Biochemical blood markers and sampling sites in forensic autopsy

ตัวบ่งชี้ทางชีวเคมีในเลือดและบริเวณที่เก็บตัวอย่างในการชันสูตรพลิกศพสืบสวนทางกฎหมาย

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Biochemical blood markers and sampling sites in forensic autopsy

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Abstract

Forensic pathologists often hesitate to use biochemical blood markers due to the risk of large postmortem changes and deviations from healthy subjects. Biochemical analyses of postmortem blood, if possible, may help to evaluate pathological status and determining the cause of death in forensic diagnosis, for example, in sudden unexpected death without obvious cause, or young adults with no apparent cause of death or antemortem information. Even commercially available biochemical markers were re-evaluated in the blood samples of 164 forensic autopsy cases. Biochemical markers examined were HbA1c, fructosamine, blood nitrogen urea (BUN), creatinine, total protein, total bilirubin, γ-glutamyl transpeptidase (γ-GTP), triglyceride, total cholesterol, C-reactive protein (CRP) and pseudocholine esterase (pChE). We collected cardiac blood (left cardiac blood and right cardiac blood) and peripheral blood (femoral vein blood) to clarify the differences in measured values by sampling site. The measured values were analyzed in relation to postmortem interval, etiology of death and sampling sites. Of all eleven markers, HbA1c is the most useful and reliable because of its negligible postmortem changes and small deviation from healthy subjects. Total bilirubin, BUN, CRP and total cholesterol can be useful if we set appropriate limit ranges and pay attention to the interpretation. For the evaluation of changes due to postmortem intervals, none of the markers except for triglyceride showed significant changes up to three days postmortem. As for sampling sites, femoral vein blood is generally recommended considering postmortem changes, but left cardiac blood was suitable for creatinine, pChE, and total cholesterol. For clinical forensic diagnosis of biochemical blood markers, we must determine the "forensic abnormal value" after collecting more cases by known causes with more information about the population.

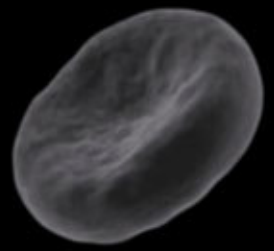
Introduction

- Antemortem Information :

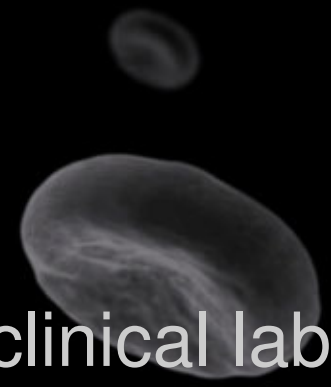
  Present and Past illness make a decision on the basis of autopsy findings

- Biochemical analysis of postmortem blood help in evaluating, determining case of death

- Forensic pathologist hesitated to use blood chemical
  - Large postmortem change
  - Large deviation from healthy subject
- This Research chose to measure 11 markers in blood from 3 sampling site



- The cost 11 markers were very low
  - cause markers are routinely measured in clinical lab
- Research aim was
  - to investigate how biochemical marker from postmortem change
  - showed differences between the etiology of death



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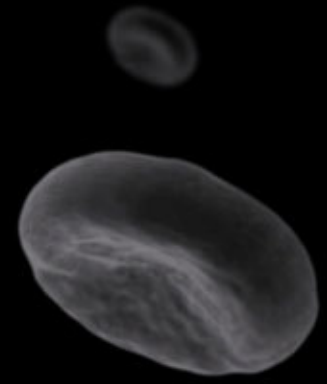
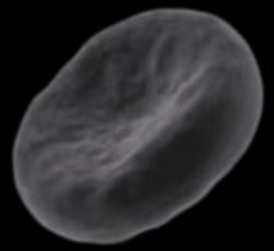


- determining suitable sampling sites
- considering when selecting markers and interpreting results



Materials and methods

➢ Blood samples

- was obtained from 164 autopsy cases in University of Tokyo from April 2003-March 2006
- average age 54.9 ± 21.8
- Male 112 case, Female 52 case

Interval of Sampling specimens	case
0-12 h	25
13-69 h	69
25-48 h	54
49-72 h	16

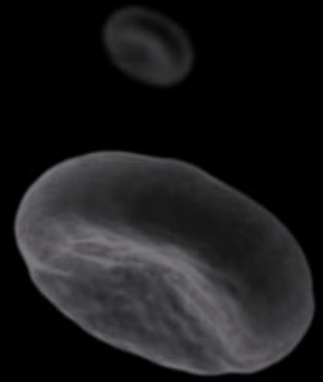
cause of death	case
blunt injury	52
sharp injury	7
asphyxiation	18
drowning	4
fire death	5
intoxication	9
internal death	39
other	30

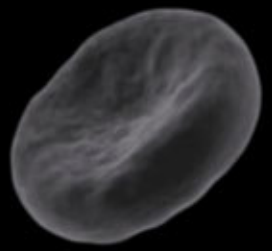
➢ Blood samples (continue)

- was sampled within 72 h postmortem
- from right and left heart cavity and femoral vein
- the sera was stored at -20℃
- the whole blood was stored at 4 ℃
- shipping to laboratory of SRL where were analyzed within a day

➢ Biochemical analyze

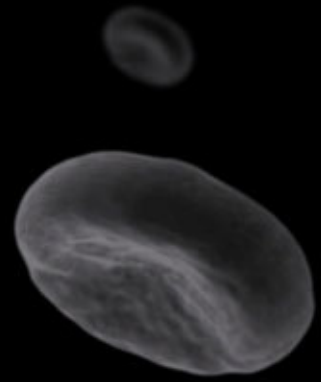
- used the sera volume for 11 markers was 2 ml





Test	Method	Standard Range of Healthy	diagnosis
HbA1C	Latex	4.3-5.8%	Chronic hyperglycemia
Fructosamine	Calorimetry	205-285 mM	Chronic hyperglycemia
BUN	Urease UV	6-20 mg/dl	Renal failure
Creatinine	Enzyme	male 0.61-1.04, female 0.47-0.79 mg/dl	Renal failure
Total protein	Biuret	6.7-8.3 g/dl	Malnutrition
Total bilirubin	Vanadinate oxidation	0.2-1.0 mg/dl	Liver function
γ-glutamyl transpeptidase	JSCC Standizati on	male <70, female <30 IU/ml	Liver function
Triglyceride	Enzyme	50-149 mg/dl	Hyper lipidemia
Total cholesterol	Enzyme	150-219 mg/dl	Hyper lipidemia
CRP	Latex	<0.3 mg/dl	Inflammation
Pseudocholine esterase	Rate assay	male 242-495, female 200-495 IU/l	Liver function and organic phosphate poisoning

Result



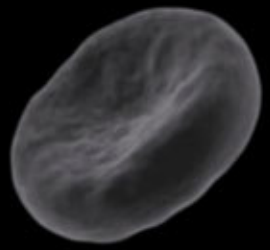


Table 1
Differences from clinical standards (right cardiac blood)

Marker	Measured value	Value obtained from healthy subjects	Unit	*n*	Results outside the reference intervals of healthy subjects (%)
HbA1c	5.23 ± 1.23	4.3–5.8	%	149	24.8
t-Bilirubin	1.32 ± 2.44	0.2–1.0	mg/dL	150	37.3
Triglyceride	129.9 ± 107.4	50–149	mg/dL	155	45.2
BUN	39.8 ± 40.6	6–20	mg/dL	162	59.3
CRP	7.54 ± 11.54	<0.3	mg/dL	163	69.3
γ-GTP	154.1 ± 173.4	Male < 70, female < 30	IU/L, 37 °C	148	74.3
Fructsamine	325.3 ± 147.1	205–285	mM	148	77.7
Creatinine	3.29 ± 2.35	Male 0.61–1.04, female 0.47–0.79	mg/dL	163	95.1
Pseudocholine esterase	204.1 ± 120.7	Male 242–495, female 200–459	IU/L, 37 °C	153	64.1
t-Cholesterol	142.3 ± 77.3	150–219	mg/dL	155	72.9
t-Protein	7.45 ± 2.09	6.7–8.3	g/dL	154	75.3

Values are expressed as the mean ± SD.

- HbA1C showed the smallest deviation from healthy subjects (24.8%)

Table 2
Postmortem interval (right cardiac blood)

Marker	Measured value				*p*-value[a]	Postmortem change
	Postmortem time					
	0–12 h	13–24 h	25–48 h	49–72 h		
HbA1c	5.43 ± 1.78 (21)	5.35 ± 1.05 (66)	4.92 ± 1.05 (49)	5.39 ± 1.59 (13)	0.1571	Unchanged
t-Bilirubin	1.25 ± 2.53 (24)	1.26 ± 2.28 (64)	1.34 ± 2.38 (48)	1.66 ± 3.32 (14)	0.9305	Unchanged
Triglyceride	158.8 ± 82.5 (25)	139.4 ± 138.0 (66)	114.1 ± 73.5 (48)	93.4 ± 65.0 (16)	0.0083	Decrease
BUN	29.5 ± 29.2 (25)	39.1 ± 34.1 (69)	48.6 ± 51.8 (52)	36.2 ± 40.8 (16)	0.2752	Unchanged
CRP	7.12 ± 12.54 (25)	9.30 ± 11.55 (69)	6.67 ± 12.22 (53)	3.44 ± 5.42 (16)	0.7540	Unchanged
γ-GTP	131.0 ± 113.3 (25)	135.8 ± 162.9 (61)	165.1 ± 172.6 (49)	229.6 ± 282.8 (13)	0.2545	Unchanged
Fructsamine	304.9 ± 122.5 (22)	308.2 ± 107.7 (66)	360.4 ± 201.7 (45)	301.8 ± 149.3 (15)	0.2711	Unchanged
Creatinine	3.14 ± 2.93 (25)	3.21 ± 2.11 (69)	3.53 ± 2.48 (53)	3.06 ± 2.02 (16)	0.3442	Unchanged
Pseudocholine esterase	235.3 ± 105.0 (24)	200.9 ± 133.1 (66)	191.4 ± 114.9 (47)	207.4 ± 106.0 (16)	0.2599	Unchanged
t-Cholesterol	165.9 ± 59.3 (25)	135.0 ± 83.5 (66)	143.6 ± 79.3 (48)	131.8 ± 67.1 (16)	0.2212	Unchanged
t-Protein	7.16 ± 1.92 (25)	7.23 ± 1.89 (66)	7.63 ± 1.96 (47)	8.34 ± 3.15 (16)	0.0998	Unchanged

Values are expressed as the mean ± SD. (*n*): *n* is the sample number.
[a] Spearman's rank correlation test.

- Negligible postmortem change

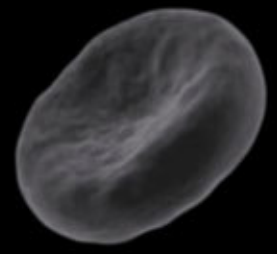


Table 3
Etiology of death (right cardiac blood)

Marker	Measured value								p-value[a]
	Blunt injury	Sharp injury	Asphyxiation	Drowning	Fire death	Intoxication	Internal death	Others	
HbA1c	5.05 ± 0.93 (44)	5.44 ± 1.01 (7)	5.39 ± 1.43 (17)	6.05 ± 1.52 (4)	5.80 ± 2.37 (5)	5.23 ± 1.50 (8)	5.33 ± 1.34 (36)	4.99 ± 1.09 (28)	0.6044
t-Bilirubin	1.25 ± 1.84 (49)	0.38 ± 0.41 (6)	0.39 ± 0.25 (18)	0.40 ± 0.26 (3)	0.70 ± 0.88 (4)	1.99 ± 3.91 (7)	1.34 ± 2.63 (36)	2.21 ± 3.52 (29)	0.2808
Triglyceride	142.5 ± 148.1 (49)	135.6 ± 46.9 (7)	163.1 ± 94.5 (18)	155.0 ± 116.2 (3)	134.8 ± 79.4 (5)	111.0 ± 61.1 (8)	117.1 ± 85.8 (36)	101.9 ± 77.1 (29)	0.5737
BUN	37.5 ± 35.0 (52)	10.4 ± 6.9 (7)	22.0 ± 20.3 (18)	18.4 ± 3.5 (3)	34.0 ± 29.2 (5)	25.2 ± 15.3 (8)	58.1 ± 54.1 (39)	47.5 ± 42.5 (30)	0.0094
CRP	12.35 ± 15.40 (52)	1.49 ± 3.30 (7)	1.82 ± 3.44 (18)	0.29 ± 0.42 (3)	1.15 ± 2.43 (5)	3.59 ± 9.43 (9)	7.24 ± 7.67 (39)	7.47 ± 11.23 (30)	0.0063
γ-GTP	130.3 ± 152.8 (49)	152.4 ± 132.1 (7)	162.9 ± 265.5 (18)	102.3 ± 76.5 (3)	138.3 ± 166.3 (4)	117.3 ± 59.9 (7)	176.2 ± 173.3 (32)	182.3 ± 179.1 (28)	0.9079
Fructsamine	293.9 ± 103.9 (48)	247.6 ± 115.6 (5)	336.6 ± 55.8 (17)	259.0 ± 214.6 (3)	258.0 ± 131.4 (5)	365.2 ± 268.9 (6)	366.8 ± 189.1 (36)	346.7 ± 149.6 (28)	0.2433
Creatinine	3.35 ± 2.25 (52)	1.91 ± 1.19 (7)	2.99 ± 3.07 (18)	4.09 ± 2.29 (3)	2.69 ± 1.30 (5)	3.16 ± 1.37 (9)	3.64 ± 2.28 (39)	3.29 ± 2.73 (30)	0.7557
Pseudocholine esterase	193.0 ± 91.0 (49)	197.2 ± 96.1 (5)	285.6 ± 151.6 (17)	274.0 ± 109.3 (3)	277.6 ± 148.8 (5)	288.8 ± 185.5 (8)	183.7 ± 117.4 (36)	159.5 ± 98.6 (30)	0.0039
t-Cholesterol	128.9 ± 53.1[b](49)	98.3 ± 32.3 (7)	219.3 ± 108.0 (18)	183.7 ± 22.6 (3)	200.2 ± 92.9 (5)	131.3 ± 60.8 (8)	130.1 ± 69.4[b] (36)	119.5 ± 66.7[b] (29)	<0.0001
t-Protein	6.96 ± 2.02[c] (50)	6.06 ± 1.87[c] (7)	8.64 ± 1.23 (18)	9.35 ± 0.78 (2)	10.76 ± 3.88 (5)	9.24 ± 1.51 (7)	7.14 ± 1.55[c] (35)	7.17 ± 2.04[c] (30)	<0.0001

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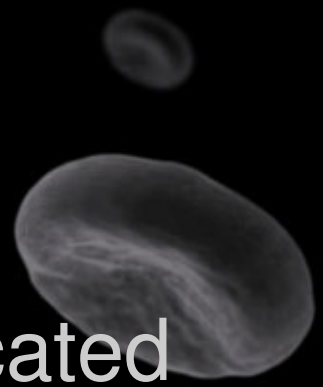
[a] One way ANOVA.

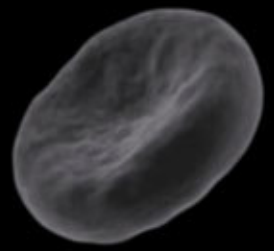
[b] $p < 0.05$ (Scheffe's posthoc test; vs asphyxiation).

[c] $p < 0.05$ (Scheffe's posthoc test; vs fire death).

- HbA1C has no difference due to etiology of death

- HbA1C and Fructosamine were indicated chronic hyperglycemia
- But Fructosamine showed large deviation from healthy subjects





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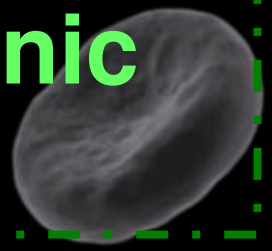
HbA1C is good marker for chronic hyperglycemia in forensic



Why ?

- Because Hemoglobin is cumulative process rate of glucose concentration under life span of erythrocytes
- But other markers evaluated are components of destruction of tissue
- or components eliminated by functioning organs

Table 2
Postmortem interval (right cardiac blood)

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- Total Bilirubin showed postmortem increase time-dependently

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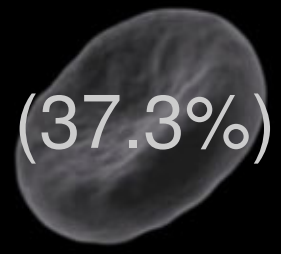
- But has small deviation from healthy subjects (37.3%)




Total Bilirubin can be used as a marker for Liver disease

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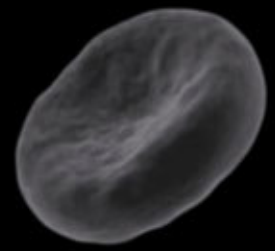
- They showed high deviation from healthy subjects (74.3%, 64.1%)

γ-GTP, Pseudocholine esterase are not appropriate for forensic diagnosis



- BUN, Creatinine are kidney injury markers
- BUN >100 mg/dl showed renal disease or acute renal failure
- Becareful considering is associate with severe hypoxia or skeletal muscle damage

BUN is a good marker for renal injury

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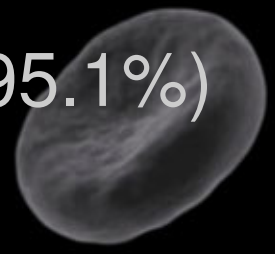
Fructsamine	325.3 ± 147.1	205–285	mM	148	77.7
Creatinine	3.29 ± 2.35	Male 0.61–1.04, female 0.47–0.79	mg/dL	163	95.1
Pseudocholine esterase	204.1 ± 120.7	Male 242–495, female 200–459	IU/L, 37 °C	153	64.1
t-Cholesterol	142.3 ± 77.3	150–219	mg/dL	155	72.9
t-Protein	7.45 ± 2.09	6.7–8.3	g/dL	154	75.3

Values are expressed as the mean ± SD.

- Creatinine showed the extremely high ratio (95.1%)



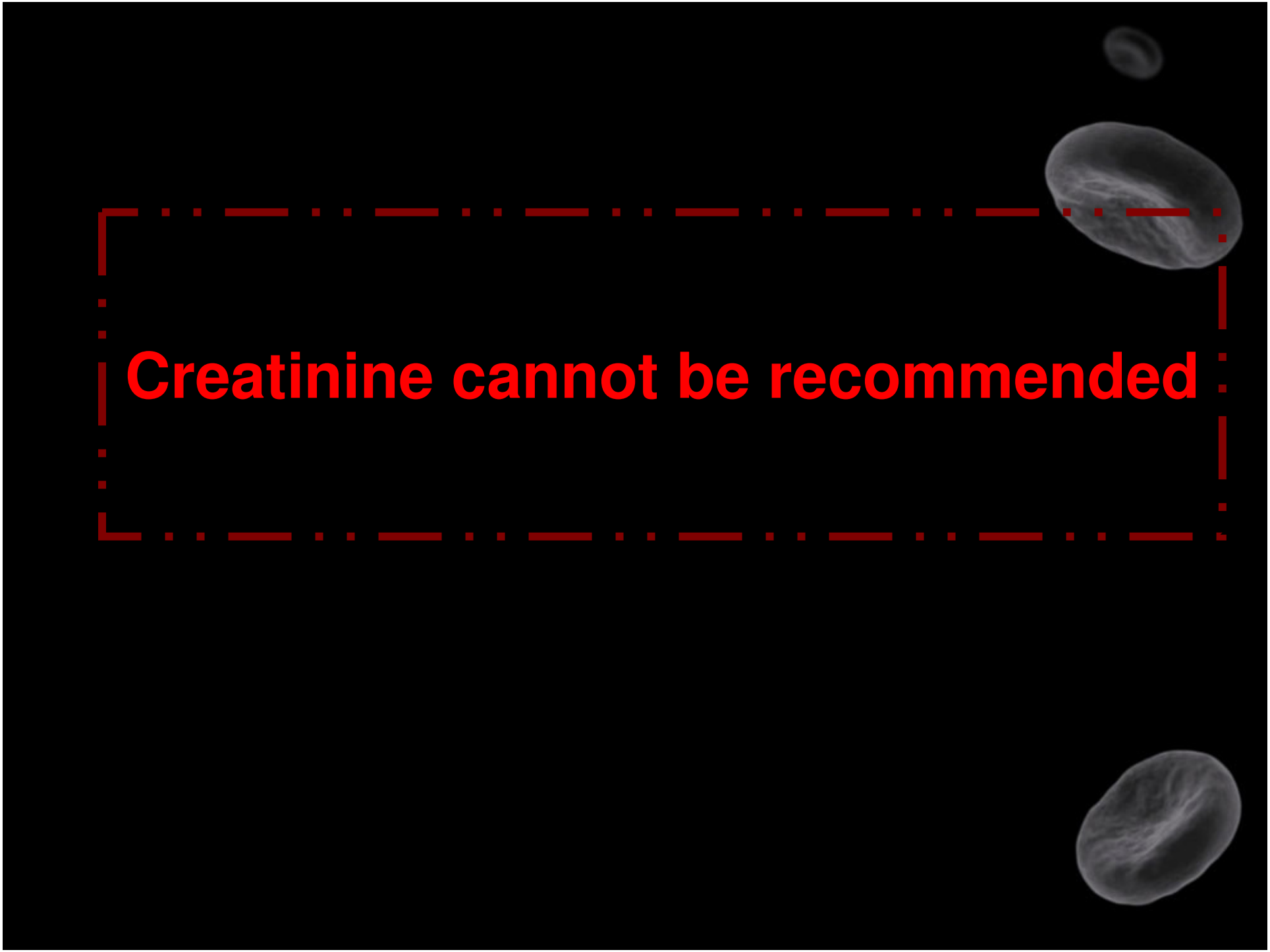

Creatinine cannot be recommended

Table 1
Differences from clinical standards (right cardiac blood)

Marker	Measured value	Value obtained from healthy subjects	Unit	*n*	Results outside the reference intervals of healthy subjects (%)
HbA1c	5.23 ± 1.23	4.3–5.8	%	149	24.8
t-Bilirubin	1.32 ± 2.44	0.2–1.0	mg/dL	150	37.3
Triglyceride	129.9 ± 107.4	50–149	mg/dL	155	45.2
BUN	39.8 ± 40.6	6–20	mg/dL	162	59.3
CRP	7.54 ± 11.54	<0.3	mg/dL	163	69.3
γ-GTP	154.1 ± 173.4	Male < 70, female < 30	IU/L, 37 °C	148	74.3
Fructsamine	325.3 ± 147.1	205–285	mM	148	77.7
Creatinine	3.29 ± 2.35	Male 0.61–1.04, female 0.47–0.79	mg/dL	163	95.1
Pseudocholine esterase	204.1 ± 120.7	Male 242–495, female 200–459	IU/L, 37 °C	153	64.1
t-Cholesterol	142.3 ± 77.3	150–219	mg/dL	155	72.9
t-Protein	7.45 ± 2.09	6.7–8.3	g/dL	154	75.3

Values are expressed as the mean ± SD.

- Triglyceride was higher than healthy subjects

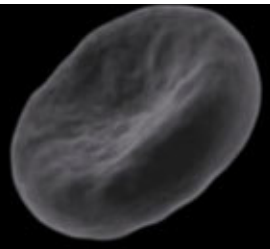
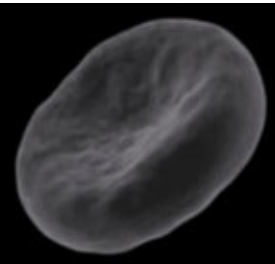


Table 2
Postmortem interval (right cardiac blood)

Marker	Measured value				*p*-value[a]	Postmortem change
	Postmortem time					
	0–12 h	13–24 h	25–48 h	49–72 h		
HbA1c	5.43 ± 1.78 (21)	5.35 ± 1.05 (66)	4.92 ± 1.05 (49)	5.39 ± 1.59 (13)	0.1571	Unchanged
t-Bilirubin	1.25 ± 2.53 (24)	1.26 ± 2.28 (64)	1.34 ± 2.38 (48)	1.66 ± 3.32 (14)	0.9305	Unchanged
Triglyceride	158.8 ± 82.5 (25)	139.4 ± 138.0 (66)	114.1 ± 73.5 (48)	93.4 ± 65.0 (16)	0.0083	Decrease
BUN	29.5 ± 29.2 (25)	39.1 ± 34.1 (69)	48.6 ± 51.8 (52)	36.2 ± 40.8 (16)	0.2752	Unchanged
CRP	7.12 ± 12.54 (25)	9.30 ± 11.55 (69)	6.67 ± 12.22 (53)	3.44 ± 5.42 (16)	0.7540	Unchanged
γ-GTP	131.0 ± 113.3 (25)	135.8 ± 162.9 (61)	165.1 ± 172.6 (49)	229.6 ± 282.8 (13)	0.2545	Unchanged
Fructsamine	304.9 ± 122.5 (22)	308.2 ± 107.7 (66)	360.4 ± 201.7 (45)	301.8 ± 149.3 (15)	0.2711	Unchanged
Creatinine	3.14 ± 2.93 (25)	3.21 ± 2.11 (69)	3.53 ± 2.48 (53)	3.06 ± 2.02 (16)	0.3442	Unchanged
Pseudocholine esterase	235.3 ± 105.0 (24)	200.9 ± 133.1 (66)	191.4 ± 114.9 (47)	207.4 ± 106.0 (16)	0.2599	Unchanged
t-Cholesterol	165.9 ± 59.3 (25)	135.0 ± 83.5 (66)	143.6 ± 79.3 (48)	131.8 ± 67.1 (16)	0.2212	Unchanged
t-Protein	7.16 ± 1.92 (25)	7.23 ± 1.89 (66)	7.63 ± 1.96 (47)	8.34 ± 3.15 (16)	0.0998	Unchanged

Values are expressed as the mean ± SD. (*n*): *n* is the sample number.
[a] Spearman's rank correlation test.

- But decreased of time-dependent



- Triglyceride level affected by ingestion or starvation

Triglyceride cannot be used postmortem marker

Table 2
Postmortem interval (right cardiac blood)

Marker	Measured value				*p*-value[a]	Postmortem change
	Postmortem time					
	0–12 h	13–24 h	25–48 h	49–72 h		
HbA1c	5.43 ± 1.78 (21)	5.35 ± 1.05 (66)	4.92 ± 1.05 (49)	5.39 ± 1.59 (13)	0.1571	Unchanged
t-Bilirubin	1.25 ± 2.53 (24)	1.26 ± 2.28 (64)	1.34 ± 2.38 (48)	1.66 ± 3.32 (14)	0.9305	Unchanged
Triglyceride	158.8 ± 82.5 (25)	139.4 ± 138.0 (66)	114.1 ± 73.5 (48)	93.4 ± 65.0 (16)	0.0083	Decrease
BUN	29.5 ± 29.2 (25)	39.1 ± 34.1 (69)	48.6 ± 51.8 (52)	36.2 ± 40.8 (16)	0.2752	Unchanged
CRP	7.12 ± 12.54 (25)	9.30 ± 11.55 (69)	6.67 ± 12.22 (53)	3.44 ± 5.42 (16)	0.7540	Unchanged
γ-GTP	131.0 ± 113.3 (25)	135.8 ± 162.9 (61)	165.1 ± 172.6 (49)	229.6 ± 282.8 (13)	0.2545	Unchanged
Fructsamine	304.9 ± 122.5 (22)	308.2 ± 107.7 (66)	360.4 ± 201.7 (45)	301.8 ± 149.3 (15)	0.2711	Unchanged
Creatinine	3.14 ± 2.93 (25)	3.21 ± 2.11 (69)	3.53 ± 2.48 (53)	3.06 ± 2.02 (16)	0.3442	Unchanged
Pseudocholine esterase	235.3 ± 105.0 (24)	200.9 ± 133.1 (66)	191.4 ± 114.9 (47)	207.4 ± 106.0 (16)	0.2599	Unchanged
t-Cholesterol	165.9 ± 59.3 (25)	135.0 ± 83.5 (66)	143.6 ± 79.3 (48)	131.8 ± 67.1 (16)	0.2212	Unchanged
t-Protein	7.16 ± 1.92 (25)	7.23 ± 1.89 (66)	7.63 ± 1.96 (47)	8.34 ± 3.15 (16)	0.0998	Unchanged

Values are expressed as the mean ± SD. (*n*): *n* is the sample number.
[a] Spearman's rank correlation test.

- Total protein increased of time-dependently
- Intravascular fluid is infused to extravasation cause overhydration

Table 3
Etiology of death (right cardiac blood)

Marker	Measured value								p-value[a]
	Blunt injury	Sharp injury	Asphyxiation	Drowning	Fire death	Intoxication	Internal death	Others	
HbA1c	5.05 ± 0.93 (44)	5.44 ± 1.01 (7)	5.39 ± 1.43 (17)	6.05 ± 1.52 (4)	5.80 ± 2.37 (5)	5.23 ± 1.50 (8)	5.33 ± 1.34 (36)	4.99 ± 1.09 (28)	0.6044
t-Bilirubin	1.25 ± 1.84 (49)	0.38 ± 0.41 (6)	0.39 ± 0.25 (18)	0.40 ± 0.26 (3)	0.70 ± 0.88 (4)	1.99 ± 3.91 (7)	1.34 ± 2.63 (36)	2.21 ± 3.52 (29)	0.2808
Triglyceride	142.5 ± 148.1 (49)	135.6 ± 46.9 (7)	163.1 ± 94.5 (18)	155.0 ± 116.2 (3)	134.8 ± 79.4 (5)	111.0 ± 61.1 (8)	117.1 ± 85.8 (36)	101.9 ± 77.1 (29)	0.5737
BUN	37.5 ± 35.0 (52)	10.4 ± 6.9 (7)	22.0 ± 20.3 (18)	18.4 ± 3.5 (3)	34.0 ± 29.2 (5)	25.2 ± 15.3 (8)	58.1 ± 54.1 (39)	47.5 ± 42.5 (30)	0.0094
CRP	12.35 ± 15.40 (52)	1.49 ± 3.30 (7)	1.82 ± 3.44 (18)	0.29 ± 0.42 (3)	1.15 ± 2.43 (5)	3.59 ± 9.43 (9)	7.24 ± 7.67 (39)	7.47 ± 11.23 (30)	0.0063
γ-GTP	130.3 ± 152.8 (49)	152.4 ± 132.1 (7)	162.9 ± 265.5 (18)	102.3 ± 76.5 (3)	138.3 ± 166.3 (4)	117.3 ± 59.9 (7)	176.2 ± 173.3 (32)	182.3 ± 179.1 (28)	0.9079
Fructsamine	293.9 ± 103.9 (48)	247.6 ± 115.6 (5)	336.6 ± 55.8 (17)	259.0 ± 214.6 (3)	258.0 ± 131.4 (5)	365.2 ± 268.9 (6)	366.8 ± 189.1 (36)	346.7 ± 149.6 (28)	0.2433
Creatinine	3.35 ± 2.25 (52)	1.91 ± 1.19 (7)	2.99 ± 3.07 (18)	4.09 ± 2.29 (3)	2.69 ± 1.30 (5)	3.16 ± 1.37 (9)	3.64 ± 2.28 (39)	3.29 ± 2.73 (30)	0.7557
Pseudocholine esterase	193.0 ± 91.0 (49)	197.2 ± 96.1 (5)	285.6 ± 151.6 (17)	274.0 ± 109.3 (3)	277.6 ± 148.8 (5)	288.8 ± 185.5 (8)	183.7 ± 117.4 (36)	159.5 ± 98.6 (30)	0.0039
t-Cholesterol	128.9 ± 53.1[b] (49)	98.3 ± 32.3 (7)	219.3 ± 108.0 (18)	183.7 ± 22.6 (3)	200.2 ± 92.9 (5)	131.3 ± 60.8 (8)	130.1 ± 69.4[b] (36)	119.5 ± 66.7[b] (29)	<0.0001
t-Protein	6.96 ± 2.02[c] (50)	6.06 ± 1.87[c] (7)	8.64 ± 1.23 (18)	9.35 ± 0.78 (2)	10.76 ± 3.88 (5)	9.24 ± 1.51 (7)	7.14 ± 1.55[c] (35)	7.17 ± 2.04[c] (30)	<0.0001

Values are expressed as the mean ± SD. (n): n is the sample number.

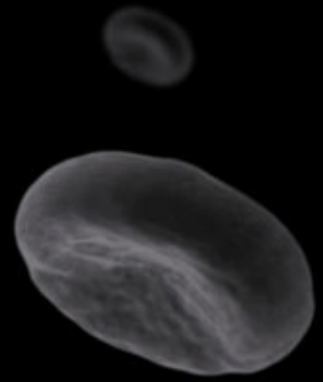
[a] One way ANOVA.

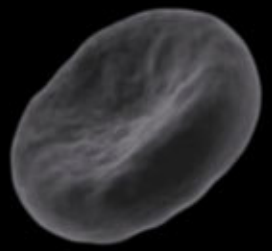
[b] $p < 0.05$ (Scheffe's posthoc test; vs asphyxiation).

[c] $p < 0.05$ (Scheffe's posthoc test; vs fire death).

- were difference in fire death-blunt, sharp injury and fire death-Internal death

- Fire death reflected intravascular extravasation due to heat



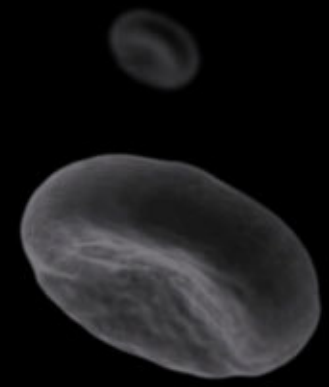


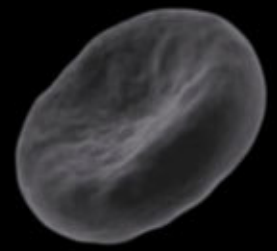
- **For Sampling site**

  - HbA1C, Triglyceride, BUN,

    Fructosamine : any site can be used

  - Their values of any site were same





- Total Bilirubin, CRP, γ-GTP, Total protein are recommended femoral vein blood

Table 2
Postmortem interval (right cardiac blood)

Marker	Measured value				*p*-value[a]	Postmortem change
	Postmortem time					
	0–12 h	13–24 h	25–48 h	49–72 h		
HbA1c	5.43 ± 1.78 (21)	5.35 ± 1.05 (66)	4.92 ± 1.05 (49)	5.39 ± 1.59 (13)	0.1571	Unchanged
t-Bilirubin	1.25 ± 2.53 (24)	1.26 ± 2.28 (64)	1.34 ± 2.38 (48)	1.66 ± 3.32 (14)	0.9305	Unchanged
Triglyceride	158.8 ± 82.5 (25)	139.4 ± 138.0 (66)	114.1 ± 73.5 (48)	93.4 ± 65.0 (16)	0.0083	Decrease
BUN	29.5 ± 29.2 (25)	39.1 ± 34.1 (69)	48.6 ± 51.8 (52)	36.2 ± 40.8 (16)	0.2752	Unchanged
CRP	7.12 ± 12.54 (25)	9.30 ± 11.55 (69)	6.67 ± 12.22 (53)	3.44 ± 5.42 (16)	0.7540	Unchanged
γ-GTP	131.0 ± 113.3 (25)	135.8 ± 162.9 (61)	165.1 ± 172.6 (49)	229.6 ± 282.8 (13)	0.2545	Unchanged
Fructsamine	304.9 ± 122.5 (22)	308.2 ± 107.7 (66)	360.4 ± 201.7 (45)	301.8 ± 149.3 (15)	0.2711	Unchanged
Creatinine	3.14 ± 2.93 (25)	3.21 ± 2.11 (69)	3.53 ± 2.48 (53)	3.06 ± 2.02 (16)	0.3442	Unchanged
Pseudocholine esterase	235.3 ± 105.0 (24)	200.9 ± 133.1 (66)	191.4 ± 114.9 (47)	207.4 ± 106.0 (16)	0.2599	Unchanged
t-Cholesterol	165.9 ± 59.3 (25)	135.0 ± 83.5 (66)	143.6 ± 79.3 (48)	131.8 ± 67.1 (16)	0.2212	Unchanged
t-Protein	7.16 ± 1.92 (25)	7.23 ± 1.89 (66)	7.63 ± 1.96 (47)	8.34 ± 3.15 (16)	0.0998	Unchanged

Values are expressed as the mean ± SD. (*n*): *n* is the sample number.
[a] Spearman's rank correlation test.

- They tend to increase postmortem

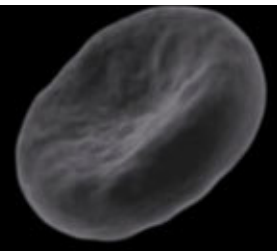
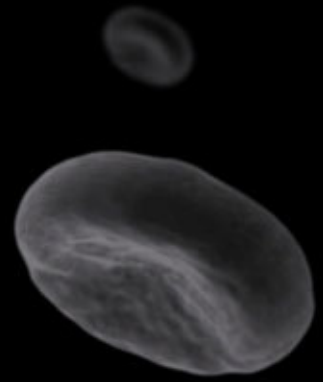


Table 4
Regional differences in biochemical markers obtained from postmortem blood

Marker	Measured value			*n*	*p*-value[a]	Regional difference[b]	Recommended sampling site
	Right cardiac blood	Left cardiac blood	Femoral vein blood				
HbA1c	5.26 ± 0.94	5.23 ± 0.97	5.20 ± 0.99	40	0.0452	r > fe (r = l, l = fe)	r, l, fe
t-Bilirubin	1.27 ± 2.12	1.35 ± 2.18	1.06 ± 1.84	34	0.0001	r = l > fe	fe
Triglyceride	131.4 ± 144.7	147.4 ± 183.1	130.6 ± 104.6	36	ns		r, l, fe
BUN	45.3 ± 42.6	44.1 ± 42.3	45.1 ± 42.5	39	ns		r, l, fe
CRP	7.94 ± 10.38	8.12 ± 10.74	6.96 ± 9.27	41	0.0032	r = l > fe	fe
γ-GTP	161.3 ± 192.4	158.4 ± 183.6	128.9 ± 154.6	38	0.0397	l > fe (r = l, r = fe)	fe
Fructsamine	355.9 ± 119.3	355.6 ± 127.0	334.8 ± 106.9	29	ns		r, l, fe
Creatinine	3.12 ± 2.32	2.95 ± 2.34	3.30 ± 2.38	40	0.0005	l < r = fe	l
Pseudocholine esterase	262.0 ± 137.1	277.3 ± 163.4	250.7 ± 134.0	35	0.0079	l > r = fe	l
t-Cholesterol	178.6 ± 96.6	195.4 ± 118.5	174.6 ± 94.7	34	0.0057	l > r = fe	l
t-Protein	7.69 ± 1.70	7.78 ± 1.84	6.97 ± 1.89	37	<0.0001	r = l > fe	fe

Values are expressed as the mean ± SD.
r, right cardiac blood; l, left cardiac blood; fe, femoral vein blood; ns, not significant.
[a] One-way repeated measures ANOVA.
[b] Paired *t*-test.

- They showed lower value in Femoral vein blood than the others



- Creatinine is recommended left cardiac blood

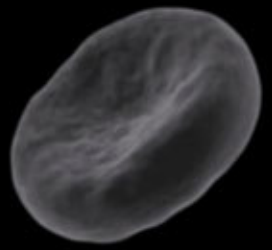


Table 2
Postmortem interval (right cardiac blood)

Marker	Measured value				*p*-value[a]	Postmortem change
	Postmortem time					
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t-Protein	7.16 ± 1.92 (25)	7.23 ± 1.89 (66)	7.63 ± 1.96 (47)	8.34 ± 3.15 (16)	0.0998	Unchanged

Values are expressed as the mean ± SD. (*n*): *n* is the sample number.
[a] Spearman's rank correlation test.

- it showed increase time-dependently

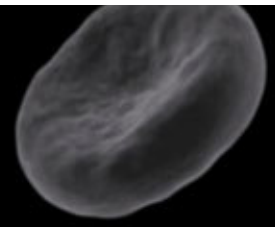

Table 4
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Marker	Measured value			*n*	*p*-value[a]	Regional difference[b]	Recommended sampling site
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t-Bilirubin	1.27 ± 2.12	1.35 ± 2.18	1.06 ± 1.84	34	0.0001	r = l > fe	fe
Triglyceride	131.4 ± 144.7	147.4 ± 183.1	130.6 ± 104.6	36	ns		r, l, fe
BUN	45.3 ± 42.6	44.1 ± 42.3	45.1 ± 42.5	39	ns		r, l, fe
CRP	7.94 ± 10.38	8.12 ± 10.74	6.96 ± 9.27	41	0.0032	r = l > fe	fe
γ-GTP	161.3 ± 192.4	158.4 ± 183.6	128.9 ± 154.6	38	0.0397	l > fe (r = l, r = fe)	fe
Fructsamine	355.9 ± 119.3	355.6 ± 127.0	334.8 ± 106.9	29	ns		r, l, fe
Creatinine	3.12 ± 2.32	2.95 ± 2.34	3.30 ± 2.38	40	0.0005	l < r = fe	l
Pseudocholine esterase	262.0 ± 137.1	277.3 ± 163.4	250.7 ± 134.0	35	0.0079	l > r = fe	l
t-Cholesterol	178.6 ± 96.6	195.4 ± 118.5	174.6 ± 94.7	34	0.0057	l > r = fe	l
t-Protein	7.69 ± 1.70	7.78 ± 1.84	6.97 ± 1.89	37	<0.0001	r = l > fe	fe

Values are expressed as the mean ± SD.
r, right cardiac blood; l, left cardiac blood; fe, femoral vein blood; ns, not significant.
[a] One-way repeated measures ANOVA.
[b] Paired *t*-test.

- Creatinine was lower level in left cardiac blood than the ohers

- Pseudocholine esterase, Total-Cholesterol are recommended left cardiac blood

Table 2
Postmortem interval (right cardiac blood)

Marker	Measured value				*p*-value[a]	Postmortem change
	Postmortem time					
	0–12 h	13–24 h	25–48 h	49–72 h		
HbA1c	5.43 ± 1.78 (21)	5.35 ± 1.05 (66)	4.92 ± 1.05 (49)	5.39 ± 1.59 (13)	0.1571	Unchanged
t-Bilirubin	1.25 ± 2.53 (24)	1.26 ± 2.28 (64)	1.34 ± 2.38 (48)	1.66 ± 3.32 (14)	0.9305	Unchanged
Triglyceride	158.8 ± 82.5 (25)	139.4 ± 138.0 (66)	114.1 ± 73.5 (48)	93.4 ± 65.0 (16)	0.0083	Decrease
BUN	29.5 ± 29.2 (25)	39.1 ± 34.1 (69)	48.6 ± 51.8 (52)	36.2 ± 40.8 (16)	0.2752	Unchanged
CRP	7.12 ± 12.54 (25)	9.30 ± 11.55 (69)	6.67 ± 12.22 (53)	3.44 ± 5.42 (16)	0.7540	Unchanged
γ-GTP	131.0 ± 113.3 (25)	135.8 ± 162.9 (61)	165.1 ± 172.6 (49)	229.6 ± 282.8 (13)	0.2545	Unchanged
Fructsamine	304.9 ± 122.5 (22)	308.2 ± 107.7 (66)	360.4 ± 201.7 (45)	301.8 ± 149.3 (15)	0.2711	Unchanged
Creatinine	3.14 ± 2.93 (25)	3.21 ± 2.11 (69)	3.53 ± 2.48 (53)	3.06 ± 2.02 (16)	0.3442	Unchanged
Pseudocholine esterase	235.3 ± 105.0 (24)	200.9 ± 133.1 (66)	191.4 ± 114.9 (47)	207.4 ± 106.0 (16)	0.2599	Unchanged
t-Cholesterol	165.9 ± 59.3 (25)	135.0 ± 83.5 (66)	143.6 ± 79.3 (48)	131.8 ± 67.1 (16)	0.2212	Unchanged
t-Protein	7.16 ± 1.92 (25)	7.23 ± 1.89 (66)	7.63 ± 1.96 (47)	8.34 ± 3.15 (16)	0.0998	Unchanged

Values are expressed as the mean ± SD. (*n*): *n* is the sample number.
[a] Spearman's rank correlation test.

- They tend to decrease time-dependently

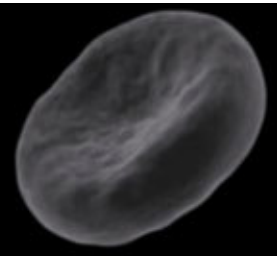


Table 4
Regional differences in biochemical markers obtained from postmortem blood

Marker	Measured value			*n*	*p*-value[a]	Regional difference[b]	Recommended sampling site
	Right cardiac blood	Left cardiac blood	Femoral vein blood				
HbA1c	5.26 ± 0.94	5.23 ± 0.97	5.20 ± 0.99	40	0.0452	r > fe (r = l, l = fe)	r, l, fe
t-Bilirubin	1.27 ± 2.12	1.35 ± 2.18	1.06 ± 1.84	34	0.0001	r = l > fe	fe
Triglyceride	131.4 ± 144.7	147.4 ± 183.1	130.6 ± 104.6	36	ns		r, l, fe
BUN	45.3 ± 42.6	44.1 ± 42.3	45.1 ± 42.5	39	ns		r, l, fe
CRP	7.94 ± 10.38	8.12 ± 10.74	6.96 ± 9.27	41	0.0032	r = l > fe	fe
γ-GTP	161.3 ± 192.4	158.4 ± 183.6	128.9 ± 154.6	38	0.0397	l > fe (r = l, r = fe)	fe
Fructsamine	355.9 ± 119.3	355.6 ± 127.0	334.8 ± 106.9	29	ns		r, l, fe
Creatinine	3.12 ± 2.32	2.95 ± 2.34	3.30 ± 2.38	40	0.0005	l < r = fe	l
Pseudocholine esterase	262.0 ± 137.1	277.3 ± 163.4	250.7 ± 134.0	35	0.0079	l > r = fe	l
t-Cholesterol	178.6 ± 96.6	195.4 ± 118.5	174.6 ± 94.7	34	0.0057	l > r = fe	l
t-Protein	7.69 ± 1.70	7.78 ± 1.84	6.97 ± 1.89	37	<0.0001	r = l > fe	fe

Values are expressed as the mean ± SD.
r, right cardiac blood; l, left cardiac blood; fe, femoral vein blood; ns, not significant.
[a] One-way repeated measures ANOVA.
[b] Paired *t*-test.

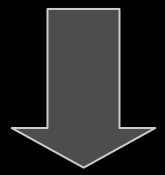
- They showed higher level in left-cardiac than the others

- Creatinine, Pseudocholine esterase, Total-Cholesterol are recommended = Left cardiac blood

- 8 markers = Femoral vein blood

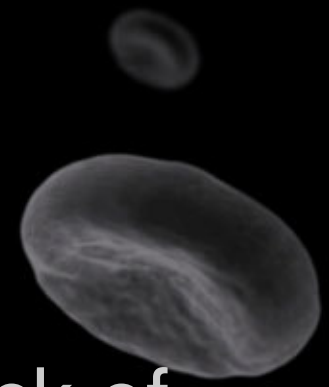
- We need the reliability of Standard value in clinical medicine
- There is no perfect standard value from forensic autopsies
- The sample are from the deceased with various cause of death

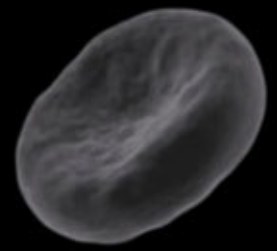
- This Research tried to calculate forensic standard value
- HbA1C (forensic standard value) is 2.77-7.69%



But This value is guidline

- Because
  - Data of HbA1C is derived from lack of information
  - Lack of present and past illness
  - Lack of backgrounds of the victims

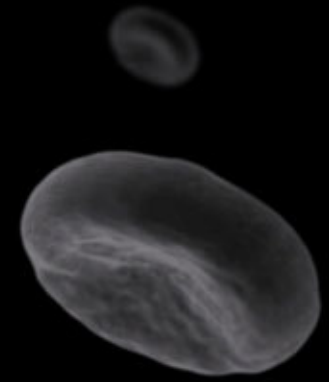




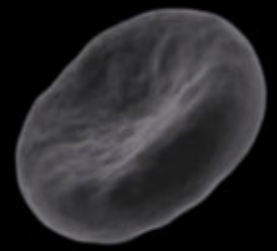
- If Data of HbA1C is derived from more accurate value
- Have more apparent abnormal data
- Collecting more sample by known cause with more information

Can obtain a genuine forensic abnormal value

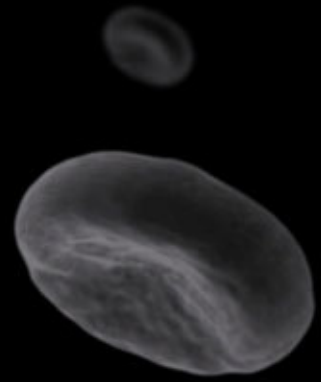
- What's require?
- Forensic abnormal value

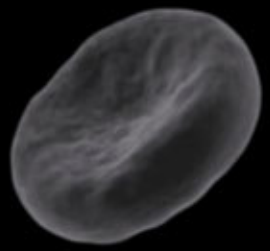


  - Unexpected death without obvious cause
  - Alcoholics with low postmortem blood alcohol level
  - Young adult with no apparent cause of death

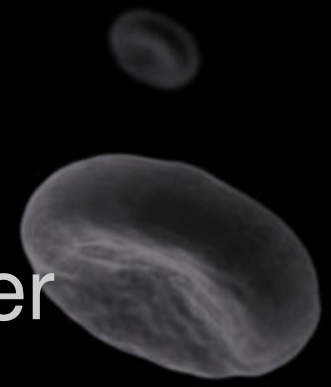


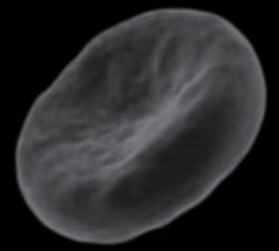
Conclusion





- HbA1C was clearly a reliable marker
- Total Bilirubin, BUN, Cholesterol have been useful
  - had set an appropriate limit range
  - Been careful interpretation





- Triglyceride decreased according to postmortem interval

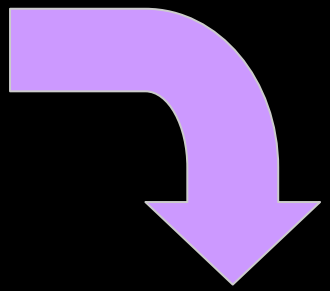
- The other markers did not significant changes within 3 days of postmortem

- In the same term of postmortem interval

Blunt injury

Sharp injury

Internal injury

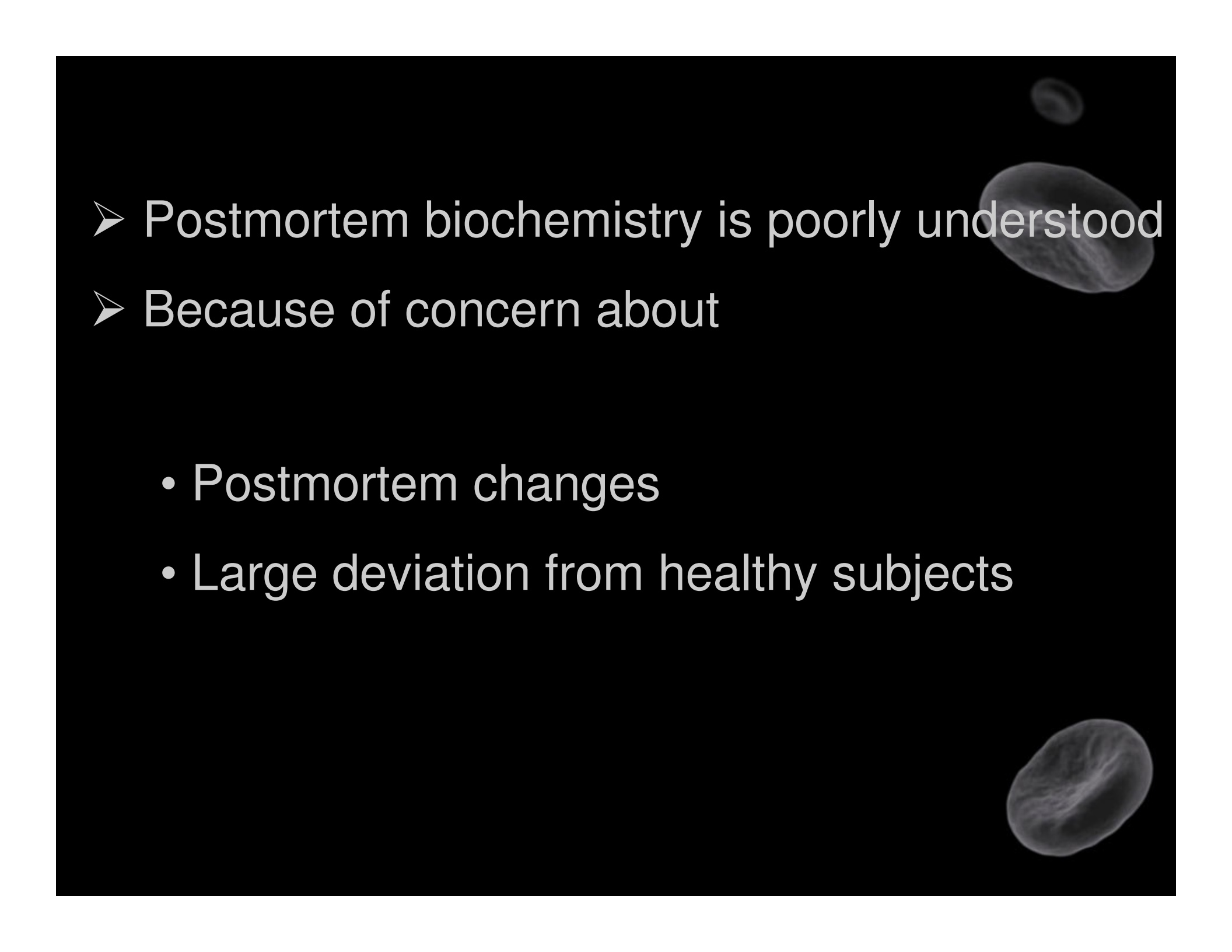


difference

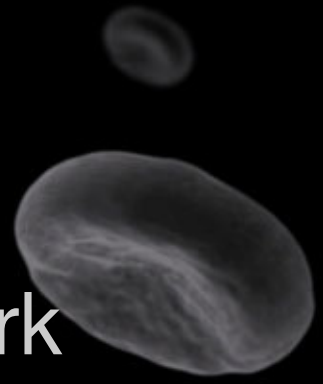
Fire death

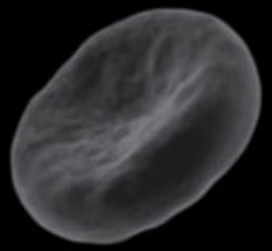
- Femoral vein blood is suitable sampling site
- Because its relatively slight postmortem changes

- Postmortem biochemistry is poorly understood
- Because of concern about
  - Postmortem changes
  - Large deviation from healthy subjects

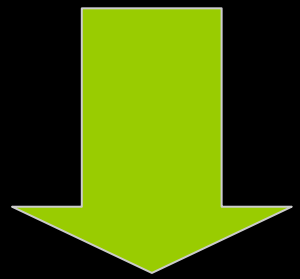


- Great potential Forensic service work
- Future Research into the sudden unexpected death without obvious cause
- Young adult with no apparent cause of death





Next step for
Forensic diagnosis
of Biochemical blood markers



Forensic Abnormal
Value


Thank you