Acil Laboratuvarlarda Kan Sayım ve Preanalitik Hata Kaynakları

Fatma Uçar

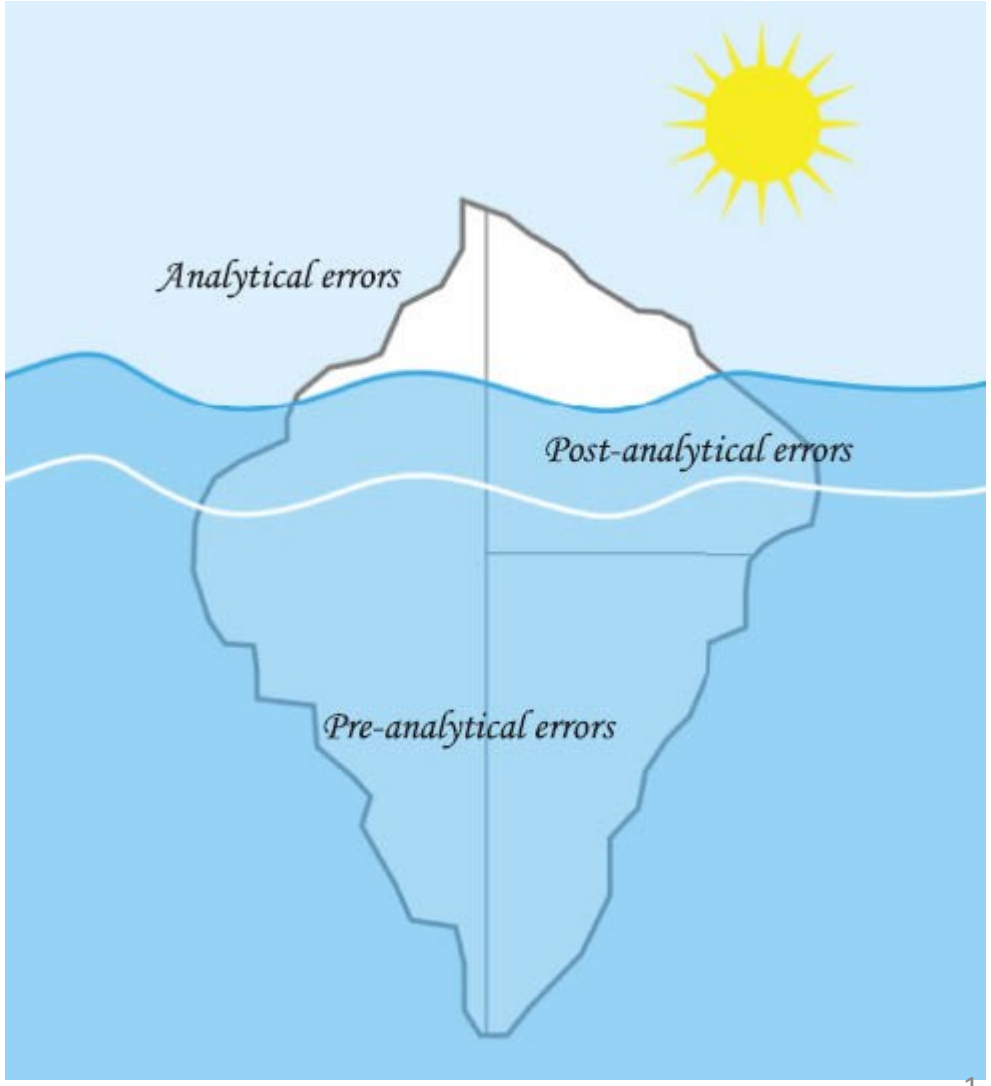
TC. SB.SBÜ.

Dışkapı Yıldırım Beyazıt Eğitim ve Araştırma Hastanesi

Preanalitik Evre Sempozyumu

17 Nisan 2019

Türk Biyokimya Derneği
Turkish Biochemical Society



İçerik

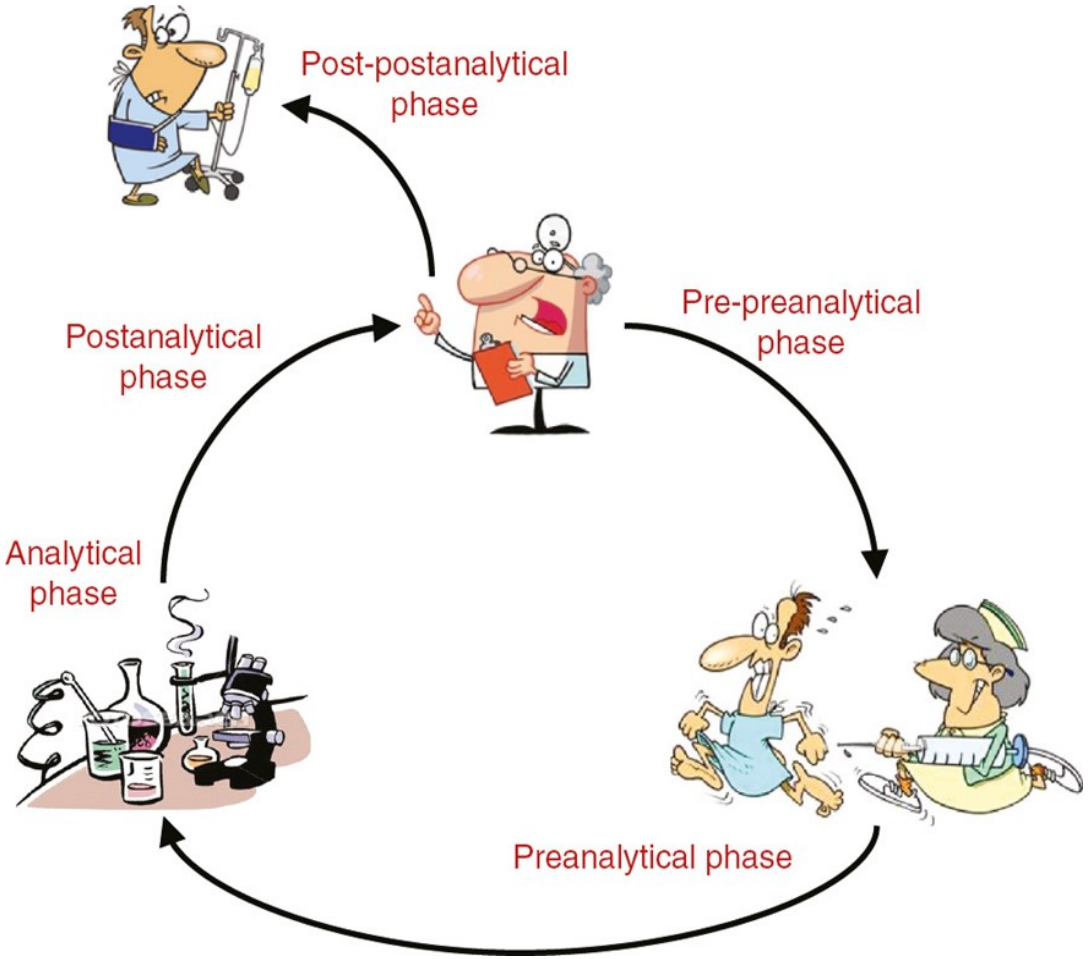
- ✓Laboratuvar Hatası
- ✓Preanalitik Evre
- ✓Preanalitik faktörler
- ✓Literatür örnekleri
- ✓Sonuç ve Öneriler

Laboratuvar Hatası

‘Test isteminden sonuçların raporlanmasına ve test sonuçlarının uygun şekilde yorumlanıp etki etmesine kadar laboratuvar döngüsünün herhangi bir bölümünde gerçekleşen, planlanan bir eylemin amaçlanan şekilde yerine getirilmemesi veya amaca ulaşabilmek için yanlış plan yapılması ve kullanılması’

ISO/PDTS 22367 Medical laboratories-reduction of error through risk management and continual improvement-complementary elements

Brain to Brain Turnaround Time Loop



- 1970 Gambino
- 1981'de Lundberg
- 9 Basamak
    1. Ordering
    2. Collection
    3. Identification
    4. Transportation
    5. Preparation
    6. Analysis
    7. Reporting
    8. Interpretation
    9. Action

Hata Oranları

- Pre-pre analitik fazda **% 46-68.2**
- Pre-analitik faz **% 3.0-5.3**
- Analitik faz **% 7–13**
- Post-analitik faz **% 12.5–20**
- Post-post-analitik faz **% 25–45.5**

- ***Giorgio Da Rin. Pre-analytıcal Workstatıons As A Tool For Reducıng Laboratory Errors. J Med Biochem 29: 315–324, 2010***

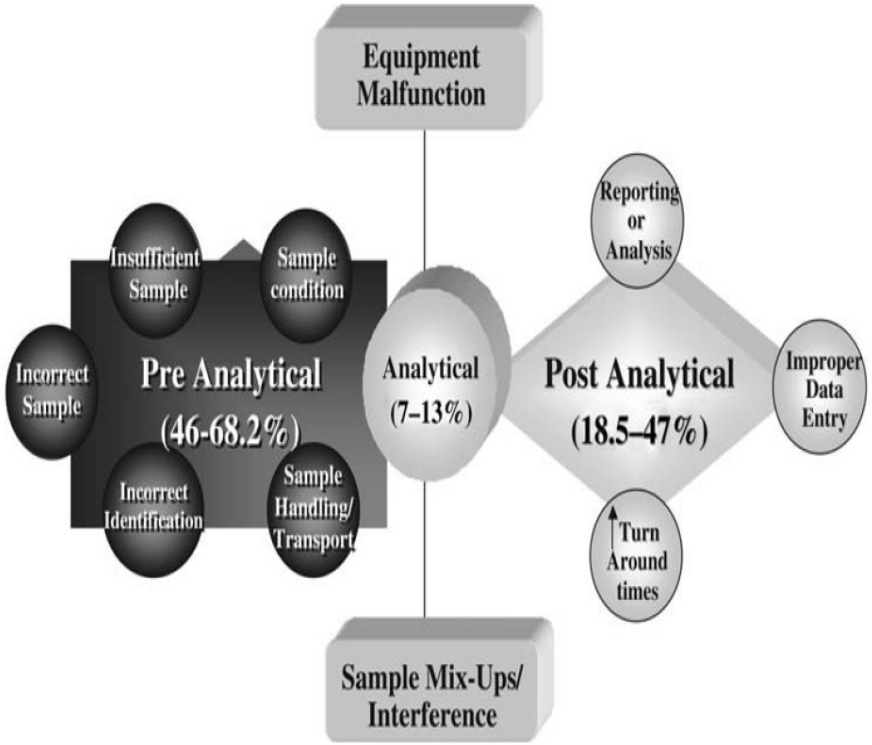


Figure 1 Types and rates of error in the three stages of the laboratory testing process (modified from reference 3).

Mario Plebani. Errors in clinical laboratories or errors in laboratory medicine? Clin Chem Lab Med 2006;44(6):750–759

Preanalitik Faktörler

Hastaya Ait Faktörler

- Irk
- Cinsiyet
- Yaş
- Gebelik
- Diyet
- Egzersiz
- Obezite
- Yaşam Biçimi
- Çevresel Faktörler
- Tedavi durumu

Örnek Alımı

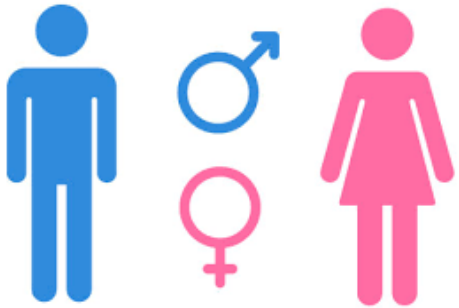
- Hastanın kimliklendirilmesi
- Postür
- Diurnal Varyasyon
- Örnek Alma Zamanı
- Açlık durumu
- Turnike uygulanması
- IV tedavi
- Örneklem yeri
- Antikoagülan tipi
- Kan almada tüp sırası
- Örnek Hacmi
- Kan alma iğne çapı

Örnek İşlenmesi

- Etiketleme
- Transport
- Sıcaklık
- Işık
- Saklama
- Hemoliz
- Lipemi
- Santrifüj
- Isı

IRK

CİNSİYET



YAŞ

GEBELİK

RAKIM

SİGARA

Hasta Kimliklendirilmesi

- **CLSI 41- A6 Procedures for the Collection of Diagnostic Blood Specimens by Venipuncture; Approved Standard—Sixth Edition**
- En az 2 bağımsız tanımlayıcı olmalıdır.
- Aktif olmalı ve açık uçlu bir soru sorulmalı

  Adınız nedir ?

  Doğum tarihiniz nedir?
- **EFLM WG-PRE** ise en az 2 tercihen 3 bağımsız tanımlayıcı soru sorulmalı, biri mutlaka ad-soyad olmalı
- Tanımlama hataları **% 0.1-5***

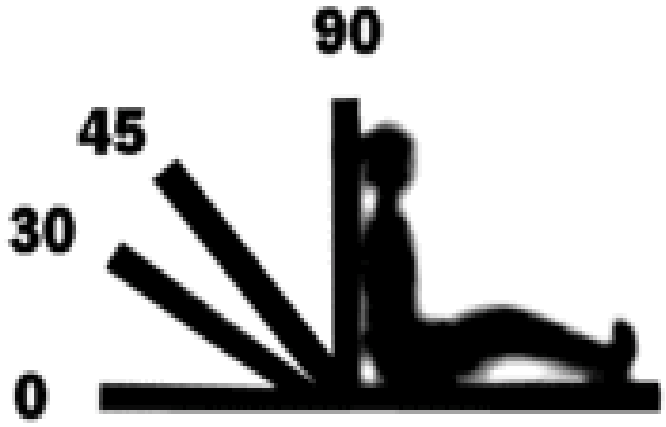
**2006 Q-Probes study of 120 institutions Valenstein et al, Arch Pathol Lab Med 130:1106-13, 2006*

Postür

- **CLSI GP 41-A6 klavuzu**: Kan örneklerinin uygun bir sandalyeye rahatça oturarak veya uzanırken alınmasını önermektedir.
- **WHO klavuzu:** Mümkünse hastayı supin pozisyonunda rahat olmasını sağlayın gibi bir ifade yer alır.
- Yatar pozisyondan oturma pozisyonuna geçişte plazma hacminin azalması nedeniyle

  Hb ↑
  Htc
  RBC
  WBC
  PLT

- Birkaç günlük yatak istirahatinde plazma ve ekstrasellüler mayi hacmi düşer. Bu sebeple **Htc %10** artar.



- *Oliveria G.L. Et al. Patient posture for blood collection by venipuncture: recall for standardization after 28 years. rev bras hematol hemoter. 2 0 1 7;3 9(2):127–132*

Diurnal Varyasyon

- Hb,Htc ve RBC öğlen 12 civarı pik değer gösterirken, gece 00.00 civarı ise en düşük değeri göstermektedir.

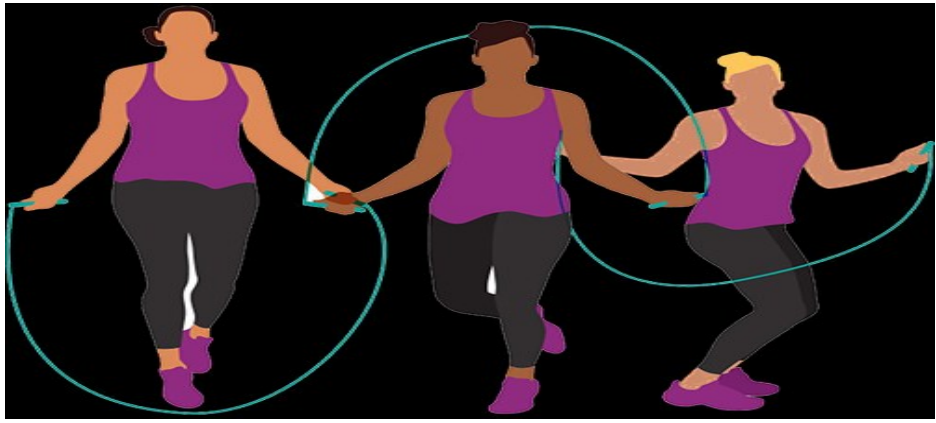
- WBC, nötrofil,lenfosit ve eosinofil ise gece en yüksek değerde iken öğle vakti en düşük değeri göstermektedir.

- ***Sennels HP, Jørgensen HL, Hansen AL, Goetze JP, Fahrenkrug J. Diurnal variation of hematology parameters in healthy young males: the Bispebjerg study of diurnal variations.Scand J Clin Lab Invest. 2011;71:532-41.***

Stress

- Özellikle çocuklarda olmak üzere kan alma korkusu olan hastalarda ciddi ajitasyon sonrası **lökositoz** ve **nötrofili** görülebilir.

Fiziksel Egzersiz



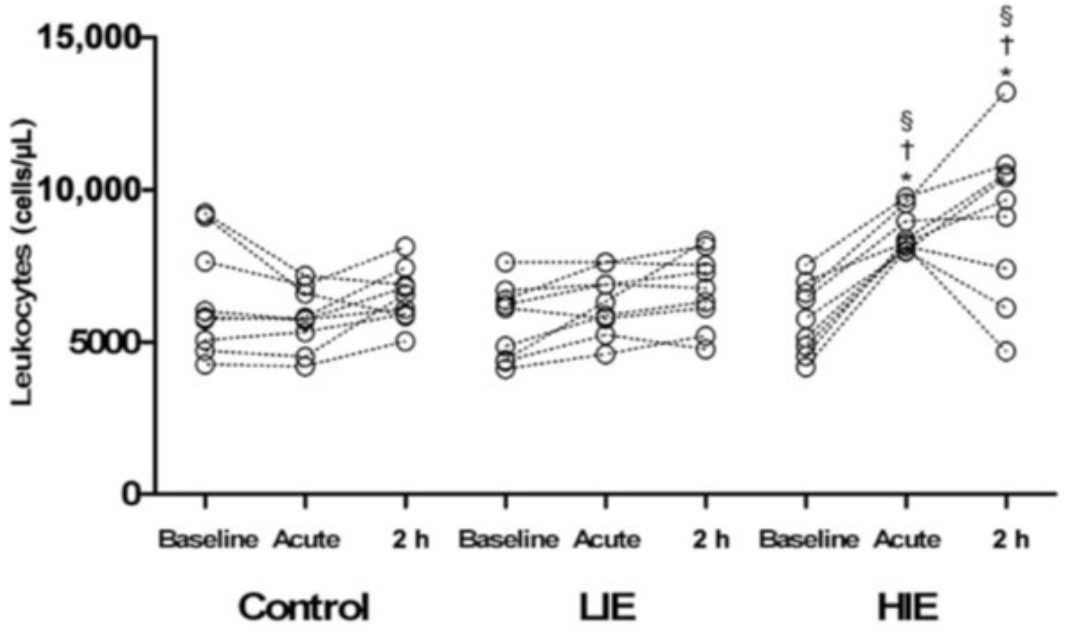


Fig. 1. Leukocyte concentration in response to different exercise intensities in physically active men *versus the baseline, †versus the control session, and §versus LIE. HIE = high-intensity exercise; LIE = low-intensity exercise.

- ***Plazma volüm değişiklikleri***
- ***Artan bazal metabolizma hızı***
- ***Reaktif oksijen türleriyle ilişkili olarak artan hücresel hasar***
- nedeni ile ilgili olarak tam kan sayım sonuçları egzersizden etkilenebilir.

P.R.D.S. Neves et al. Acute effects of high- and low-intensity exercise bouts on leukocyte counts. Journal of Exercise Science & Fitness 13 (2015) 24-28.

Açlık Durumu

Hafif bir öğün;

- Nötrofillerde artış,
- Lenfositlerde ve eozinofillerde yemekten sonra 4 saate kadar önemli azalma
- RBC, Hb ve Htc'de azalma

- ***Lippi G. Et al. Influence of a light meal on routine haematological tests. Blood Transfus. 2010 Apr;8(2):94-9. doi: 10.2450/2009.0142-09***

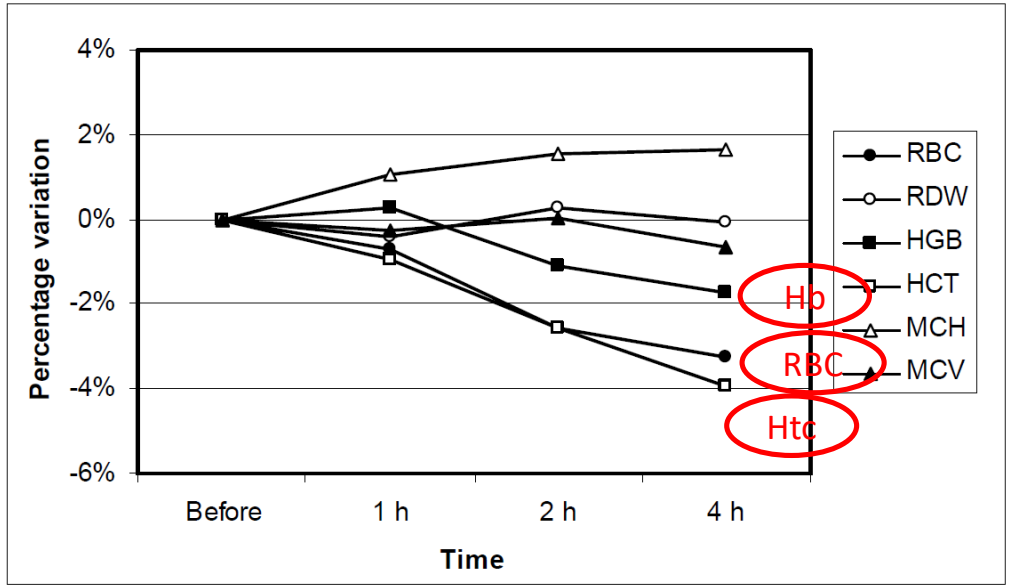


Figure 1 - Percentage post-prandial variation of red blood cell count (RBC), haemoglobin concentration (HGB), haematocrit (HCT), mean corpuscular haemoglobin (MHC), mean corpuscular volume (MCV) and RBC distribution width (RDW) after a light meal.

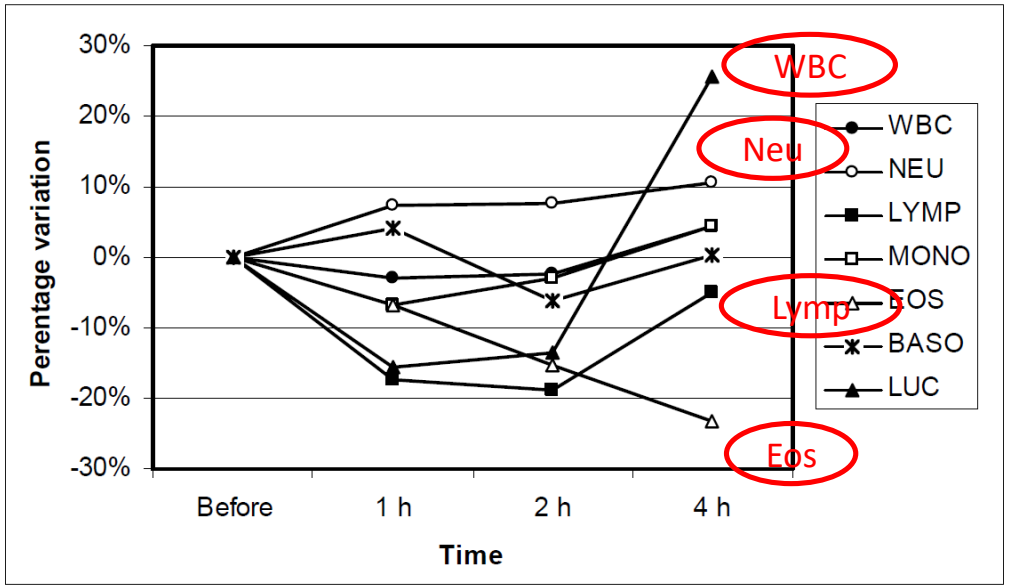


Figure 2 - Percentage post-prandial variations of white blood cell (WBC) count, neutrophils (NEU), lymphocytes (LYMP), monocytes (MONO), eosinophils (EOS), basophils (BASO) and large unstained cells (LUC) after a light meal.

Lippi G. Et al. Influence of a light meal on routine haematological tests. Blood Transfus. 2010 Apr;8(2):94-9. doi: 10.2450/2009.0142-09

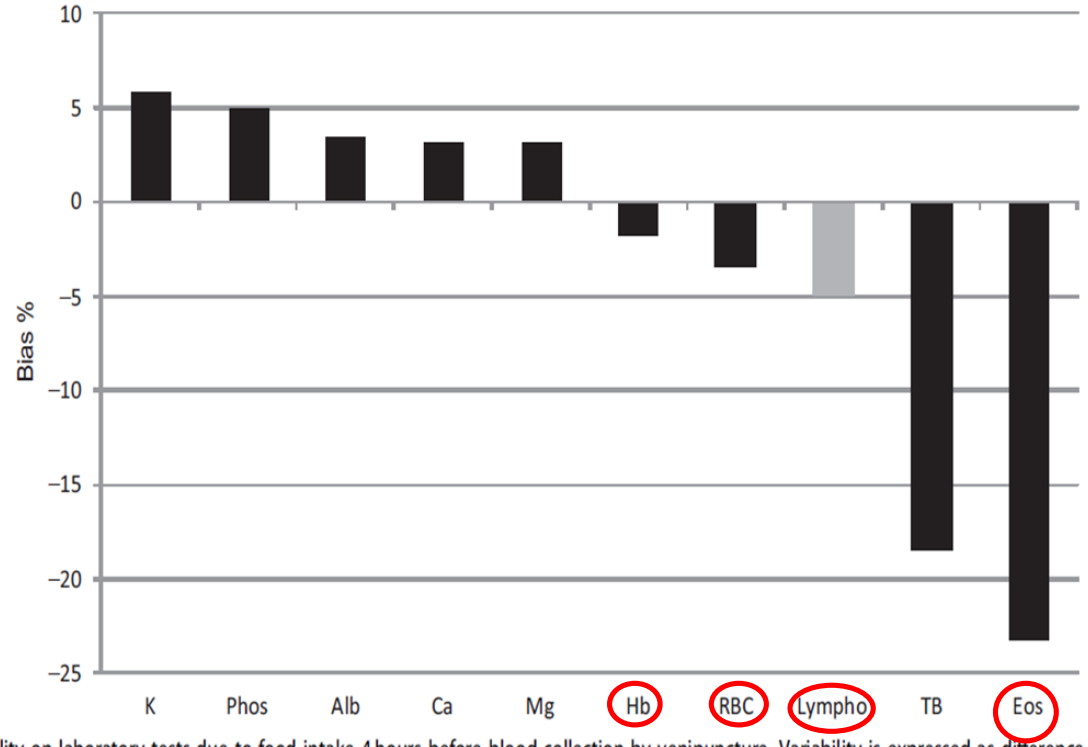


Figure 1. Variability on laboratory tests due to food intake 4 hours before blood collection by venipuncture. Variability is expressed as difference (bias, %) from 4 h fasting (during day) compared to 12 h fasting (overnight). This Figure was constructed from results previously published by Lima-Oliveira et al. and Lippi et al. [13,14]. Black bars, higher than desirable specification derived from biologic variation; grey bar, lower than desirable specification derived from biologic variation. K, potassium; Phos, phosphate; Alb, albumin; Ca, calcium; Mg, magnesium; Hb, haemoglobin; RBC, red blood cells; Lympho, lymphocytes; TB, total bilirubin; Eos, eosinophils.

Oliveira GL. et al.Pre-analytical phase management: a review of the procedures from patient reparation to laboratory analysis. SCandinavian Journal Of Clinical And Laboratory Investigation, 2017 VOL. 77, NO. 3, 153–163.

Turnike

- 7.5-10.0 cm. (3-4 parmak)
- 60 sn den fazla tutulmamalıdır.
- Venöz staz (60 saniyeden uzun) kan damarlarından su, iyon ve düşük moleküler ağırlıklı maddelerin çıkışını teşvik eder, böylelikle damar delme bölgesinde biyobelirteçlerin konsantrasyonunu arttırır.

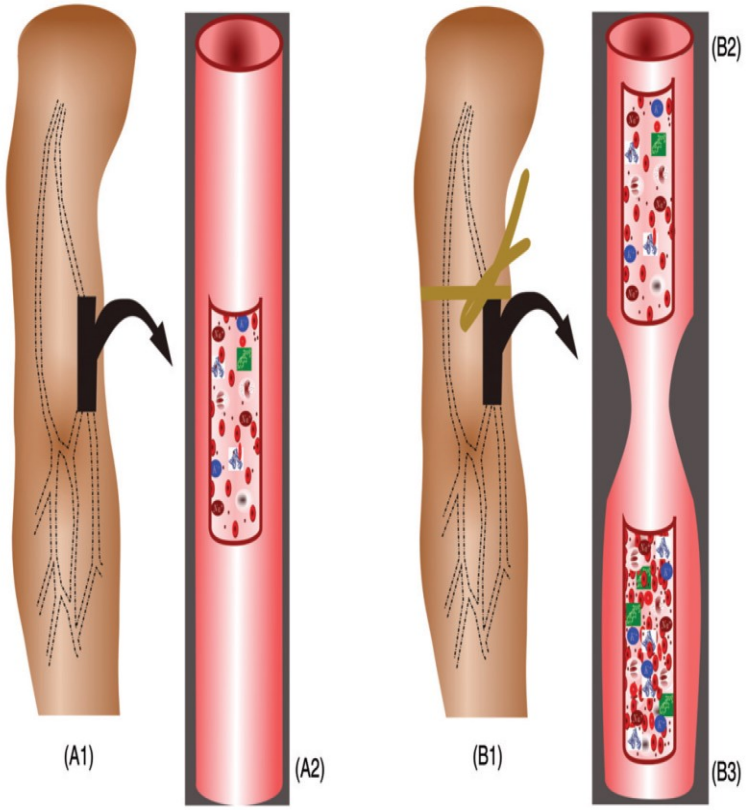


Figure 3. Venous stasis due to tourniquet application. (A1). Schematic upper limb without tourniquet application; (A2) Schematic blood vessels at physiological condition. (B1) Schematic upper limb after tourniquet application; (B2) Schematic blood vessels over tourniquet application; (B3) Schematic blood vessels at venous stasis condition due to tourniquet application by more than 1 minute.

Oliveira GL. et al.Pre-analytical phase management: a review of the procedures from patient reparation to laboratory analysis. SCandinavian Journal Of Clinical And Laboratory Investigation, 2017 VOL. 77, NO. 3, 153–163.

Table 3. Impact of physiology disturbance on vein caused by two different source of variability (vein stasis by tourniquet application and cold with vibration by Buzzy®) on routine haematological testing [48,55].

	Source of variability				
	Tourniquet application by				
Parameters	60 s	90 s	120 s	180 s	Cold and vibration by Buzzy®
PLT	3.4 ($p < .05$)	3.6 ($p < .01$)	4.9 ($p < .01$)	4.1 ($p < .01$)	−0.7 (NS)
WBC	2.5 ($p < .01$)	4.8 ($p < .01$)	4.9 ($p < .01$)	3.1 ($p < .01$)	−3.5 ($p < .01$)
NEU	3.3 ($p < .01$)	4.2 ($p < .01$)	6.6 ($p < .01$)	3.9 ($p < .01$)	−2.9 ($p < .05$)
MONO	4.3 ($p < .01$)	3.9 ($p < .05$)	3.6 (NS)	3.7 (NS)	−3.6 (NS)
EOS	4.2 ($p < .05$)	24.1 ($p < .01$)	7.5 (NS)	3.8 ($p < .05$)	0.0 (NS)
LYMP	0.8 (NS)	2.6 ($p < .01$)	5.6 ($p < .01$)	2.8 ($p < .05$)	−3.9 ($p < .05$)
RBC	1.5 ($p < .01$)	2.8 ($p < .01$)	2.8 ($p < .01$)	4.7 ($p < .01$)	2.0 ($p < .001$)
Hb	1.3 ($p < .01$)	2.6 ($p < .01$)	2.7 ($p < .01$)	4.1 ($p < .01$)	2.5 ($p < .001$)
Hct	1.5 ($p < .01$)	2.9 ($p < .01$)	2.9 ($p < .01$)	4.3 ($p < .01$)	2.2 ($p < .001$)

Results are expressed as percentage of variation (%) from the source of variability compared to the no-stasis by transilluminator. NS: not statistically significant ($p > .05$). All data presented in this table were previously published by *International Journal of Laboratory Hematology* (ISSN 1751-553X) and *Blood Transfusion* (ISSN 1723-2007).

Oliveira GL. et al.Pre-analytical phase management: a review of the procedures from patient reparation to laboratory analysis. SCandinavian Journal Of Clinical And Laboratory Investigation, 2017 VOL. 77, NO. 3, 153–163.

Transluminatör

Transillumination: a new tool to eliminate the impact of venous stasis during the procedure for the collection of diagnostic blood specimens for routine haematological testing

G. LIMA-OLIVEIRA*,†,‡,§, G. LIPPI¶, G. L. SALVAGNO§, M. MONTAGNANA§, M. SCARTEZINI*, G. C. GUIDI§, G. PICHETH*

SUMMARY

Introduction: The collection of diagnostic blood specimens for routine haematological testing (RHT) is traditionally performed with tourniquet. However, the transillumination devices based on cold near-infrared LEDs have been formerly proposed as a valuable tool for identifying reliable venous accesses, especially in patients with difficult or small veins, such as children. This study was aimed to evaluate whether a transillumination device can advantageously replace the use of the tourniquet during the procedure for collection of blood specimens for RHT and thereby eliminating the discomfort and risk of spurious results caused by excessive or prolonged venous stasis.

Methods: Two hundred and fifty volunteers were divided into five groups (G1, G2, G3, G4 and G5) to compare the results of RHT between blood sample collected with transilluminator device (left arm) and with tourniquet application (right arm) for 30 s(G1), 60 s(G2), 90 s(G3), 120 s(G4) and 180 s(G5).

Results: No significant increases were observed in any of the haematological parameters tested in G1 when compared with blood collected by the transilluminator device. From G2 to G5, significant increases were observed for the platelet count, red blood cell count, haemoglobin, haematocrit, white blood cell count, neutrophils, monocytes and eosinophils. From G3–G5, further increases were observed for lymphocytes. Clinically significant variations were, however, observed for basophils in G2; red blood cell count, haemoglobin, haematocrit and basophils in G3 and eosinophils in G3 only.

Conclusion: As such, considering that inappropriate use of the tourniquet is commonplace, we conclude that transillumination devices can represent a suitable tool to eliminate the venous stasis and to improve the quality of phlebotomy procedures.

Buzzy®

- Kan alma esnasında damarın delinmesi sırasında oluşan ağrıyı azaltmak için üretilmiş soğutmalı buz paketi ve titreşim sağlayan bir alet
- Potansiyel preanalitik varyasyon kaynağı
- WBC
- Nötrofil
- Lenfosit

↓

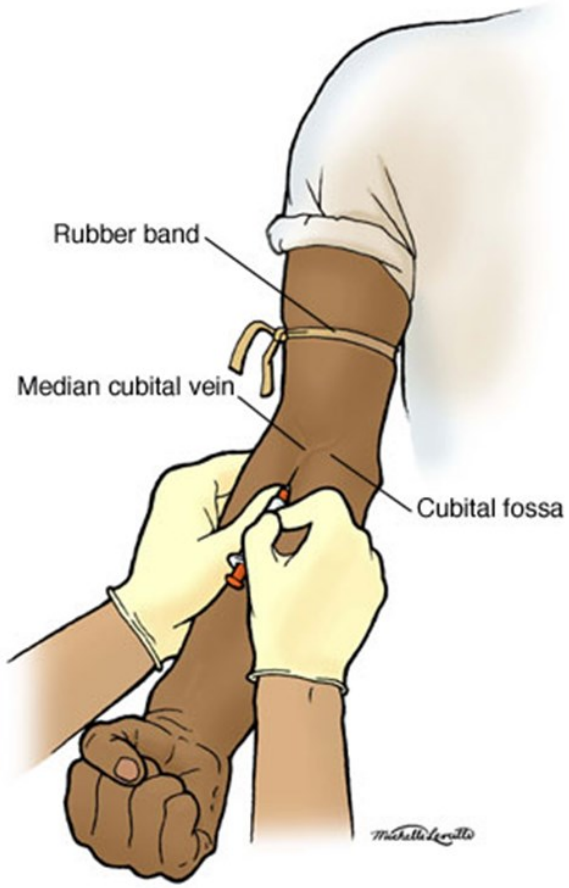
- RBC
- Hb
- Htc

↑

Yumruk Açıp Kapama

TABLE 1 Impact of fist clenching and maintenance during blood collection by venipuncture for routine hematology testing

Parameter	Unit	Fist clenching	No fist clenching	*P*	Mean % difference	Desirable imprecision (%)	CVa %
RBC	10^{12}/L	4.53 [4.22-4.84]	4.46 [4.15-4.90]	.422	1.5	1.6	1.2
HGB	g/L	135 [126-139]	134 [124-137]	.151	0.7	1.4	1.6
HCT	%	40.3 [38.8-41.7]	39.4 [37.6-41.6]	.132	**2.2**	1.4	1
MCV	fL	89.8 [85.8-92.0]	88.7 [85.5-91.7]	**<.001**	**1.2**	0.7	0.5
RDW	%	13.9 [13.4-14.4]	13.9 [13.3-14.4]	.041	0	1.8	1
WBC	10^9/L	5.36 [4.69-7.34]	5.52 [4.84-7.48]	.352	−3	5.7	1.9
NEU	10^9/L	2.55 [2.30-4.33]	2.78 [2.58-4.29]	.535	**−9**	8.6	1.7
LYMPHO	10^9/L	2.01 [1.83-2.51]	2.08 [1.74-2.72]	.389	−3.5	5.1	2.3
MONO	10^9/L	0.30 [0.25-0.44]	0.31 [0.27-0.42]	.183	−3.3	8.9	6.5
EOS	10^9/L	0.15 [0.09-0.22]	0.17 [0.08-0.24]	.363	**−13.3**	10.5	7.8
BASO	10^9/L	0.03 [0.01-0.04]	0.03 [0.02-0.04]	.192	0	14	13
LUC	10^9/L	0.10 [0.07-0.12]	0.10 [0.08-0.14]	.977	0	NA	10.5
PLT	10^9/L	226 [166-278]	234 [169-286]	.979	−3.5	4.6	2.4
MPV	fL	9.30 [8.92-9.50]	9.25 [8.90-9.80]	.343	0.5	2.2	1.3
RETIC	10^9/L	60.6 [46.4-78.3]	55.6 [48.4-71.4]	.066	**8.2**	5.5	3.2



Gabriel Lima-Oliveira,Gian Cesare Guidi,Gian Luca Salvagno,Giuseppe Lippi. The impact of fist clenching and its maintenance during venipuncture on routine hematology testing. J Clin Lab Anal 2016; 1–4

IV Tedavi

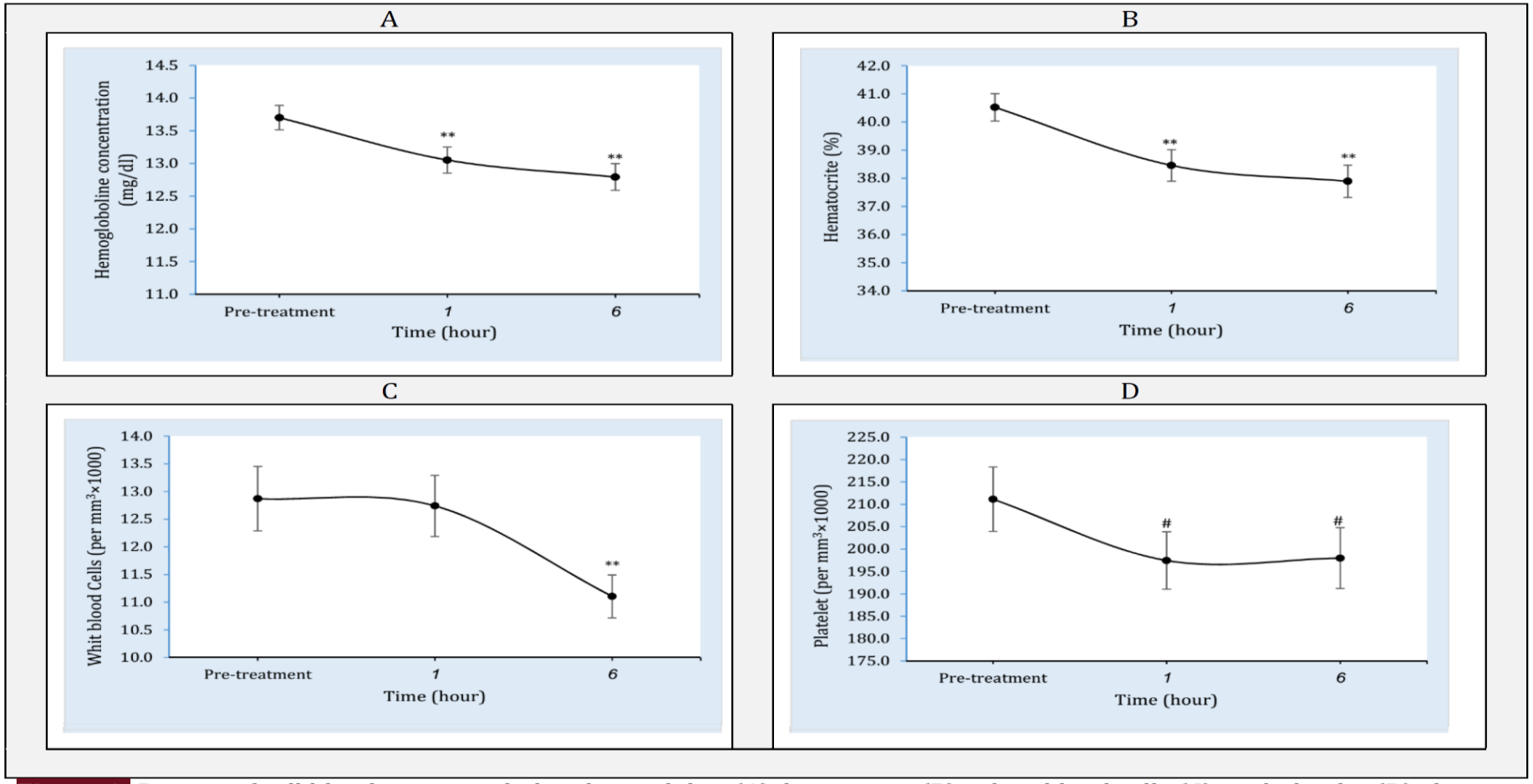


Figure 1: Pattern of cell blood counts including hemoglobin (A), hematocrit (B), white blood cells (C), and platelet (D) changes following infusion of one liter normal saline at the time of study. ** Significant difference from pre-treatment time at level $p<0.001$. * Significant difference from baseline at level $p<0.01$. # Significant difference from baseline at level $p<0.05$.

Paydar S. et al. Effects of Intravenous Fluid Therapy on Clinical and Biochemical Parameters of Trauma Patients. Emergency (2014); 2 (2): 90-95

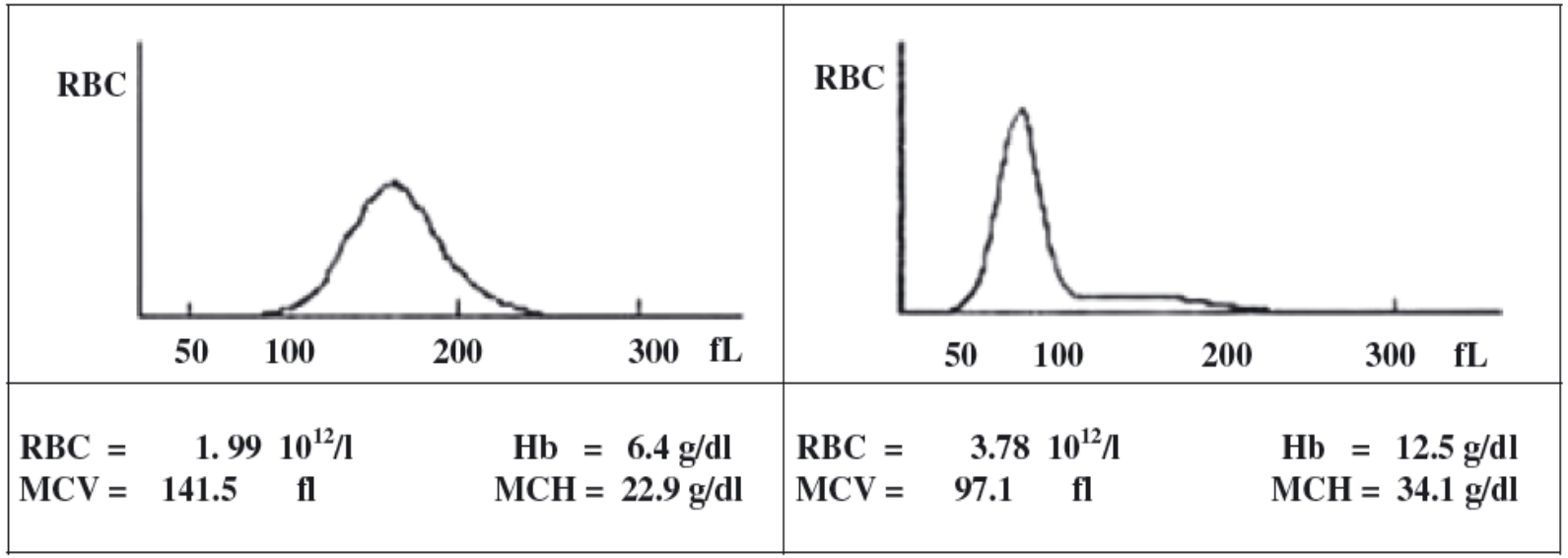


Figure 7. Venepuncture performed near a glucose infusion. Blood sample from that patient was diluted (Hb low) and excess of glucose led to a swelling of RBC; MCV was spuriously high and in turn MCHC spuriously low. Sample drawn correctly by the next morning showed normal values (no transfusion had been performed). RBC histogram on diluted sample (left) and on new sample (right; Beckman Coulter STKS II).

M. ZANDECKI, F. GENEVIEVE, J. GERARD, A. GODON. Spurious counts and spurious results on haematology analysers: a review. Part I: platelets. INTERNATIONAL JOURNAL OF LABORATORY HEMATOLOGY. doi:10.1111/j.1365-2257.2006.00870.x

Kan Alma Bölgesi

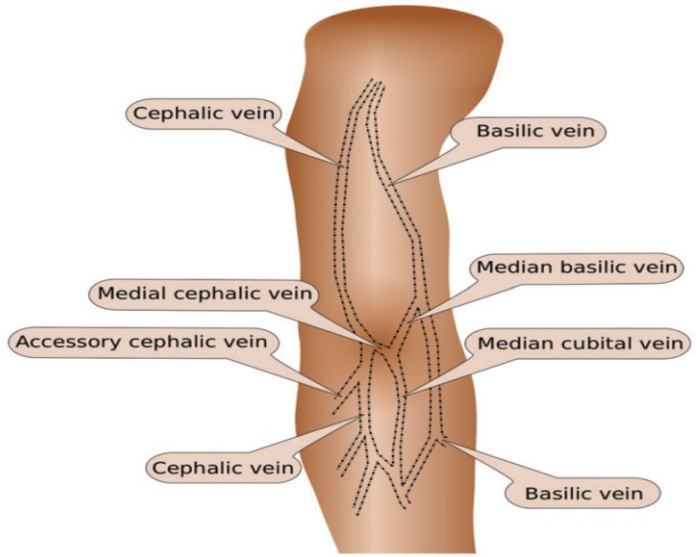


Figure 2. Venipuncture sites at upper limb.

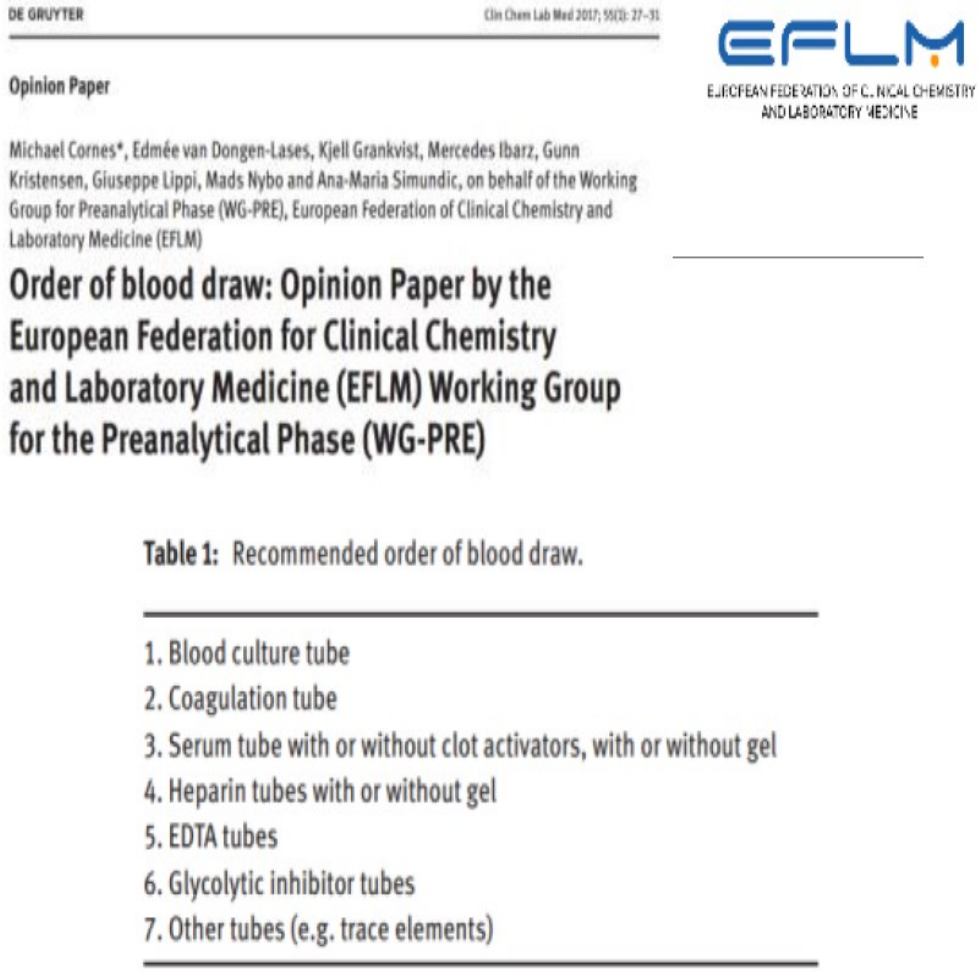
- Cilt yüzeyine yakın ve geniş venlerin bulunduğu dirseğin ön yüzü ve kolun iç kısmı venöz kan almada tercih edilen bölgedir (antekübital fossa).
- Pediatrik hastalarda kapiller kan tercih edilebilir.
- Hb
- Htc — Kapiller kanda daha yüksek
- RBC
- MCV → Kapiller kanda daha düşüktür.

Tüp Sırası

Tablo 3. İstemi yapılan testlerin özelliklerine göre alınacak numune tüpleri için uyulması gereken kan alma sırası ve altüst çevirme

Kapak rengi	Tüp/Katkı maddesi	Altüst çevirme sayısı
Değişken (1)	Kan kültürü/Besiyeri	Besiyeri ile kan karışımını sağlamak için hafifçe altüst edilir
(2)	Katkısız cam veya plastik serum tüpü	Gerek yok
(3)	Koagülasyon tüpü/Sitratlı	3-4 kez
(4)	ESR tüpü/Sitratlı	3-4 kez
(5)	Serum tüpü/ Jelsiz	5 kez
(5)	Serum tüpü/Jelli	5 kez
(5)		5 kez
(5)	Serum tüpü/Trombin pıhtı aktivatörlü tüp	5 kez
(6)	Plazma tüpü/Jelli veya jelsiz heparinli tüp	8-10 kez
(7)	Plazma tüpü/Jelli veya jelsiz EDTA'lı tüp	8-10 kez
(8)	Plazma tüpü/ Florür/potasyum okzalat;Florür/EDTA Florür/heparin	8-10 kez

EDTA; etilendiamin tetraasetik asit, ESR; eritrosit sedimantasyon hızı



DE GRUYTER Clin Chem Lab Med 2017; 55(2): 27–31

Opinion Paper

Michael Cornes*, Edmée van Dongen-Lases, Kjell Grankvist, Mercedes Ibarz, Gunn Kristensen, Giuseppe Lippi, Mads Nybo and Ana-Maria Simundic, on behalf of the Working Group for Preanalytical Phase (WG-PRE), European Federation of Clinical Chemistry and Laboratory Medicine (EFLM)

Order of blood draw: Opinion Paper by the European Federation for Clinical Chemistry and Laboratory Medicine (EFLM) Working Group for the Preanalytical Phase (WG-PRE)

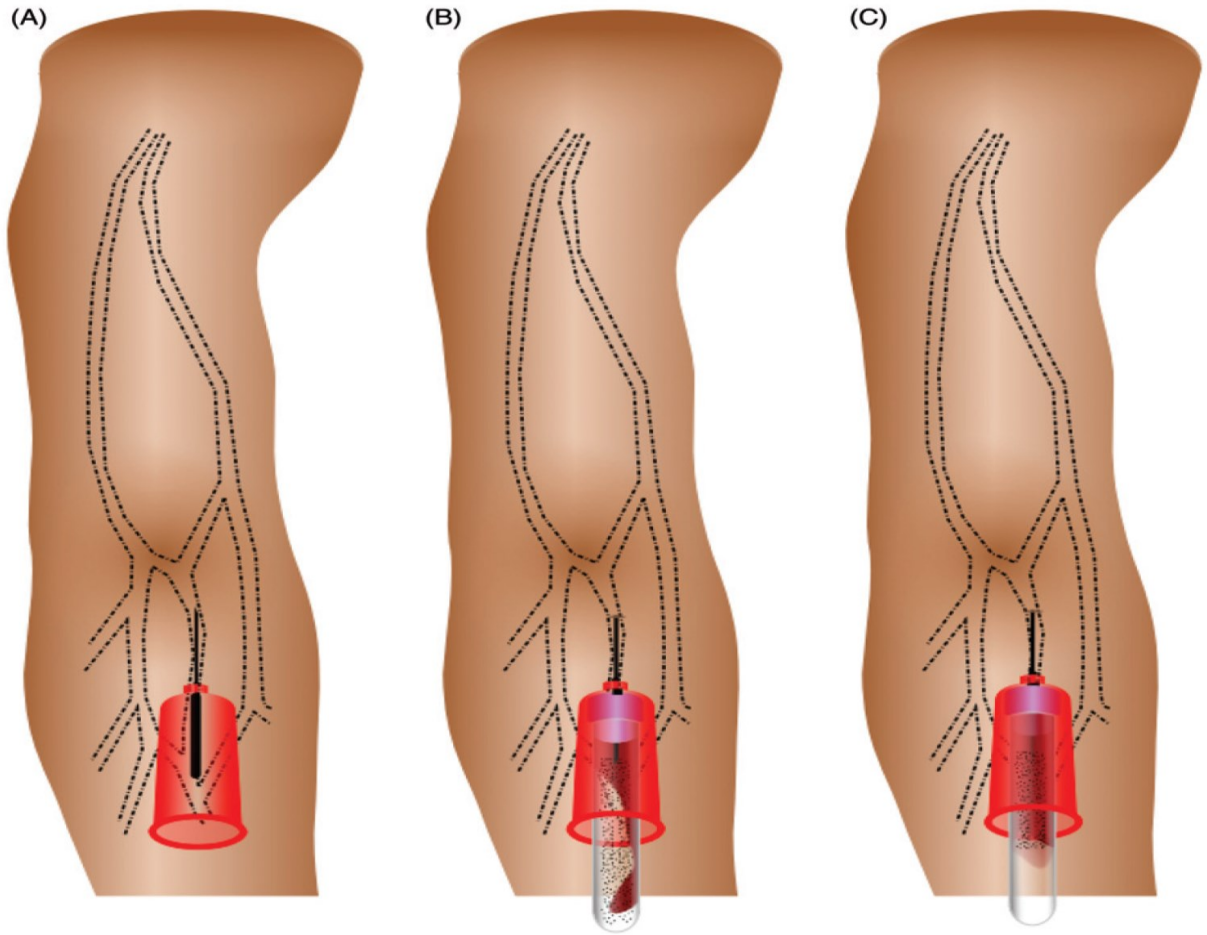
EFLM EUROPEAN FEDERATION OF CLINICAL CHEMISTRY AND LABORATORY MEDICINE

Table 1: Recommended order of blood draw.

1. Blood culture tube
2. Coagulation tube
3. Serum tube with or without clot activators, with or without gel
4. Heparin tubes with or without gel
5. EDTA tubes
6. Glycolytic inhibitor tubes
7. Other tubes (e.g. trace elements)

VENÖZ KAN ALMA (FİLEBOTOMİ) KILAVUZU, Türk Biyokimya Derneği Preanalitik Evre Çalışma Grubu,2015
CLSI GP41-A6

EDTA Kontaminasyonu



Oliveira GL. et al.Pre-analytical phase management: a review of the procedures from patient reparation to laboratory analysis. SCandinavian Journal Of Clinical And Laboratory Investigation, 2017 VOL. 77, NO. 3, 153–163.

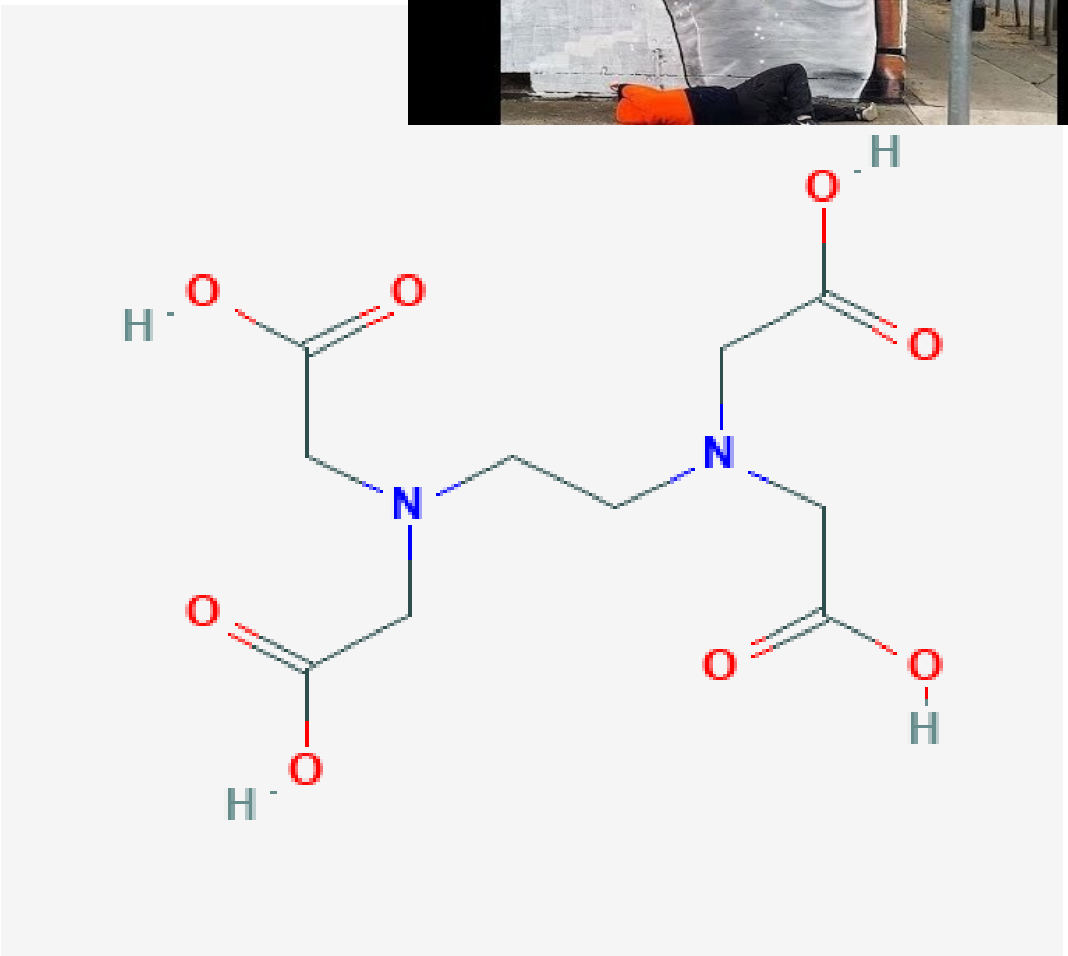
EDTA Kontaminasyonu

- Hipernatremi (Na sitrat veya NaEDTA kontaminasyonu)
- Hiperkalemi (KEDTA kontaminasyonu)
- Hipokalsemi (EDTA kontaminasyonu)
- Çinko düşüklüğü (EDTA kontaminasyonu)
- Demir düzeyinde düşüklük (EDTA kontaminasyonu)
- ALP düzeyinde düşüklük (EDTA kontaminasyonu)
- Antikoagülanların transferi nedeniyle zayıf pıhtılaşma
- Bir numunenin başka bir numuneye dökülmesi nedeniyle dilüsyon etkileri

- ***Michael Cornes, Edmée van Dongen-Lases, Kjell Grankvist, Mercedes Ibarz, Gunn Kristensen, Giuseppe Lippi, Mads Nybo and Ana-Maria Simundic, on behalf of the Working Group for Preanalytical Phase (WG-PRE), European Federation of Clinical Chemistry and Laboratory Medicine (EFLM).Order of blood draw: Opinion Paper by the European Federation for Clinical Chemistry and Laboratory Medicine (EFLM) Working Group for the Preanalytical Phase (WG-PRE) Clin Chem Lab Med 2017; 55(1): 27–31***

EDTA

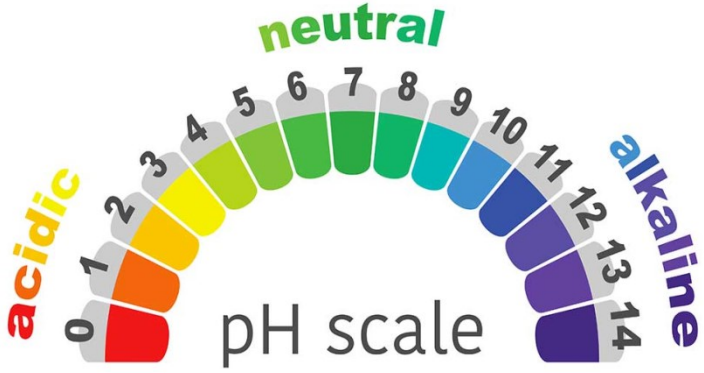
- EDTA(Etilendiamintetraasetik asit)tuzları;
  - ***Dipotasyum EDTA***
  - ***Tripotasyum EDTA***
  - ***Disodyum EDTA***
- Hematolojik testler için yaygın olarak kullanılan bir antikoagülandır.
- Kandaki kalsiyumu bağlayarak koagülasyon kaskadını inhibe eder.



EDTA

- **K_2EDTA :**Plastik tüplerin iç yüzeyine spreylenerek kurutulmuş bir solüsyondur.
- **K_3EDTA :**Sıvı bir solüsyon halinde tüplerin içinde bulunur.

EDTA Tuzları

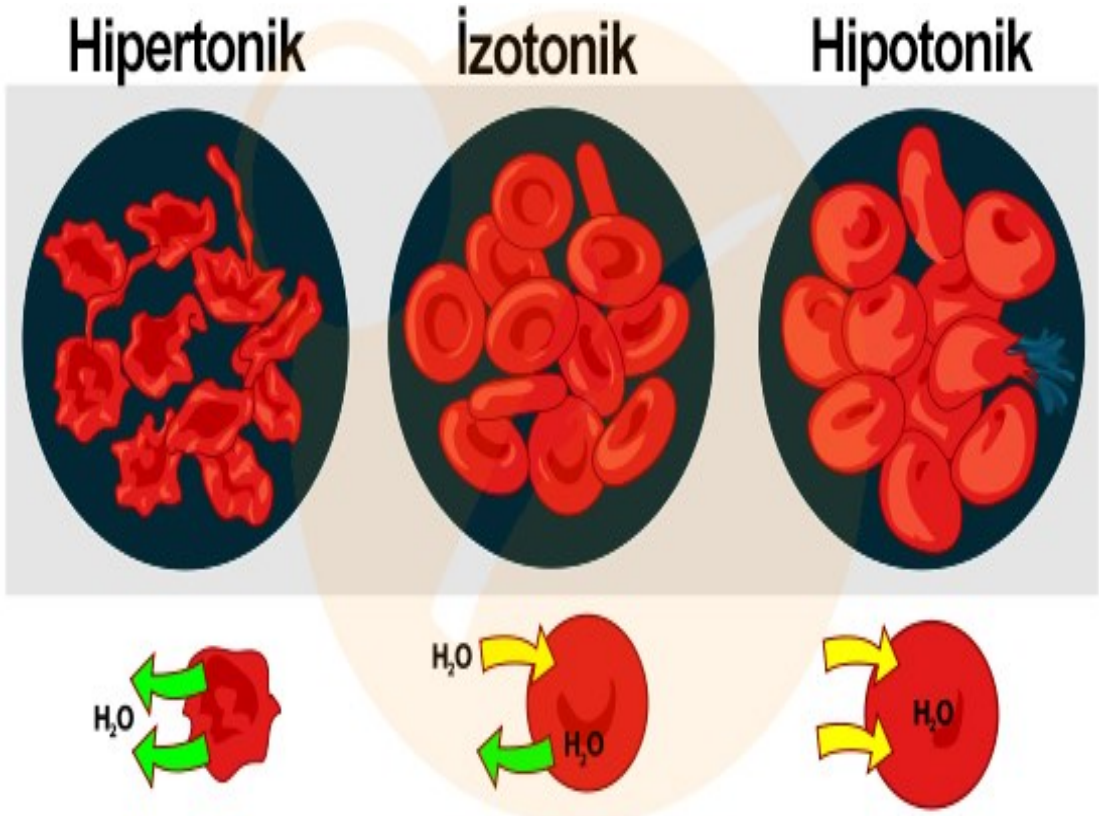


- EDTA nın pH değeri tuzuna bağlı olarak değişir.

- EDTA pH=2.5±1.0 (serbest asit solüsyonu olarak)
- K_3EDTA pH=7.5±1.0
- Na_2EDTA pH=5.0±1.0
- K_2EDTA pH=4.8±1.0

EDTA

- Bu pH değerindeki farklılıklar eritrosit boyutlarını etkiler.
- EDTA'nın tüm tuzları hücrelerden su kaybı ve hücre küçülmesine yol açan hiperosmolar moleküller olmalarına rağmen bu küçülme etkisi yalnızca K_3EDTA ile dikkati çekmektedir.
- K_2EDTA ve NA_2EDTA ile hücre büzülmesi olmasına rağmen, düşük pH ın hücre şişmesine neden olması ile oluşan osmotik dengelenme sonucu hücre boyutu değişmez.



K_3EDTA

- K_3EDTA MCV değerlerinde K_2EDTA ile karşılaştırıldığında %0.1-1.3 lük azalmaya neden olur.
- K_3EDTA sıvı olması nedeni ile örneğin dilüsyonuna neden olur.
- Doğrudan ölçülen bütün değerlerin (Hb,Htc,RBC,WBC,PLT) K_2EDTA ile ölçülen değerlere göre %1-2 daha düşük çıkmasına neden olur.

CLINICAL AND LABORATORY STANDARDS INSTITUTE®

September 2008

GP42-A6

Procedures and Devices for the Collection of Diagnostic Capillary Blood Specimens; Approved Standard—Sixth Edition

16.1.1 Additives

Hematology specimens can be collected directly into tubes containing EDTA (currently, dipotassium EDTA is the recommended type [see CLSI/NCCLS document H01][41]); such specimens are stable for 2 to 12 hours and provide accurate hematologic results.[42] Since heparin distorts cell morphology and interferes with cell staining, specimens for hematology tests should not be collected in heparinized tubes, unless the specimens are used only for the PCV determination.

SPECIAL REPORT

Laboratory Hematology

K_2EDTA konsantrasyonu 1.5-2.2 mg/ml kan olarak önerilmiştir.

Recommendations of the International Council for Standardization in Haematology for Ethylenediaminetetraacetic Acid Anticoagulation of Blood for Blood Cell Counting and Sizing

INTERNATIONAL COUNCIL FOR STANDARDIZATION IN HAEMATOLOGY: EXPERT PANEL ON CYTOMETRY*

Of the three ethylenediaminetetraacetic acid (EDTA) salts used for anticoagulation of blood specimens for hematologic testing, potassium salts are the most readily soluble. Tripotassium EDTA is dispensed as a liquid and thus causes a slight dilution of the specimen. This salt also has been shown to affect the red blood cell size more at increased concentrations and on storage than the dipotassium salt. Therefore, dipotassium EDTA is recommended as the anticoagulant of choice in specimen collection for blood cell counting and sizing. The amount of dipotassium EDTA used is 1.5–2.2 mg (3.7–5.4 μmol) per milliliter of blood. (Key words: Anticoagulant; Blood cell count; EDTA) Am J Clin Pathol 1993;100:371–372.

EDTA'ya Bağlı Psödotrombositopeni

- EDTA'nın, kalsiyum iyonlarını bağlarken trombosit membranında bulunan glikoprotein IIb-IIIa molekülüyle etkileşerek, glikoprotein IIb epitopunu açığa çıkardığı ve bu epitopa karşı otoantikora sahip kişilerde, trombositlerin kümelenmesine neden olduğu ileri sürülmektedir.
- Trombosit kümeleri büyüklüklerinden dolayı otomatik kan sayım cihazlarında trombosit olarak sayılamadıklarından, olduğundan daha düşük değerler raporlanmaktadır .

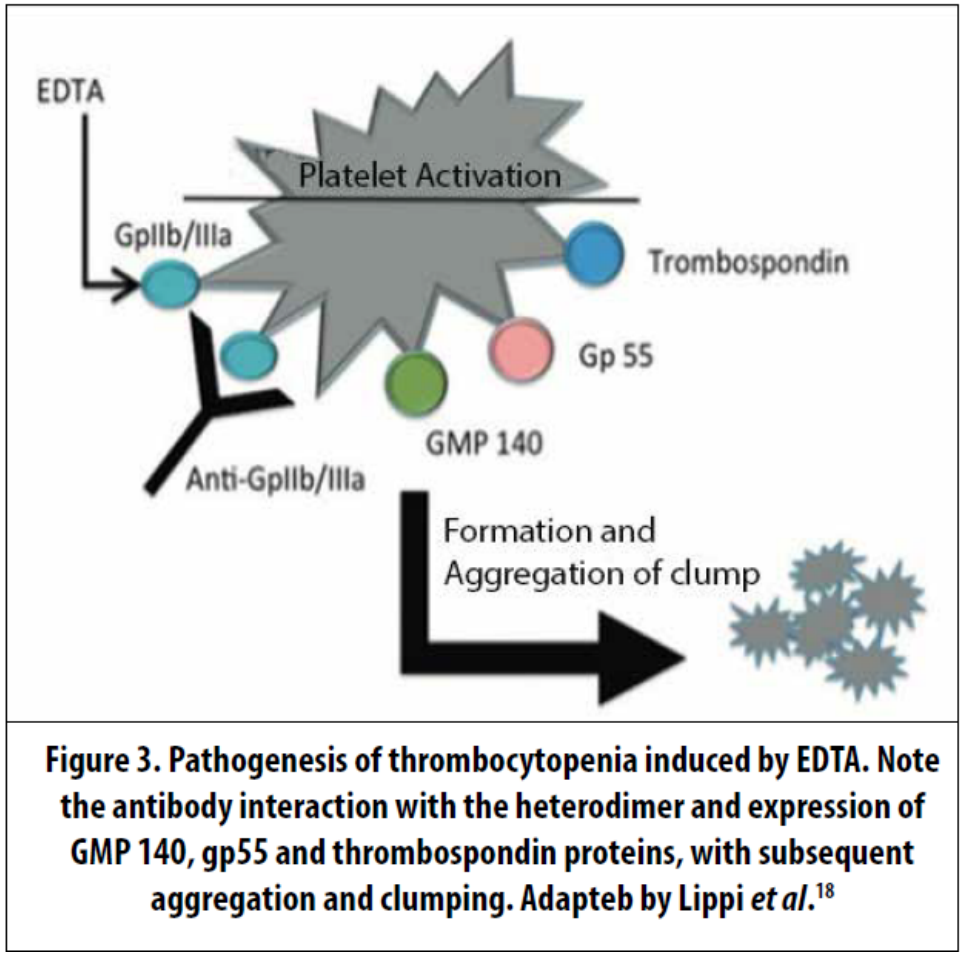


Figure 3. Pathogenesis of thrombocytopenia induced by EDTA. Note the antibody interaction with the heterodimer and expression of GMP 140, gp55 and thrombospondin proteins, with subsequent aggregation and clumping. Adapteb by Lippi *et al.*[18]

Lippi G, Plebani M. EDTA-dependent pseudothrombocytopenia: further insights and recommendations for prevention of a clinically threatening artifact. Clin Chem Lab Med. 2012 Aug;50(8):1281-5. doi: 10.1515/cclm-2012-0081.

Table 1 Major criteria for establishing a diagnosis of EDTA-dependent pseudothrombocytopenia.

1. Platelet count typically <100×10^9/L
2. Onset in only EDTA-anticoagulated sample kept at room temperature
3. Time-dependent fall of the platelet count in the EDTA specimen
4. Presence of platelet aggregates and clumps in EDTA-anticoagulated samples
5. Lack of clinical signs or symptoms of platelet disorders

Table 2 Additives and other compounds used to prevent EDTA-dependent pseudothrombocytopenia.

• Warming the sample at 37°C
• Buffered sodium citrate
• Lithium or calcium chloride heparin
• Ammonium oxalate
• β-hydroxyethyltheophylline
• Sodium fluoride
• Trisodium citrate, pyridoxal 5′-phosphate and Tris (CPT)
• Antiplatelet agents (e.g., acetylsalicylic acid, prostaglandin E1, apyrase, monoclonal antibodies)
• Potassium azide
• Kanamycin, amikacin and other aminoglycosides

Lippi G, Plebani M. EDTA-dependent pseudothrombocytopenia: further insights and recommendations for prevention of a clinically threatening artifact. Clin Chem Lab Med. 2012 Aug;50(8):1281-5. doi: 10.1515/cclm-2012-0081.

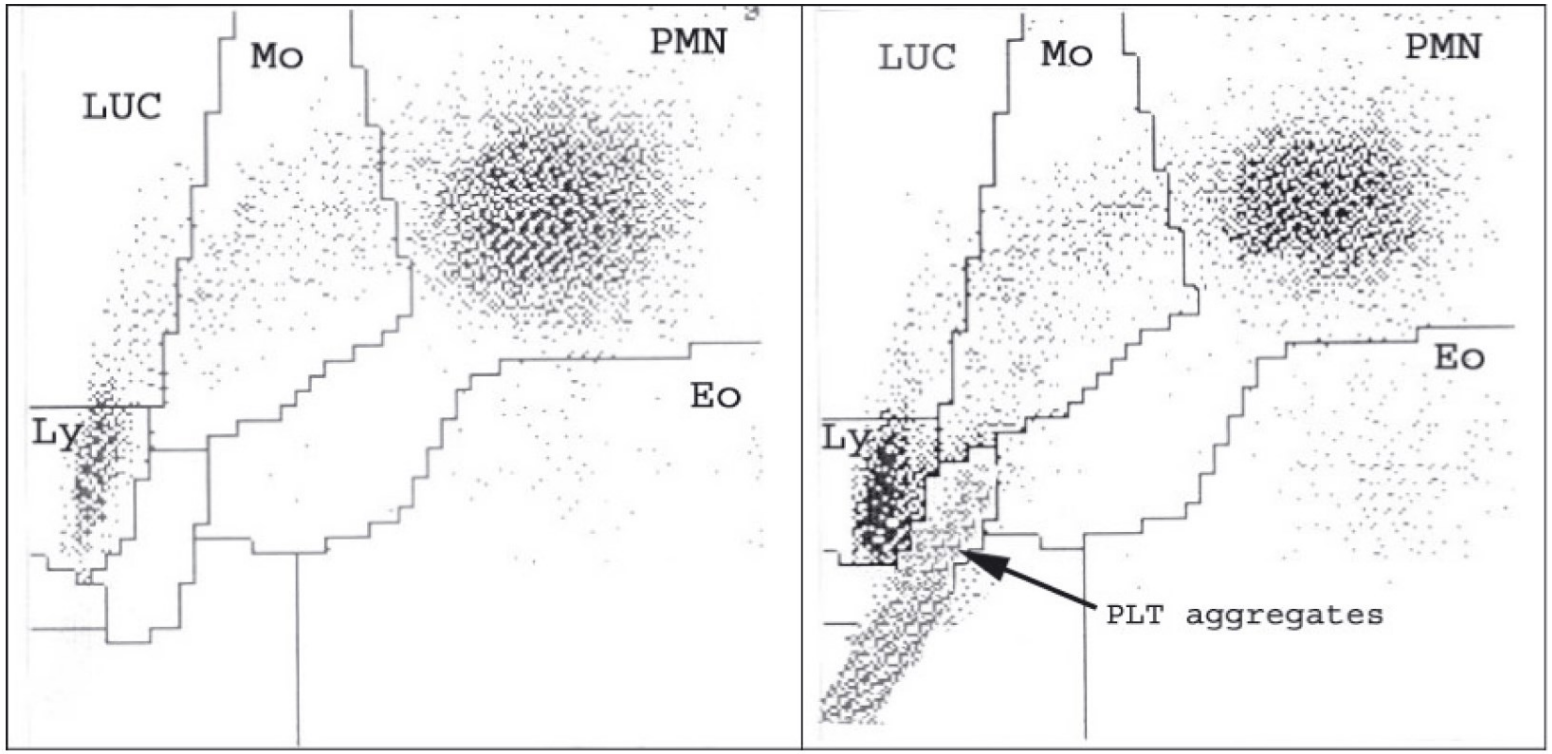


Figure 2. WBC scattergram form on normal patient (left) and another one showing EDTA-induced PLT aggregates (right). PLT aggregates generate a rocket of particles of small and intermediate size (outing from the origin from the *X*–*Y* display), leading to inability to perform accurate identification of WBC (Bayer Advia 120). Ly, lymphocytes; LUC, large unstained cells; Mo, monocytes; PMN, polymorphonuclear neutrophils; Eo, eosinophils.

M. ZANDECKI, F. GENEVIEVE, J. GERARD, A. GODON. Spurious counts and spurious results on haematology analysers: a review. Part I: platelets. INTERNATIONAL JOURNAL OF LABORATORY HEMATOLOGY. doi:10.1111/j.1365-2257.2006.00870.x

Uygunsuz Hacim

- EDTA'lı tüpün yetersiz doldurulması **Htc,MCV,MCHC,RDW** ve **RBC** etkilenecektir. **WBC ve RBC**'lerde morfolojik değişiklikler olur.
- Fazla doldurulması ise tüpün düzgün şekilde karışmasını önler ve pıhtılaşmaya neden olur.
- CLSI/NCCLS tarafından test tüplerinin nominal çekme hacminin **±% 10'una** kadar doldurulması önerilmektedir.

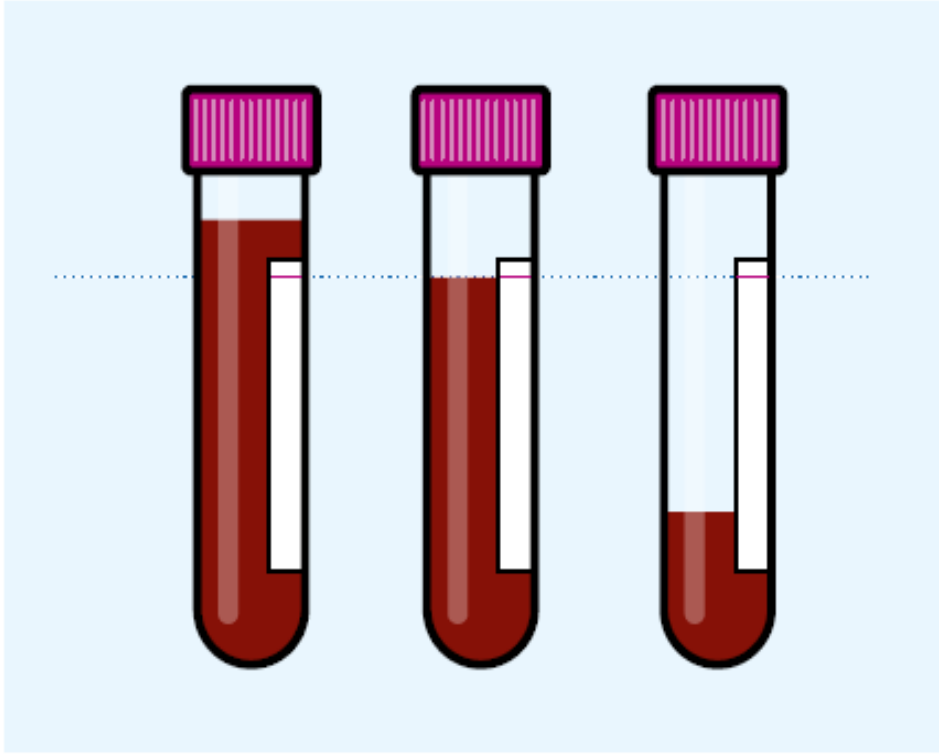
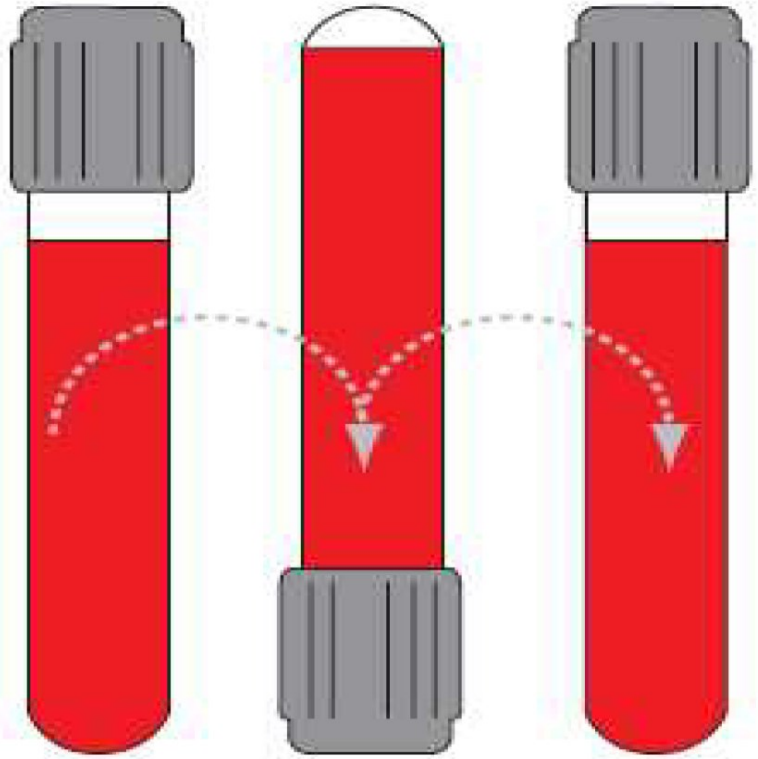


Fig. 1 *EDTA tubes from left to right: overfilled, correctly filled and underfilled.*

Tüplerin Karıştırılması

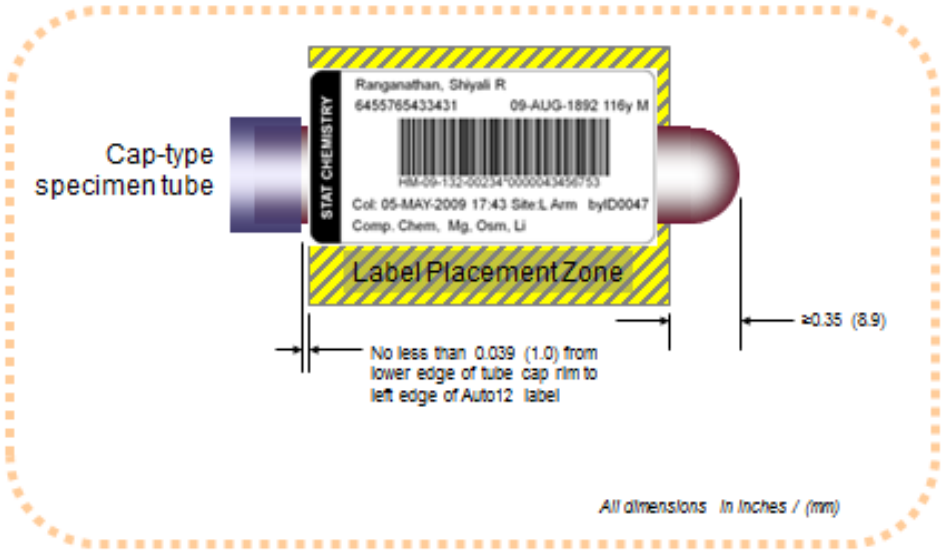
- Katkı maddesi içeren tüpler her numune alındıktan sonra yeterli karışımın sağlanması için (pıhtı,mikropıhtı ve fibrin filament oluşmasını önlemek için) özellikle üretici firmanın önerileri doğrultusunda nazikçe alt üst edilerek karıştırılmalıdır.
- Tüpler, numunelerde hemolize neden olacağından şiddetle çalkalanmamalıdır.



Tüplerin Etiketlenmesi

- Hastanın kimlik doğrulaması ve kan alımı için uygunluğunun sorgulanmasından sonra tüpler etiketlenmelidir.

- ***TBD. Venöz Kan Alma (Filebotomi) Kılavuzu,2015***.



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October 2007

GP41-A6

Procedures for the Collection of Diagnostic Blood Specimens by Venipuncture; Approved Standard—Sixth Edition

8.15 Step 15: Label Blood Collection Tubes and Record Time of Collection

The patient and the patient's blood specimen must be positively identified at the time of collection. Tubes must be positively identified after filling, not before, with a firmly attached label bearing at least the following:

- patient's first and last names;
- identification number;
- date;
- time (as required, eg, therapeutic drug monitoring); and
- identification of the person collecting the specimen.

The tube must be labeled with the above information before leaving the side of the patient. This may be accomplished by inscription or a computer-generated label or a bar-code label. There must be a mechanism to identify the person who drew the blood.[14] Where possible, compare the labeled tube to the patient's identification bracelet or have the patient verify that the information on the labeled tube is correct.

Transport ve Depolama

Table 3 *Stability of haematology parameters in EDTA blood samples*

Parameter	Storage at 4 °C	Effect of delayed processing
HGB	Stable up to 72 h	
RBC count	Stable up to 72 h	
MCV	Stable up to 6 – 12 h	Tends to increase
HCT	Stable up to 6 – 12 h	Tends to increase
PLT	Stable up to 24 h	
Reticulocytes (RET)	Stable up to 72 h	
WBC	Stable up to 72 h	

Table 2
Reccomendations for maximum allowable storage time (h) on EDTA anticoagulated blood

Test	Room temperature (18–22 °C)	Refrigerated (2–6 °C)
Blood smear	2–8 [2,14]	12–24 [5,12]
Complete blood count	6 [5,16]	24 [12]
Differential count	6 [5,16]	24 [12]
Reticulocytes	6 [15]	72 [15]

Buttarello M. Quality specification in haematology: the automated blood cell count. Clinica Chimica Acta 346 (2004) 45–54.

Pnömatik Sistem

The pneumatic tube system does not affect complete blood count results; a validation study at a tertiary care hospital

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SUMMARY

Introduction: Effect of the pneumatic tube system (PTS) on sample quality is controversial. Herein we aim at evaluating the impact of sample transportation via the PTS on complete blood count (CBC) results.

Methods: Duplicate CBC samples from normal donors and anemic patients were sent in parallel to the laboratory for testing through the PTS and the courier (CO). We used scatter plots, Bland–Altman plots, correlation coefficient (r), and coefficient of determination for the validation.

Results: A total of 115 samples (donors: 59, patients: 56) were tested. There was excellent correlation between both methods for red blood cell parameters (r range = 0.9213–0.9958) and platelet count. White blood cell (WBC) count and differential count showed similar results (r range = 0.8605–0.9821) for all, with exception of basophils which showed modest correlation (r = 0.4827 for patients and 0.5758 for normal donors). Most of the differences in measurement of all CBC parameters were within the 95% confidence interval of the mean difference on Bland–Altman plots.

Conclusion: Modern PTS can be safely used for transporting CBC samples.

The Effects of Sample Transport by Pneumatic Tube System on Routine Hematology and Coagulation Tests

Table 1: Summary of the differences in CBC between pneumatic tube samples and hand delivered samples.

S. no.	Paired samples	Mean difference	Standard deviation of mean difference	95% confidence interval of mean difference		*P* value
				Lower	Upper	
1	RBC P-RBC M ($x10^{12}$/l)	-.03	.21	-.08	.01	.11
2	HB P-HB M (g/dl)	-.01	.24	-.06	.05	.84
3	MCV P-MCV M (fl)	-.82	1.9	-1.28	-.37	.001
4	MCH P-MCH M (pg)	.03	.41	-.06	.12	.500
5	MCHCP-MCHC M (g/dl)	.36	.84	.17	.56	<0.001
6	RDW P-RDW M (%)	-.33	.67	-.49	-.18	<0.001
7	WBC P-WBC M ($x10^9$/l)	.04	1.2	-.24	.32	.759
8	NE P-NE M (%)	-.45	2.94	-1.13	.21	.182
9	LY P-LY M (%)	.20	3.30	-.55	.96	.590
10	MO P-MO M (%)	.30	1.37	-.01	.62	.057
11	EO P-EO M (%)	.28	3.46	-.50	1.08	.472
12	BA P-BA M (%)	.01	.33	-.06	.08	.754
13	PLT P-PLT M ($x10^9$/l)	.13	.26	.07	.19	<0.001
14	MPV P-MPV M (fl)	-.18	.64	-.32	-.03	.017

P: pneumatic tube samples; M: hand delivered samples; RBC: red blood cells count; HB: hemoglobin; MCV: mean corpuscular volume; MCH: mean corpuscular hemoglobin; RDW: red cell distribution width; WBC: white blood cell count; NE: neutrophils; LY: lymphocytes; MO: monocytes; EO: eosinophils; BA: basophils; PLT: platelets; MPV: mean platelet volume

MCV
MCHC
RDW
PLT

in PT and APTT samples compared to the hand delivered samples. *Conclusion*. Despite statistically significant changes in RBC parameters such as MCV, RDW, and MCHC and platelet count, these changes were clinically insignificant. Hence, blood samples for CBC and coagulation assay can safely be transported via our hospital's PTS. However, further studies on platelet count are warranted to ensure safe transport and accuracy of the results.

Assessing Safety of Pneumatic Tube System (PTS) for Patients with Very Low Hematologic Parameters

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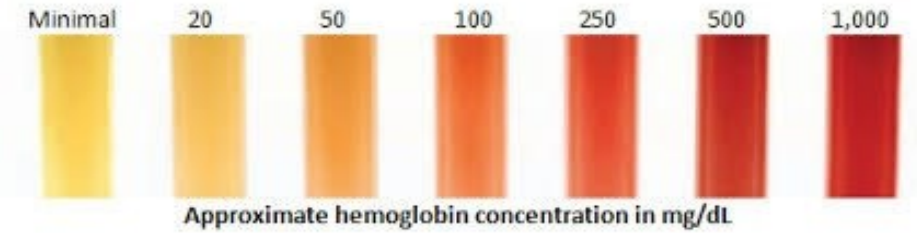
Table 2. Descriptive statistics of blood analysis results for two types of transportation.

	Group 1		Group 2		*P*
WBC (×10³/μL)#	0.800	(0.100–7.800)	0.700	(0.100–7.700)	0.021
RBC (×10³/μL)*	3.012±0.278		2.981±0.282		**0.000**
HGB (g/dL)#	9.300	(7.200–10.900)	9.100	(7.000–10.300)	**0.000**
HCT (%)*	27.09±2.28		26.56±2.11		**0.000**
MCV (fL)#	89.00	(80.30–106.50)	88.80	(81.10–106.70)	0.29
MCH (pg)#	29.70	(26.80–33.70)	29.70	(27.00–32.60)	0.96
MCHC (g/dL)#	30.10	(26.80–33.70)	30.10	(27.00–33.70)	**0.000**
RDW#	15.0	(12.0–25.3)	15.0	(12.1–27.1)	0.94
PLT (×10³/μL)#	22.0	(2.0–64)	17.0	(9.0–63.0)	**0.000**
MPV (fL)#	7.85	(5.9–10.5)	7.8	(5.9–11.6)	0.81
LD (U/L)#	168.0	(56.0–815.0)	189.5	(60.0–847.0)	**0.000**
TB (mg/dL)#	0.97	(0.22–21.34)	0.97	(0.09–21.35)	0.70
CB (mg/dL)#	0.43	(0.13–16.5)	0.44	(0.14–16.48)	0.76
UB (mg/dL)#	0.52	(0.10–4.97)	0.49	(0.08–4.84)	**0.000**
AST (U/L)#	13.0	(4.0–82.0)	16.0	(4.0–82.0)	**0.000**
ALT (U/L)#	21.0	(3.0–158.0)	22.0	(6.0–159.0)	0.15
Potassium (K) (mmol/L)#	3.7	(2.3–6.8)	3.9	(2.5–6.9)	**0.000**

Conclusions

In our study, we found that the PTS had a potential effect on routine hematological testing. Blood cell counts in patients with leukemia may be altered by the use of PTS transportation. Because each extra transfusion leads to an increase

Hemoliz



- Hemoliz, eritrosit membranının bozulması ile Hb ve diğer intrasellüler madddelerin serum veya plazmaya geçmesidir.
- The Working Group on Laboratory Errors and Patient Safety (WG-LEPS) of the International Federation of Clinical Chemistry and Laboratory Medicine (IFCC) 391 laboratuvarda yaptığı çalışmada

  Hemolizli örneklerin %53 acil servisten,

  %16 sı pediatri servisinden

  % 7'sinin Yoğun Bakım Üniteleri

- ***Giuseppe Lippi, Mario Plebani, Salvatore Di Somma & GianfrancoCervellin (2011) Hemolyzed specimens: a major challenge for emergency departments and clinical laboratories, Critical Reviews in Clinical Laboratory Sciences, 48:3, 143-153, DOI:10.3109/10408363.2011.600228***

Hemoliz

- Hemolizin derecesine göre ve kullanılan ölçüm yöntemine göre değişmekle birlikte hemolizli örnekte;
- RBC ↓
- Htc ↓
- MCV ↓
- MCHC ↑
- RDW ↑
- PLT ↑

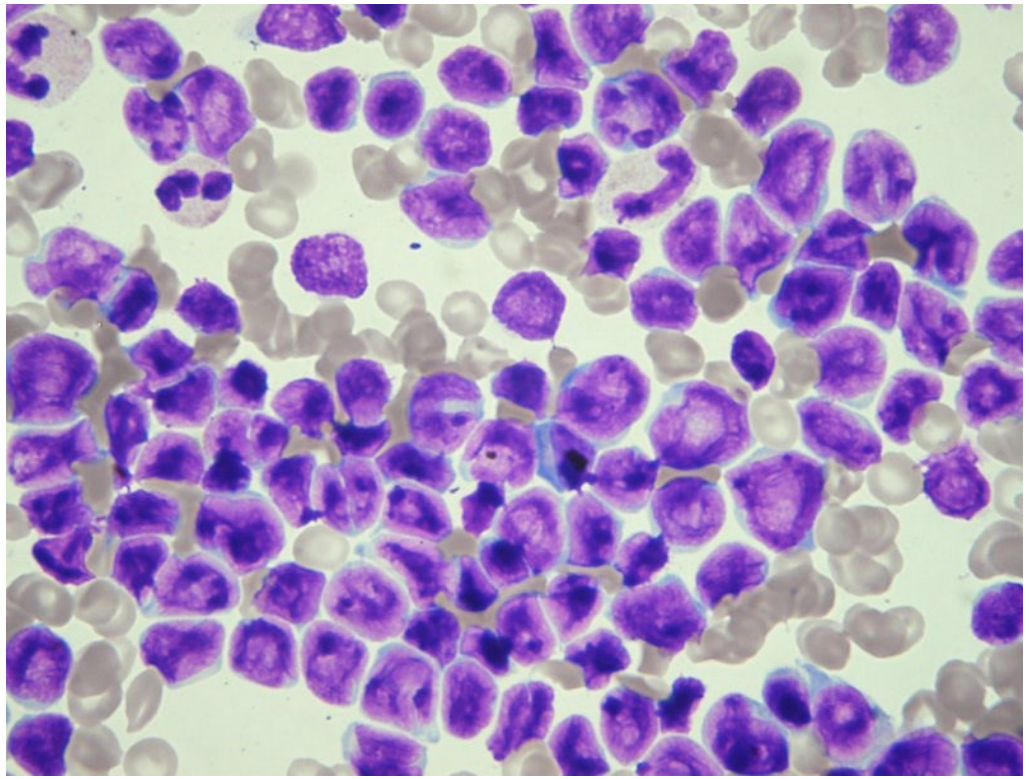
Most common situations causing hemolysis in EDTA specimens.[10,11]
When a tourniquet is too tight
Blood tube is vigorously mixed/shaken (mix gently 8-10 times)
Poor phlebotomy technique (probing for vein)
Specimen transportation conditions (time, temperature, etc.)
Vascular access devices
Specimen storage (should be 2-8oC for <24 hrs)
Over-clenching of fist
Needle size too small (use 23g or bigger)
Milking a finger-stick (newborns, geriatric, oncology patients)
Drawing specimen before alcohol dries (wait 30-60 seconds)
Over-centrifugation (time/speed)
Frozen EDTA tubes

Lipemi

- Hematolojik testler de lipid ve şilomikronlardan etkilenir.
- Lipemik örneklerdeki bulanıklık spektrofotometrik ölçüm üzerinden interferansa bağlı olarak yanlış **yüksek Hb** ölçümüne neden olur. (MCHC>36 g/dl)
- **PLT, WBC ve Lenfositlerde** interferansa no.
- Lipitler yüksek hacimli damlacıklar oluşturduğunda, PLT sayımını engelleyebilirler.

Hiperlökositoz

- >100.000/µl
- Hb
- RBC
- MCV
- PLT



Soğuk Aglütinin

- Soğuk Aglütinin hastalığı karakteristik olarak eritrosit üzerindeki polisakkarit antijenlere yönelik oluşan genellikle IgM nadiren de IgA veya IgG tipindeki antikorların neden olduğu otoimmün bir hastalıktır .
- Soğuk aglütinin hastalığında soğukta aktifleşen antikorların eritrositlerin zarında dejenerasyon oluşturması ve eritrositlerin otoaglütinasyona uğraması sonucu hemoliz gerçekleşir.
- RBC ↓
- Htc ↓
- MCV ↑
- MCH ↑
- MCHC ↑

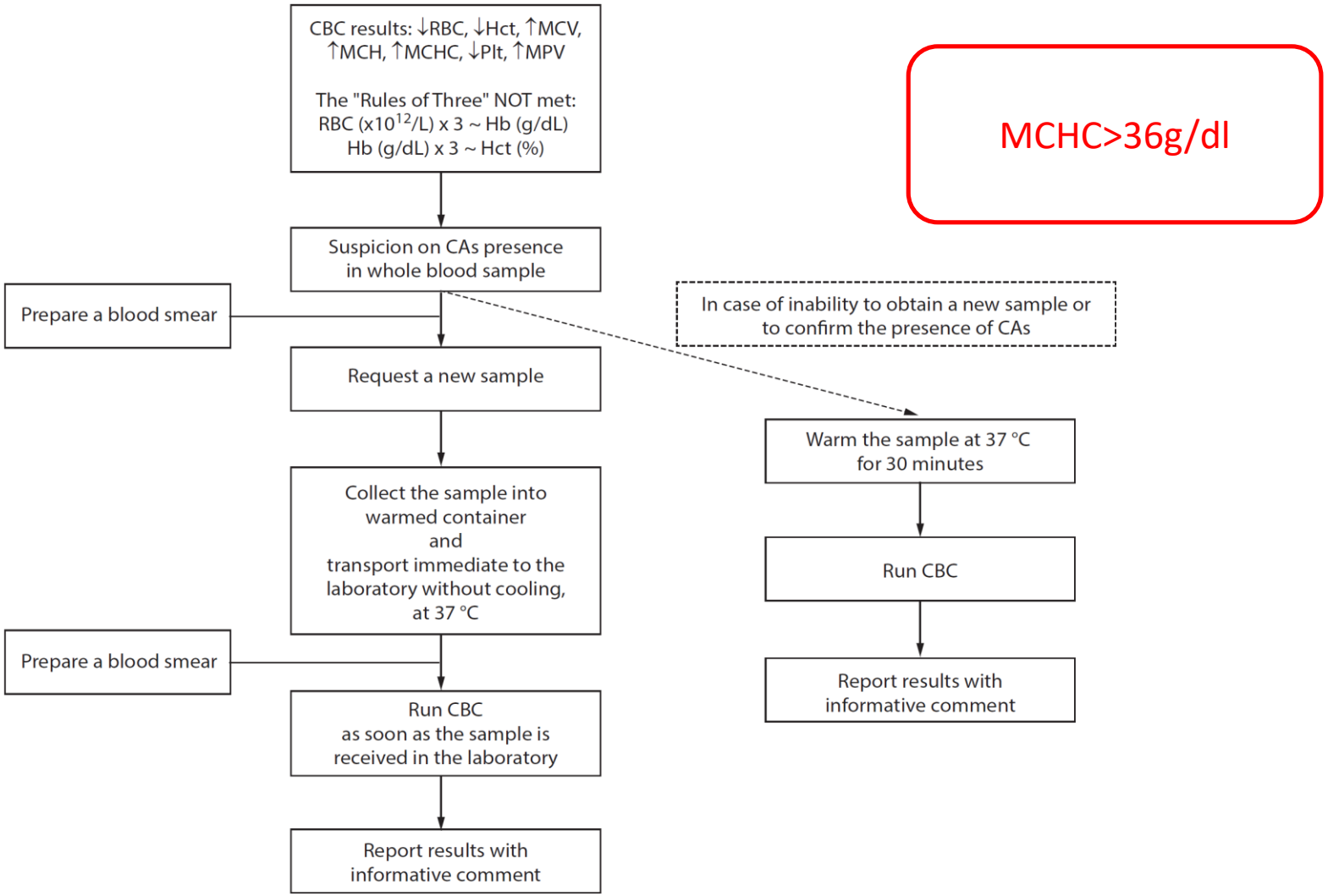


Figure 2. A proposed laboratory procedure for whole blood samples with suspected cold agglutinins. CBC - complete blood count. Hct - haematocrit. MCV - mean corpuscular volume. MCH - mean corpuscular haemoglobin. MCHC - mean corpuscular haemoglobin concentration. RDW - red cell distribution width. Plt - platelet. MPV - mean platelet volume. WBC - white blood cells. CAs - cold agglutinins.

Topic A.et al. Effect of cold agglutinins on red blood cell parameters in a trauma patient: a case report. Biochem Med (Zagreb) 2018;28():031001

Kriyoglobulinler

- Genellikle 37°C den düşük sıcaklıkta presipite olarak, yüksek moleküler ağırlıklı agregatlar meydana getiren immunglobulinlerdir.

- Kriyoglobulinler de otomatik kan sayımı sonuçlarını etkileyerek **lökosit ve trombosit sayılarının yüksek çıkmasına** neden olurlar.

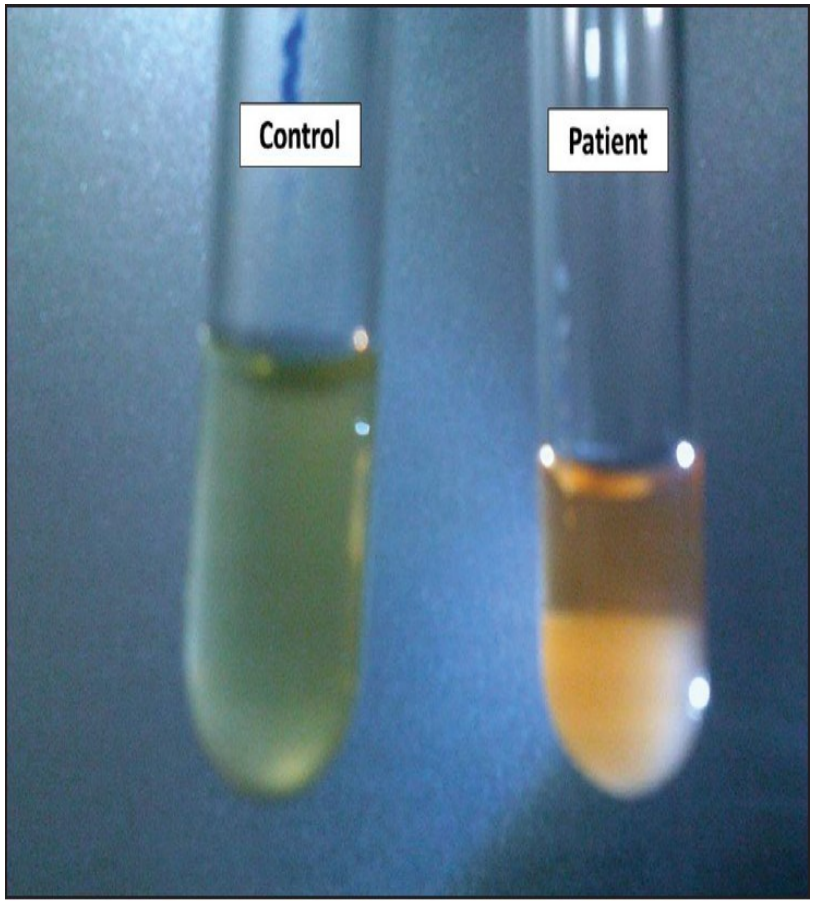


Table 3. Laboratory mistakes in stat testing.

Defects detection steps	Defects found: No.	Defects found: Frequency, %
Preanalytical		
Wrong name of patient given	5	2.6
Erroneous specification of hospital unit	36	19.0
Physician's order missed	34	18.1
Order misinterpreted	6	3.2
Inappropriate container used	5	2.6
Specimen collection incorrect	4	2.1
Specimen collected from infusion route	39	20.6
Subtotal	129	68.2
Analytical		
Isolated malfunctioning of instrument	5	2.6
Lack of specificity of the method	4	2.1
Unacceptable performance	16	8.5
Subtotal	25	13.3
Postanalytical		
Correction of erroneous finding overlooked	9	4.8
Keyboard entry error	5	2.6
Turnaround time exceeded	6	3.2
Physician not notified of problem	15	7.9
Subtotal	35	18.5

Plebani M, Carraro P. Mistakes in a STAT laboratory: types and frequency. Clin Chem 1997;43:1348–51

Table 1. Laboratory errors in stat testing.

Defects: detection steps	Defects found: No.	Defects found: Frequency, %
Preanalytical		
Specimen collected from infusion route	3	1.9
Sample contaminated	1	0.6
Tube filling error	21	13.1
Empty tube	11	6.9
Inappropriate container	13	8.1
Nonrefrigerated sample	3	1.9
Missing tube	5	3.1
Digoxin test timing error	1	0.6
Patient identification error	14	8.8
Request procedure error	12	7.5
Data communication conflict	6	3.8
Physician's request order missed	3	1.9
Order misinterpreted	2	1.3
Check-in not performed (in the Laboratory Information Systems)	4	2.5
Subtotal	99	61.9
Analytical		
Instrument-caused random error	3	1.9
Analytical inaccuracy not recognized	21	13.1
Subtotal	24	15
Postanalytical		
Results communication breakdown	32	20
Lack of communication within laboratory	3	1.9
TAT excessive	2	1.3
Subtotal	37	23.1

Plebani M, Carraro P. Errors in a Stat Laboratory: Types and Frequencies 10 Years Later. Clin Chem 2007;53:1388–42

Table 1 Distribution of rejected blood samples and type of preanalytical error detected according to the analytical test requested and the requesting department.

	Rejected samples, n (%)					
	HS	MS	IVS	CS	WS	Total
Requested tests						
Clinical chemistry (n=9106)	242 (39.5)	16 (2.6)	–	–	50 (8.2)	308 (50.2)
Blood gases (n=2537)	–	29 (4.7)	–	37 (6.0)	–	66 (10.8)
Blood counts (n=9052)	–	9 (1.5)	–	25 (4.1)	–	34 (5.5)
Coagulation (n=5715)	67 (10.9)	28 (4.6)	64 (10.4)	28 (4.6)	18 (2.9)	205 (33.4)
Requesting departments						
Emergency (n=14,525)	229 (37.3)	42 (6.8)	35 (5.7)	47 (7.7)	35 (5.7)	388 (63.3)
ICU (n=5471)	12 (1.95)	14 (2.3)	14 (2.3)	10 (1.6)	19 (3.1)	69 (11.3)
Walk-in clinic (n=1285)	19 (3.1)	3 (0.49)	–	2 (0.32)	–	24 (3.9)
Hospitalisation ward (n=5129)	49 (8.0)	23 (3.7)	15 (2.4)	31 (5.1)	14 (2.3)	132 (21.5)
Overall mistakes, n (%)	309 (50.4)	82 (13.4)	64 (10.4)	90 (14.7)	68 (11.1)	613 (100)

ICU, intensive care unit; HS, haemolysed sample; MS, missed sample; IVS, inappropriate volume sample; CS, coagulated sample; WS, wrong sample.

Romero A. et al. Identification of preanalytical mistakes in the stat section of the clinical laboratory. Clin Chem Lab Med 2005;43(9):974–975

TABLE 1. Specimen rejection rates according to the error reasons.

Laboratory test groups	Improperly labelled samples (%)	Hemolysis (%)	Clotted specimen (%)	Insufficient volume (%)
Clinical chemistry inpatient	0.03*	0.06	0	0.01
Clinical chemistry outpatient	0	0	-	0
Immunoassay	0	0	-	0.10
Coagulation	0.02	0.48	0.26	1.38**
HbA1c	0.01	-	0.01	0.01
Hematology	0.01	-	0.16*	0.02
ESR	0.01	-	0.64*	0.25

Percentages were calculated by 'number of rejected samples'/ total number of samples' of each laboratory test unit for a 1 year period. *P=0.027 among other test groups, **P < 0.001 among other error reasons.
ESR - erythrocyte sedimentation rate.

Atay A. Et al. Clinical biochemistry laboratory rejection rates due to various types of preanalytical errors. Biochem Med (Zagreb). 2014 Oct 15;24(3):376-82.

- Pıhtılı örnek; Toplam reddedilen örneklerde %14
  Reddedilen hematoloji örneklerinde ise % 65

Alsina, et al. Preanalytical quality control program – an overview of results (2001–2005 summary) Clin Chem Lab Med 2008;46(6):849–854
Jones, et al. Complete blood count specimen acceptability. A CAP Q-Probes study of 703 laboratories. Arch Pathol Lab Med V119, March 1995

Table 3. The error frequencies rate of laboratory QIs according to laboratories

	Total rejected samples	Biochemistry, %	Immunoassays, %	HbA1C, %	Hematology, %	Urinalysis, %	Blood gases, %	Coagulation,.%	ESR, %	Total, %
Total samples		169717	110856	27073	205068	54412	10009	41134	30732	649001
Pre-analytical phase										
Inappropriate test request	16	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Misidentification error	59	0.00	0.01	0.00	0.01	0.00	0.01	0.02	0.07	0.01
Incorrect container	446	0.05	0.06	0.08	0.04	0.03	0.19	0.14	0.32	0.07
Incorrect sample type	148	0.02	0.02	0.00	0.01	0.01	0.14	0.09	0.08	0.02
Insufficient sample volume	756	0.04	0.04	0.04	0.08	0.10	0.17	0.83	0.14	0.12
Sample hemolyzed	501	0.22	0.01	0.00	0.01	0.00	0.00	0.23	0.00	0.08
Sample clotted	1842	0.00	0.00	0.53	0.58	0.00	2.18	0.44	0.33	0.28
Samples not delivered	42	0,01	0.01	0.00	0.00	0.00	0.03	0.00	0.00	0.01
Unsuitable transportation	35	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0,00	0.01
Excessive transportation time	6	0,002	0.00	0.00	0.001	0,00	0.00	0.00	0.00	0,00
Other	35	0.01	0.01	0.00	0,00	0,01	0,02	0,01	0,00	0,01
Analytical phase										
Analyzer fault	13	0.004	0.00	0.00	0.00	0.00	0.002	0,005	0,00	0.002
Device pipetting error	4	0,002	0.000	0.00	0.00	0.00	0.00	0.002	0.00	0.001
Unacceptable performance in EQA	62	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Post-analytical phase										
Inappropriate turnaround time	792	0.05	0.22	0.17	0.04	0.17	0.47	0.35	0.19	0.12
Total error rate	4757	0.48	0.38	0.83	0.78	0.31	3.24	2.13	1.15	0.73

This table describes the error percentage for all samples (total number of samples: 649,001). The formula of the error frequency rate: % rejected samples/total number of samples.
ESR: Erythrocyte sedimentation rate; EQA: External quality assurance; HbA1c: Glycated hemoglobin.

Alpdemir M.et al. Evaluation of biochemistry laboratory quality indicators according to the national Laboratory Error Classification System. Int J Med Biochem 2018;1(2):65-71

Table 4. Error percentage by phase according to location of the error

	Pre-analytical phase, % (n=3886)	Analytical phase, % (n=79)	Post-analytical phase, % (n=792)	Total, % (n=4757)
Clinic	19.6	-	-	16.0
Intensive care unit	19.6	-	-	16.0
Emergency department	25.6	-	-	20.9
Outpatient clinic	12.7	-	-	10.4
Sample receiving unit	22.1	-	-	18.1
Sample acceptance unit	-	-	-	-
Laboratory	0.4	100.0	100.0	18.6
Other	-	-	-	-

Alpdemir M.et al. Evaluation of biochemistry laboratory quality indicators according to the national Laboratory Error Classification System. Int J Med Biochem 2018;1(2):65-71

Table 2. Quality indicators of the preanalytical phase proposed by the IFCC Working Group - Laboratory Errors and Patient Safety (IFCC WG-LEPS) and sample rejection ratios (SRRs) in the emergency laboratory of Hacettepe University.

Quality Indicators of the pre-analytical phase proposed by the IFCC WG-LEPS	SRRs in the emergency laboratory of Hacettepe University (%)
Patient identification	
Number of requests with errors concerning patient identification/Total number of requests	0.1
Data entry of the request	
Number of requests with errors concerning test input (missing or added or misinterpreted) / Total number of requests	1.4
Sample identification	
Number of improperly labeled samples / Total number of samples	0.2
Sample collection	
Number of samples collected in inappropriate container / Total number of samples	3.6
Number of samples with insufficient sample volume / Total number of samples	22
Transport of sample	
Number of damaged samples / Total number of samples	0.2
Number of samples transported at inappropriate time / Total number of samples	3.4
Number of samples transported under inappropriate temperature / Total number of sample	1.2
Number of improperly stored samples / Total number of samples	0.4
Number of samples lost-not received / Total number of samples	0.2
Suitability of sample	
Number of samples with inadequate sample-anticoagulant ratio / Total number of samples	34.9
Number of fibrin clotted samples / Total number of samples	27.9
Number of hemolyzed samples / Total number of samples	2.2
Number of lipemic samples / Total number of samples	0.1
Number of samples contaminated by intravenous infusion / Total number of samples	2.2

SRR - sample rejection ratio

Dikmen ZG. Specimen rejection in laboratory medicine: Necessary for patient safety? Biochemia Medica 2015;25(3):377–85

- Türk Biyokimya Derneği Preanalitik Evre Çalışma Grubu -2014
- Venöz Kan Alma Kılavuzu-2015
- Tıbbı Laboratuvarlarda Santrifüj Kullanım Kılavuzu,2017

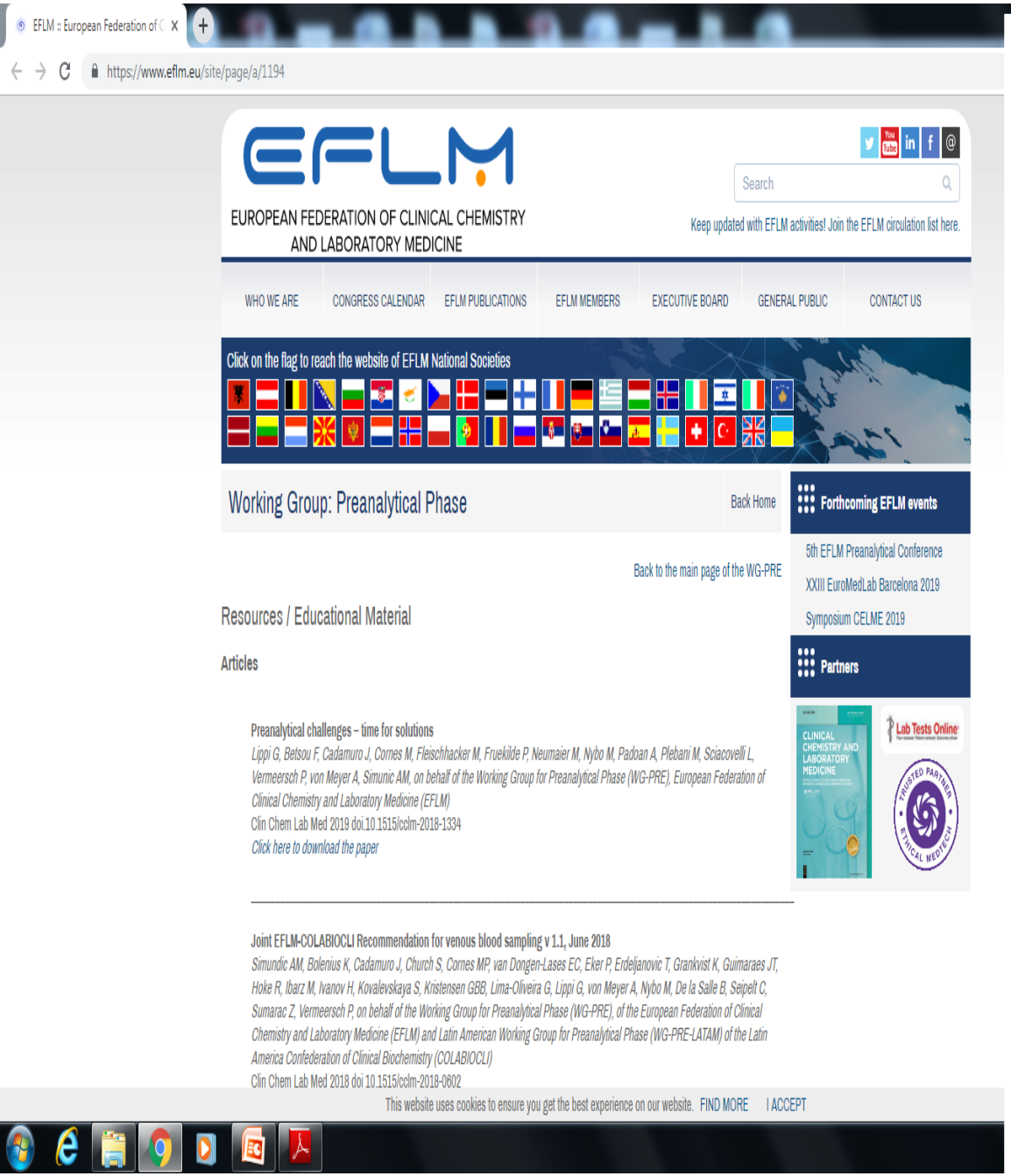


Table 1: Activities of the European Federation of Clinical Chemistry and Laboratory Medicine (EFLM) Working Group for the Preanalytical Phase (WG-PRE).

Finalized projects

- Harmonization of fasting status
- Harmonization of patient and blood tubes identification
- Harmonization of color-coding of blood collection tubes
- Harmonization of the sequence of blood tubes to be followed during blood drawing
- Harmonization of preanalytical quality indicators
- Guidance on local validation of blood collection tubes
- Performance and publication of two European surveys on blood sampling procedures
- Organization of four international meetings
- Walter Guder Preanalytical Award

Ongoing projects

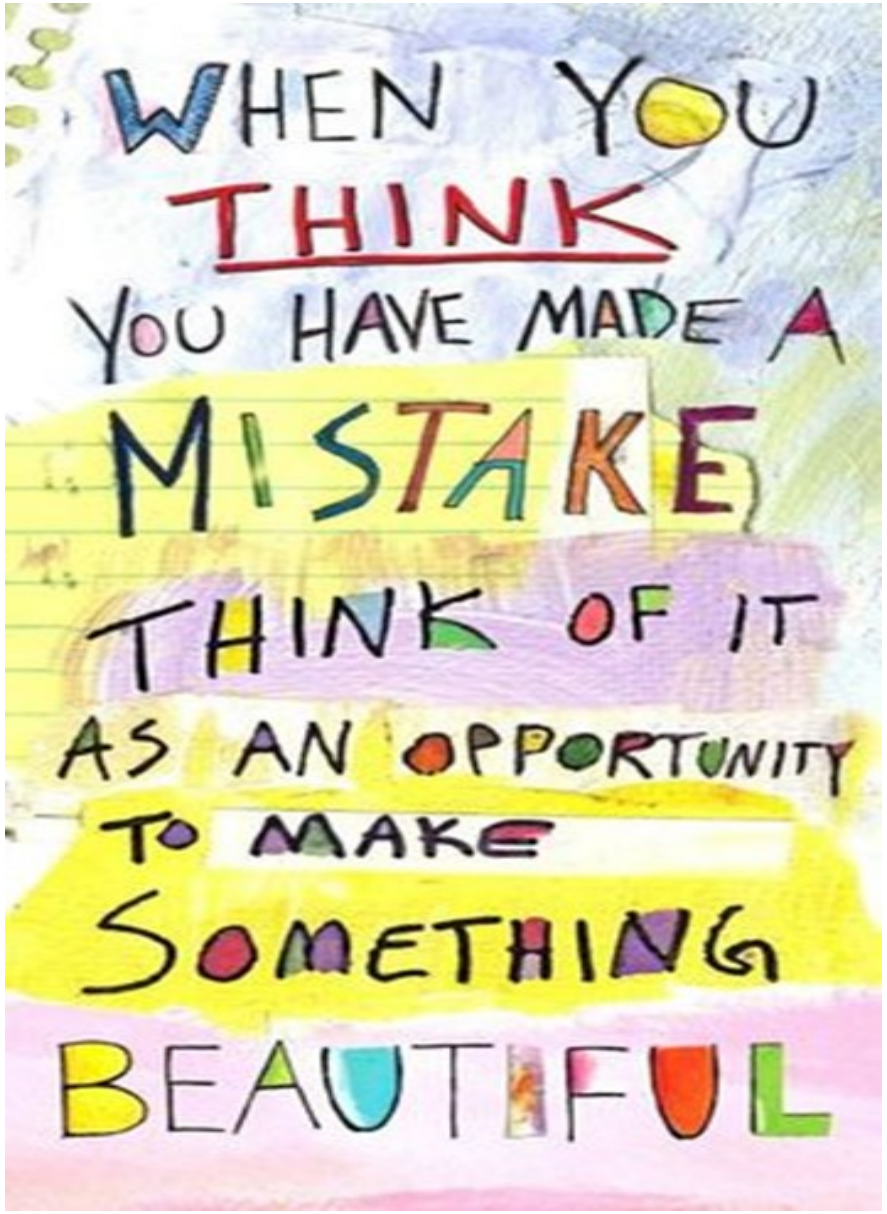
- Development and validation of an external quality assessment (EQA) scheme on preanalytical variables
- Development and dissemination of a survey about local management of unsuitable samples
- Release of EFLM phlebotomy guidelines
- Organization of webinars for harmonizing preanalytical activities

Sonuç ve Öneriler

- Multidisipliner yaklaşım
- Harmonizasyon, standardizasyon
- Kalite indikatörleri
- Sürekli eğitim ve takip
- Preanalitik ve postanalitik faz-Eksternal Kalite Kontrol

➢ **Medical laboratories - Particular requirements for quality and competence (ISO 15189:2012)**

"5.6.4. External quality assessment programmes should, as far as possible, provide clinically relevant challenges that mimic patient samples and have the effect of checking the entire examination process, including pre-and post-examination procedures."



Teşekkürler…