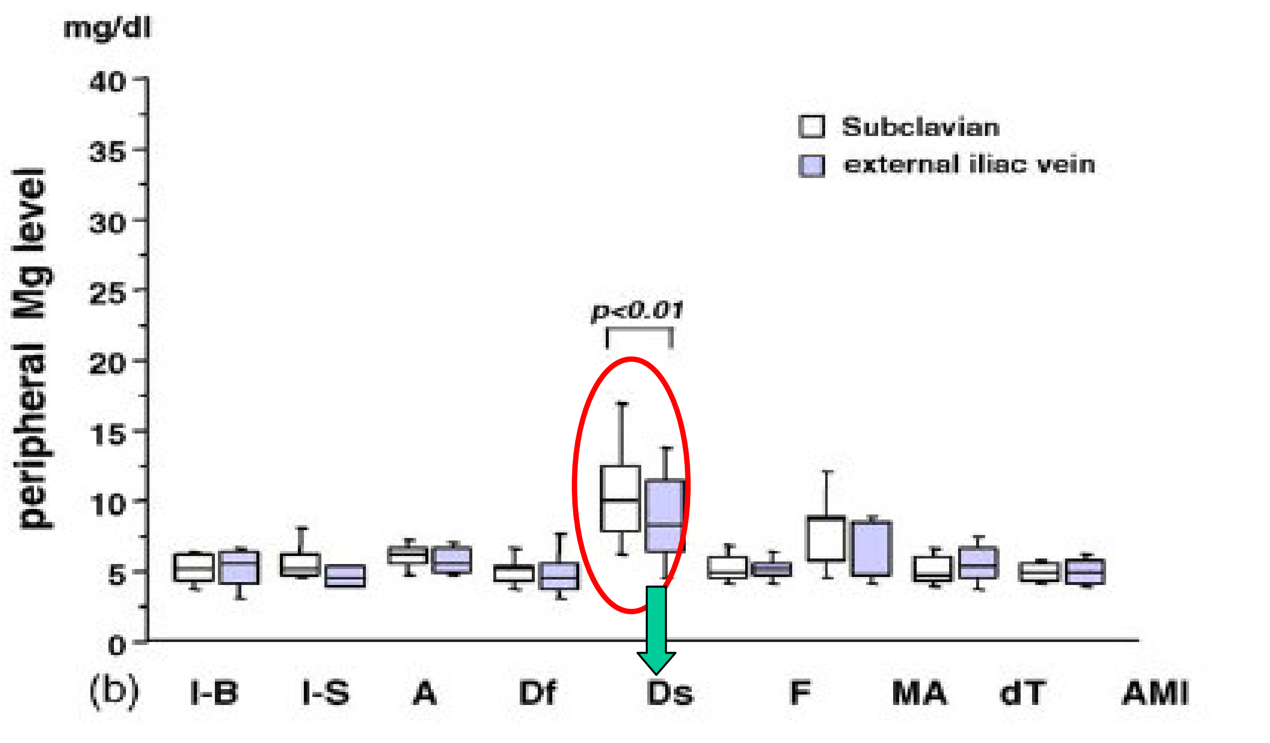


I–B, blunt injury , I–S, sharp injury ,A, mechanical asphyxiation ,Df, freshwater drowning Ds, saltwater drowning, F, fire fatalitie ,MA, fatal methamphetamine poisoning ,dT, delayed traumatic death ,AMI, acute myocardial infarction/ ischemia

Postmortem serum magnesium (Mg) levels in the heart blood

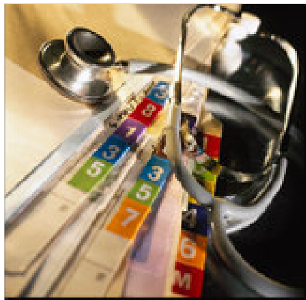
RESULT (Cont.)

3.2 Difference in relation to the causes of death



I–B, blunt injury , I–S, sharp injury ,A, mechanical asphyxiation ,Df, freshwater drowning Ds, saltwater drowning, F, fire fatalitie ,MA, fatal methamphetamine poisoning ,dT, delayed traumatic death ,AMI, acute myocardial infarction/ ischemia

Postmortem serum magnesium (Mg) levels in peripheral blood



DICUSSION

Previous studies

[S. Balabanova, V. Gras (1992) ,S.D. Lincoln, V.M. Lane(1985) and J.I. Coe (1974)]

- Serum Ca and Mg levels depending on the time after death

In the present study

- Postmortem time-dependent rise was not evident during 5-48 h after death

DICUSSION (Cont.)

[D.S. Cohen, M.A. Matthay, M.G. Cogan, J.F. Murray (1992)]

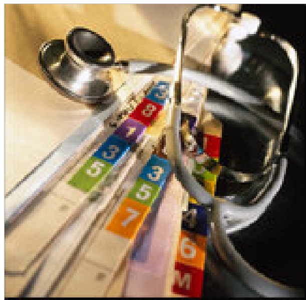
- Both Ca and Mg levels in the cardiac and peripheral blood were significantly higher in saltwater drowning.

[J. Turinsky, W.A. Gonnerman, L.D. Loose (1981)]

- Elevated serum Ca level was also observed in fire fatalities and freshwater drowning in the peripheral blood, suggesting an increase of skeletal muscle origin

[J .G. Toffaletti (1996)]

- Lower serum Ca level was observed in MA fatality and delayed traumatic death cases, by skeletal muscle damage and renal failure.



DICUSSION (Cont.)

[H.A. Harper (1979)]

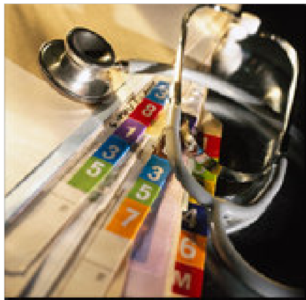
- Elevated serum Mg level was observed in asphyxiation in the right heart blood and fatal MA intoxication

[G.T. Sanders, H.J. Huijgen, R. Sanders (1999)]

- Origin of increased serum Mg may be skeletal muscle and/or myocardium, possibly being varied depending on the causes of death.

[R. Lappalainen, M. Knuuttila (1985)]

- Age-dependent decrease in the postmortem serum Mg level, a possible contributory factor may be reduced nutrition

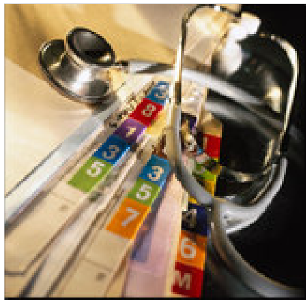


CONCLUSION

- No significant postmortem time-dependent rise in serum Ca and Mg during the early postmortem period.

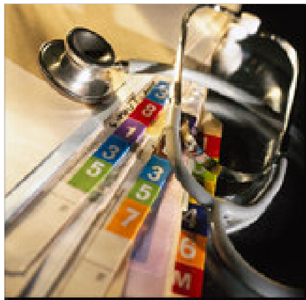
- Although, Increase in cadaveric blood levels, a significant difference in postmortem serum Ca and Mg levels was observed between the causes of death

Useful especially for diagnosis and differentiation of salt and freshwater drownings to determine the causes of death

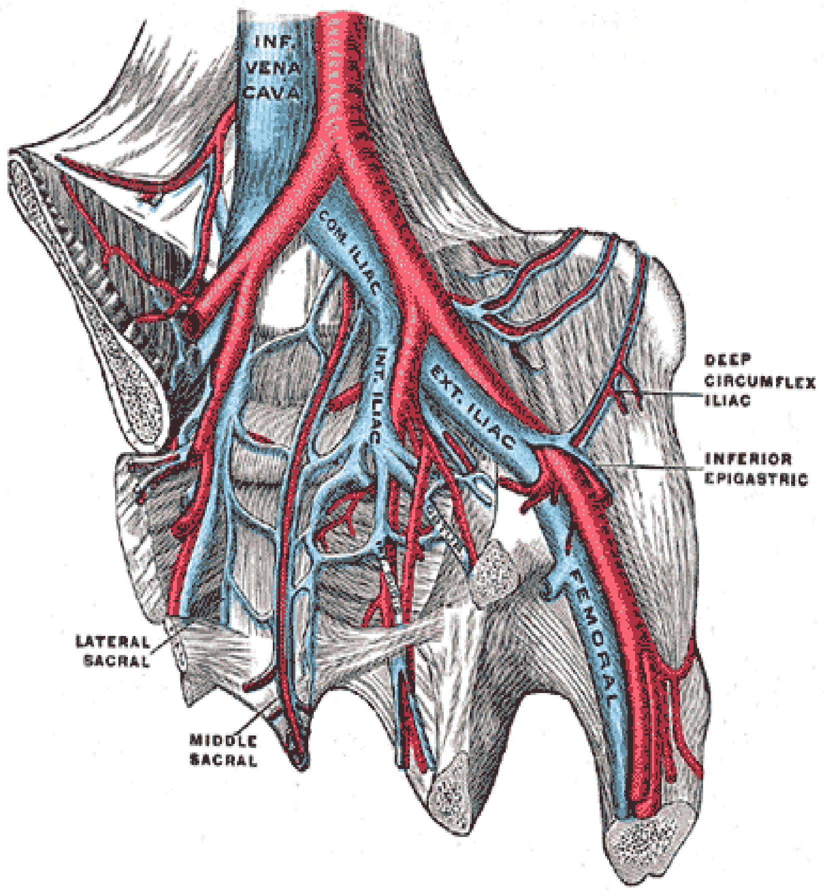


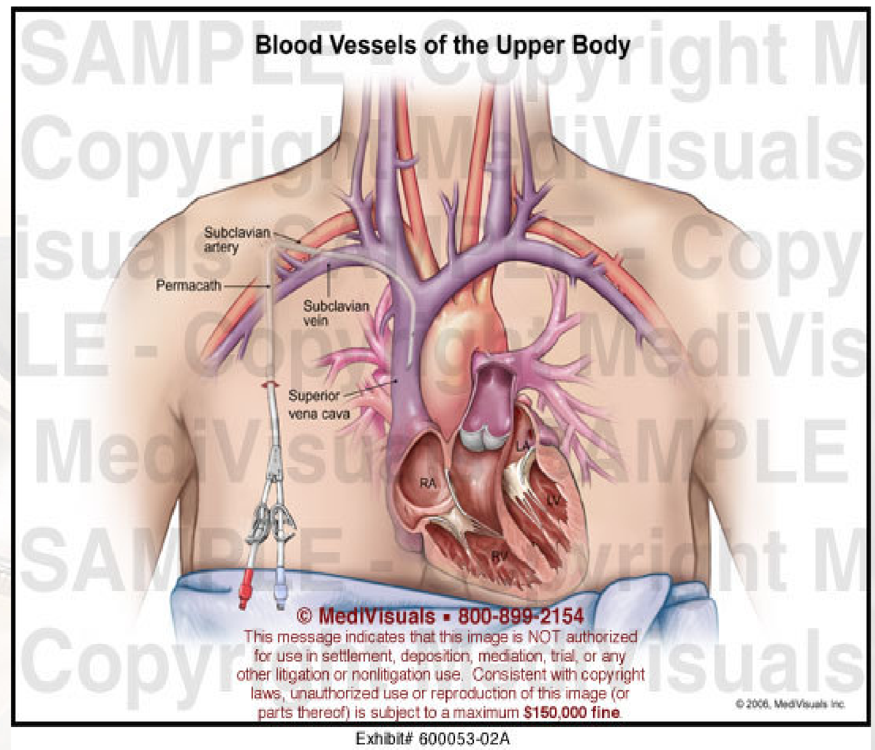
THANK YOU FOR YOUR ATTENTION

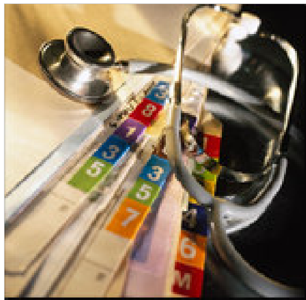
Q & A



External iliac & Subclavian vein







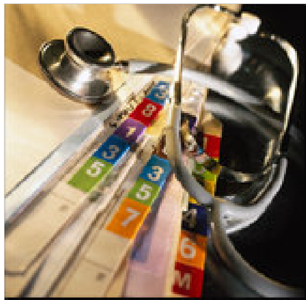
Calcium-O-Cresolphthalein Complexone Method

Principle of the method

- Ca forms a purple-coloured complex in an alkaline medium
  - Inclusion of HCl helps to release Ca bound to proteins and 8 hydroxy-quinoline
    - Eliminates the interference by Mg
      - The intensity of the colour is measured at 540nm/yellow green filter.

Reference

1. Gitelman H.(1967) Anal.Biochem 20 : 521.
2. Gindler EM & King JD (1972) Am JClin Pathol 58: 376.

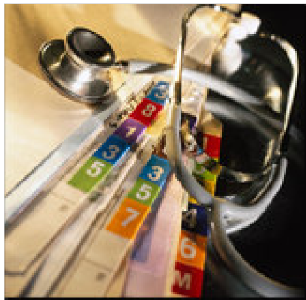


Xylidyl blue method

Reaction Principle

$$\text{Xylidyl blue} + \text{Magnesium} \xrightarrow{OH^-} \text{Xylidyl blue-Magnesium complex}$$

- By using the EGTA to eliminate the interference of Ca
- Mg-ions combine with xylidyl blue to produce a xylidyl blue-Mg complex
- The absorbency increase is directly proportional to the concentration of Mg



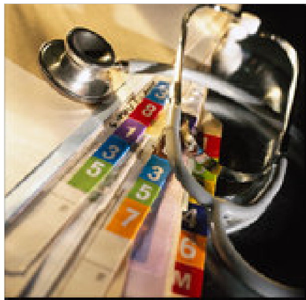
Urease-glutamate dehydrogenase method

Principle of the method

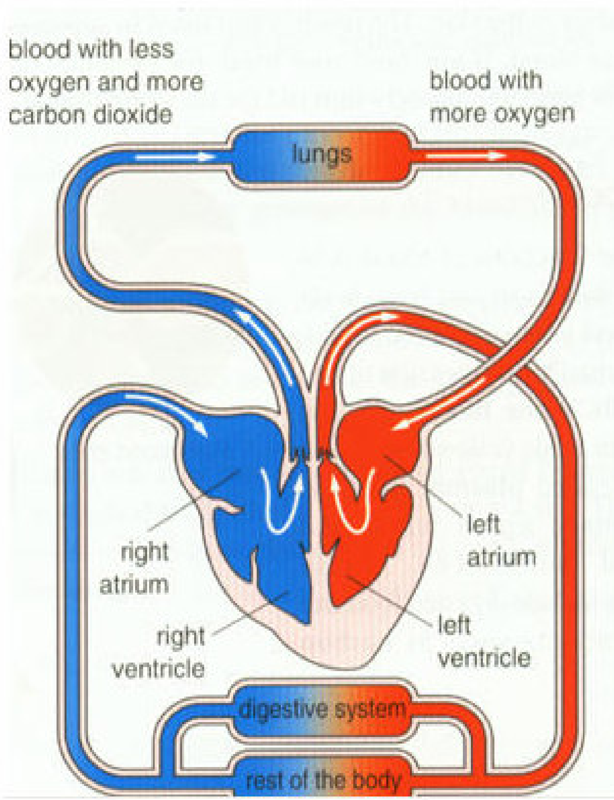
$$Urea + H_2O \xrightarrow{\text{Urease}} 2\,NH_3 + CO_2$$

$$NH_3 + \alpha\text{-Ketoglutarate} + NADH + H^+ \xrightarrow{\text{GD}} \text{L-glutamate} + NAD^+ + H_2O$$

- Urea is hydrolyzed by Urease to produce ammonia and carbon dioxide
  - The liberated ammonia reacts with a-Ketoglutarate in the presence of NADH
    - The reaction resulting in a decrease in absorbance that is directly proportional to the urea nitrogen concentration



ระบบการไหลเวียนเลือด



1. เลือดจากส่วนต่าง ๆ ของร่างกายซึ่งเป็นเลือดที่มีปริมาณแก๊สออกซิเจนต่ำ จะไหลกลับเข้าสู่หัวใจห้องบนขวา (Right Atrium)

2. เมื่อหัวใจบีบตัวเลือดจะไหลจากหัวใจห้องบนขวา ผ่านลิ้นหัวใจลงสู่ห้องล่างขวา (Right Ventricle)

3. เมื่อหัวใจห้องล่างขวาบีบตัว เลือดจะไหลเข้าสู่หลอดเลือดไปยังปอด เมื่อมีการแลกเปลี่ยนแก๊สระหว่างแก๊สคาร์บอนไดออกไซด์และแก๊สออกซิเจน เลือดที่มีปริมาณแก๊สออกซิเจนสูงจะไหลกลับเข้าสู่หัวใจห้องบนซ้าย (Left Atrium)

4. เมื่อหัวใจห้องบนซ้ายบีบตัว เลือดจะไหลผ่านลิ้นหัวใจลงสู่ห้องล่างซ้าย(Left Ventricle)

5. เมื่อหัวใจห้องล่างซ้ายบีบตัว เลือดจะไหลเข้าสู่หลอดเลือดไปเลี้ยงส่วนต่าง ๆ ของร่างกาย และเมื่อเลือดมีปริมาณแก๊สออกซิเจนต่ำก็จะไหลกลับเข้าสู่หัวใจห้องบนขวาเป็นเช่นนี้เรื่อย ๆ ไป