



Pediyatrik Kardiyak Cerrahide Sıvı ve Transfüzyon Yönetimi *Sorunlar ve Çözümler*

Ayda Türköz
Bezmialem Vakıf Üniversitesi
Dragos Hastanesi

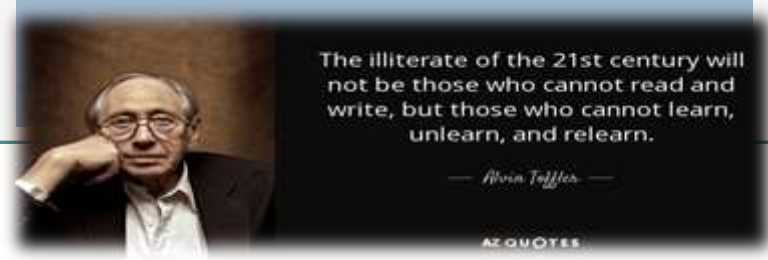




23. ULUSAL KONGRESİ
Göğüs Kalp Damar Anestezi ve Yoğun Bakım Derneği
25-28 Mayıs 2017
Marriott Hotel Asia
İSTANBUL

- Mali veya başka çıkar çatışması yok

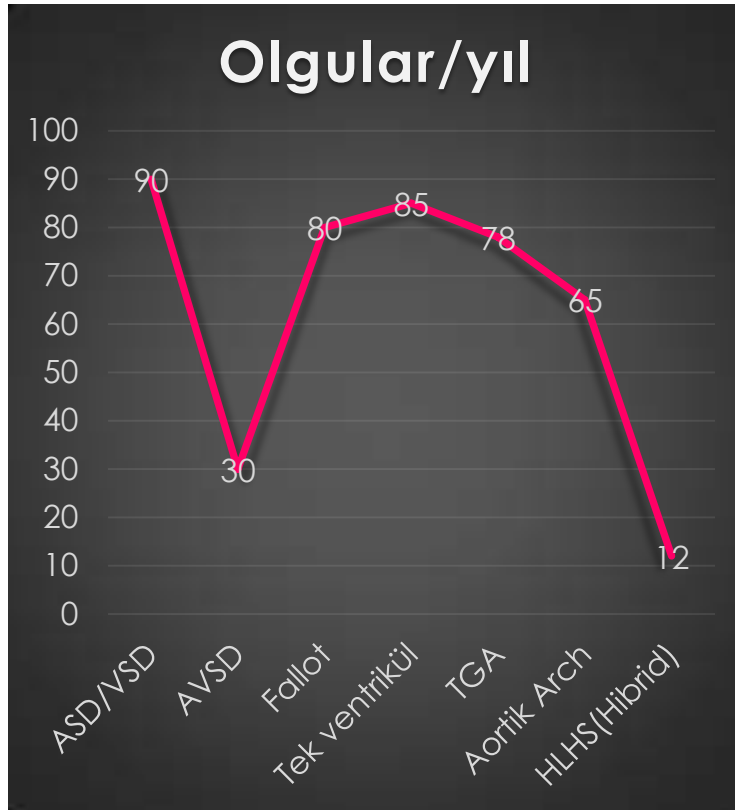




21. Yüzyılın cahilleri okuması yazması olmayanlar değil, öğrenemeyen, ezberini bozamayan ve yeniden öğrenemeyenler olacaktır



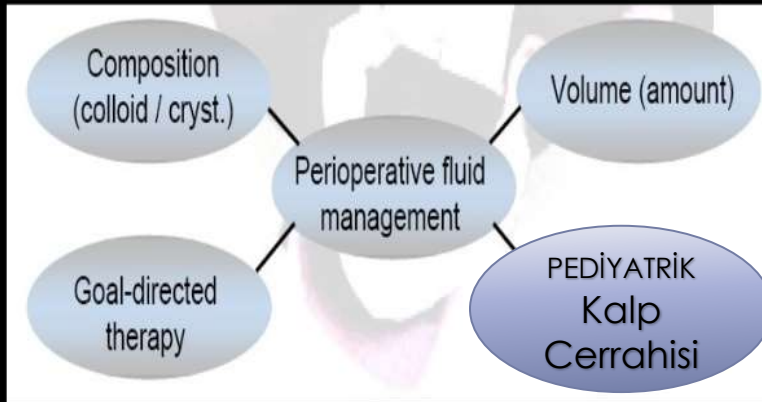
1996-2015 yılları arası: 300 vaka



- POMPA
 - Hematokrit
 - Düşük-Yüksek-hasta grubuna
 - Düşük volümlü prime
 - Minyatür pompa (alb, denge krist)
 - Minipleji
- Peroperatif EKO ve USG 2000....
 - Restriktif sıvı
- Aortik arch rekonst StcO₂...mVO₂
 - **İlimli** hipotermi, düşük akım ssp
- İlk hibrid...Hibrid lab
 - Restriktif sıvı-yüksek htc
- Kan ürünü ayrıştırılması
 - RBC, Tromb, Kriopresipitat
 - Endikasyona göre

....”Dođru miktar ve zaman” “İdeal sıvı ve Kompozisyon” hala belirsizliđini koruyor!

perioperative fluid therapy - the issues



İntraoperatif Sıvı Tedavisi

- Defisit tedavisi
 - Dehidratasyon ve açlık
- İdame tedavi
 - İnsensibil ve idrar
- Replasman Tedavisi
 - Üçüncü boşluk ve kan kaybı

Intraoperatif (**idame**) Sıvı Tedavisi

İdame sıvıda glukoz ve Na



Dektroz (YD, prematür, nütrisyon)
Ringer laktat (Na..↓Cl yerine laktat)



Pediyatrik kalp hastası için, IV sıvı bileşimi ve oranı için özel guideline mevcut değildir.

COMMONLY USED IV FLUIDS

	NS	RL	Iso lyte P	Plasmalyte A	5D	Album in 5%	Hetastarch 6%
Na	154	130	26	140		150	154
K		4	21	5		<2.5	
Cl	154	109	21	98		100	154
Ca		3					
Mg			3	3			
Acetate			24	27			
Lactate		28					
Glucose			5		5		
Phosphate			3				
Osmolality	308	274		295	252	330	310

Dengeli Na yükü düşük isosmolar



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Pediyatrik Kalp Cerrahisi Replasman Tedavisi

Kalp Cerrahisi

- Kay kaybı
- KPB-prime-hemodilüsyon
- Kardiyak fonksiyon ↓



Patient risk, monitoring, fluid goal and surgical time

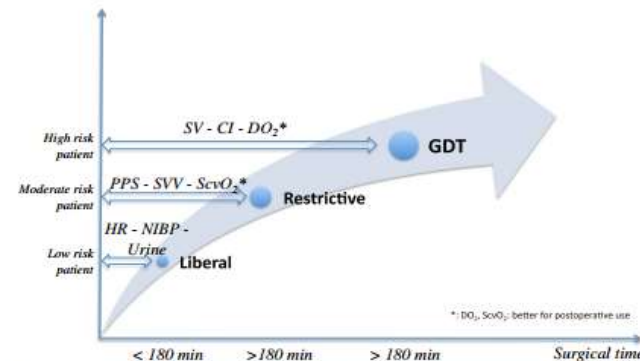


Figure 1 Patient monitoring. Hemodynamic monitoring need to be considered on the basis of patient risk, surgical type and time.

Pediyatrik Kalp Cerrahisi: İntrooperatif Replasman

Kanıt düzeyi yüksek meta analizlere baktığımızda

- **Kristalloid:** Dektroz içermemeli ve Dengeli tuz solüsyonu. **En Favori**
- **Albumin:** Kolloid onkotik basıncı sağlamalıdır
 - Kalp cerrahisinde kolloid osmotik basıncın sürdürülmesi ve plazma genişletici olarak **ilk tercih en güvenilir** olarak kullanılmaktadır
- **Kolloid:** Kristalloid<Kolloid<Albumin pahalıdır
 - Sentetik kolloid: HES kullanımı erişkin olumsuz sonuçlarından dolayı azalmıştır
 - Mortalite ↑ jelatin ve HES²
 - Renal fonksiyon bozukluğu ve trombositopeni (HES)¹
 - Kanama (Gelatin)²

Avrupa : Kalp Cerrahisi

Author's Accepted Manuscript

Fluid Management in Cardiac Surgery – Results of a Survey in European Cardiac Anesthesia Departments

Volodymyr Protsyk, Bodil Steen Rasmussen, Fabio Guarracino, Joachim Erb, Edwin Turton, Joerg Ender



Table 1: Comparison of results regarding fluid therapy from recent surveys in cardiac surgery

	Kastrup 2007	Kastrup 2013	Bignami 2016	Sponholz 2014	Protsyk 2017
Country/Year	Germany 2006	Germany 2008	Italy 2013	Germany 2013	Europe 2016
Setting	Postoperative	Postoperative	Perioperative	Intraoperative	Intraoperative
1 st fluid of choice	HES (65%)	Crystalloid (42%)	Crystalloid (86%)	No data	Balanced crystalloid (74%)
1 st colloid of choice	HES	HES	HES	HES (64%)	Gelatin (60%)
Proportion of albumin among colloids	No data	No data	No data	2%	16%
Not using colloids intraoperatively	No data	No data	No data	12%	32%
CPB priming fluids	No data	No data	No data	Crystalloid 54% HES 32% Gelatin 10% Albumin 4%	Crystalloid 55% Syn. colloid 5% Cryst.+coll.40%

18 ülkeden, 300 merkez

İntraoperatif Replasman KPB: Albumin

- KPB devre kaplaması
 - Dolaşımdaki fibrinojenin emilimini geciktirir
 - Trombositin aktivasyonu azaltır
- İntraoperatif KPB başlaması ile
 - Plazma Kolloid onkotik basıncını korur (%5 Alb)
 - Postoperatif SB ~, Kg ↓ ve Trombosit ↑

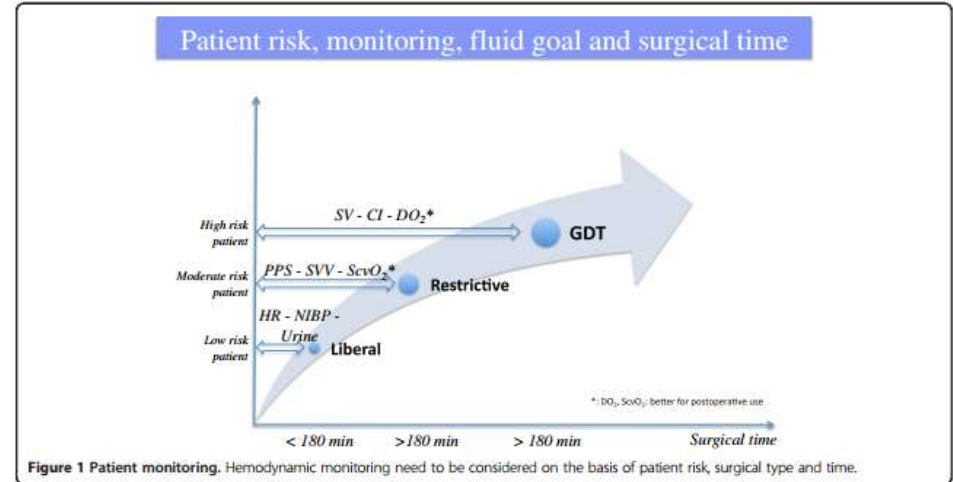
- Pahalı ve temini zor
- Hasta volümünün %25↓
- Tromb agregasyon inh. ve antitrombin III üzerinde heparin benzeri etki oluşur



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Postoperatif Replasman

- Dengeli tuz solüsyonları tercih edilir
- Volüm restriktif & hedefe yönelik monitörizasyon yapılmalı





Fizyopatoloji: Peroperatif Sıvı Yüğü

Miyokard disfonksiyonu

Nöro-endokrin yanıt

Renal disfonksiyon

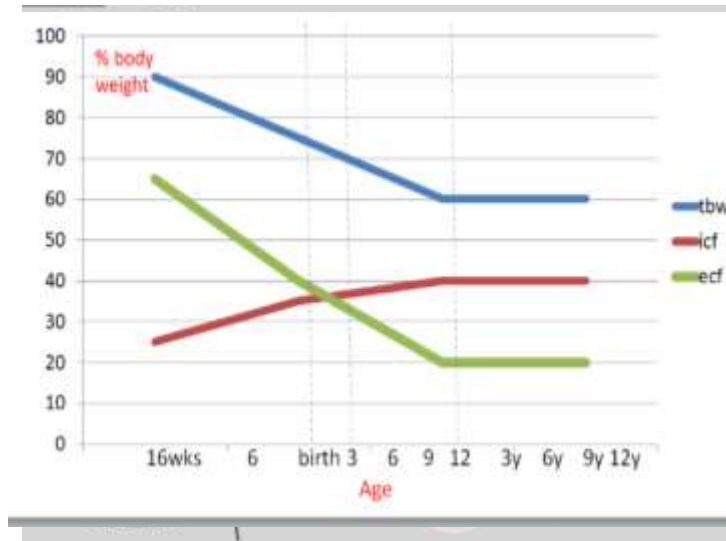
Oligürü

SIRS

Endotel hasarı

Etyoloji: Fizyolojik

Yaş



Ödem, elektrolit ve glukoz imbalansına yatkın bir tablo var

DISTRIBUTION OF BODY WATER

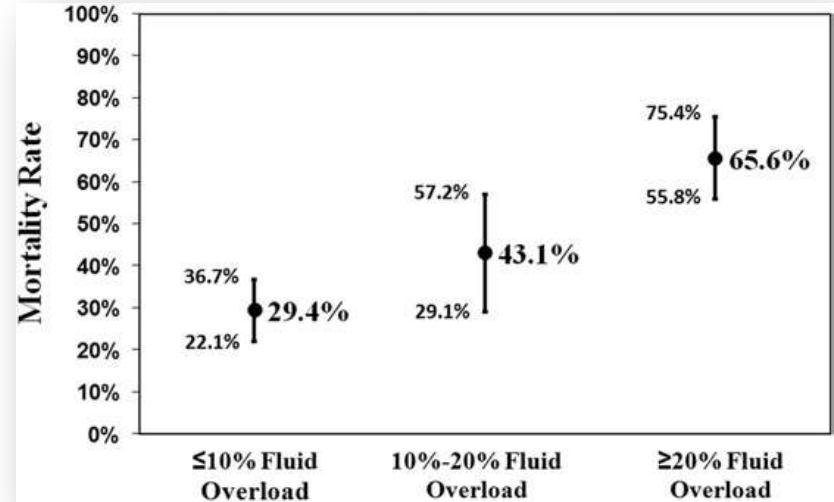


Etyoloji: Perop Sıvı Yükü fizyopatolojik



Sıvı Yükü: Klinik Etkileri

- %5
 - Akut böbrek hasarı ↑
 - MV ↑
 - Vazoaktif ilaç ↑
 - Hastanede kalış ↑
 - Mortalite ↑



Sıvı Yükünün Belirlenmesi

İnput-output/kg x100: %5 \uparrow =50 ml/kg

Kilo artışının yatak başı izlenmesi: **iAB**

Bioelektrik empedans analizi (0.8)



Hemodinami. **CVP, LA**

Kardiyopulm: Pulmoner ödem, diyafram solunumu

Radyolojik: Pulmoner efüzyon ve hiperekojenik B çizgileri

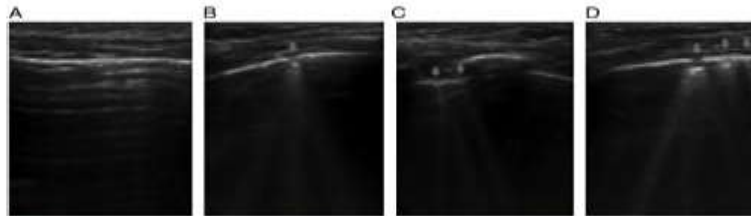
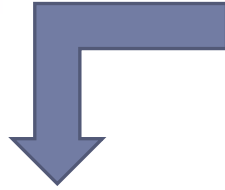


FIGURE 2: Numerical assessment of B-lines during lung ultrasound. (A) Normal lung: horizontal hyper-echogenic lines represent the lung-pleura interface (A-lines). (B-D) Pulmonary congestion: hyperechogenic B-lines with a narrow base radiating from the transducer to the lower border of the window. Images show one B-line (B), two B-lines (C) and three B-lines (D).

IDEAL PRELOAD MONITOR?



- CVP?
- PCWP?
- IVC?
- LVEDV?
- SPV
- PPV/ SVV?
- sVO2

- **Dinamik ölçümler:** V peak %7 ile %20 arasında varyasyon gösterdiğinden çalışma sonuçları farklı
- Daha kesin kanıt değeri yüksek veriler alınana kadar **CVP ve sol atrium P trendini en güvenilir monitör olarak kullanmaya devam edelim!**



23. ULUSAL KONGRESİ

28-30 Mayıs 2017
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Önemli Noktalar.....

- **Preoperatif:** Oral sıvı tedavisi: Son 2 saate kadar
- **Intraoperatif:**
 - Dengeli izotonik sıvıları kullanılması
 - **KPB:** Plazma kolloid onkotik basıncın korunması (%5 Alb) volüm: %25 geçmeyecek
- **Postop:** FB<%5 tutulması
 - Sol atriyum, İAB, ve CVP
 - Hedefe yönelik veya restriktif tedavi protokol
 - Böbrek için ek destek sağlanması
 - Diüretik rutin, periton diyalizi, RRT



British Journal of Haematology, 2016, **175**, 784–828

bjh guidelines

Guidelines on transfusion for fetuses, neonates and older children

Helen V. New,^{1,2} Jennifer Berryman,³ Paula H. B. Bolton Maggs,⁴ Carol Cartwell,⁵ Elizabeth A. Chalmers,⁶ Tony Davies,⁴ Ruth Gombstein,⁷ Andrea Kellchen,⁸ Arlesh Kumar,⁹ Sarah L. Morley¹⁰ and Simon L. Stanworth,¹¹ on behalf of the British Committee for Standards in Haematology

¹NHS Blood and Transplant, ²Imperial College Healthcare NHS Trust, London, ³University College Hospital NHS Trust, London, ⁴Service Haematology, NHS Blood and Transplant, Manchester, ⁵Royal Hospital for Sick Children, Glasgow, ⁶NHS Blood and Transplant, ⁷St. Mary's Hospital, Manchester/University of Manchester, Manchester, ⁸Royal Brompton Hospital, London, UK, ⁹Mater Research Institute, University of Queensland, Brisbane, Australia, ¹⁰Addenbrooke's Hospital/NHS Blood and Transplant, Cambridge, and ¹¹Oxford University Hospitals NHS Trust/NHS Blood and Transplant, Oxford, UK

4 Cardiac surgery

Kırmızı kan hücresi

YARAR

RİSK



Blood transfusions in children: a multi-institutional analysis of practices and complications

Anthony D. Skonim, Jill G. Joseph, Wendy M. Darenne, Aditya Sharmangani, and Naomi L.C. Luban

ONIM ET AL.

TABLE 1. Types of transfusions and transfusion reactions in pediatric patients admitted to children's hospitals

ICD 9 code	ICD 9 code									
	99.00 Perioperative transfusion of whole blood	99.01 Exchange transfusion	99.02 Transfusion of autologous blood	99.03 Other whole-blood transfusions	99.04 RBC transfusion	99.05 PLT transfusion	99.06 Transfusion of coagulation factors	99.07 Other serum plasma	99.08 Blood expanders	99.09 Transfusion of other substances
999.4 Anaphylactic shock	0	0	0	0	3	1	0	0	0	0
999.5 Serum reactions	0	0	0	0	19	15	0	2	0	0
999.6 ABO incompatibility	0	0	0	0	3	2	0	0	0	0
999.7 Rh incompatibility	0	0	0	0	1	0	0	0	0	0
999.8 Other transfusion reactions	2	8	2	2	401	247	7	60	7	11
Total transfusion reactions	2	8	2	2	427	265	7	62	7	11
Total transfusions	651	962	544	560	44,632	14,274	1,935	8,407	665	1,503

1000 erişkin 2.5 iken 1000 pediyatrik 10.7

N.A. Guzzetta

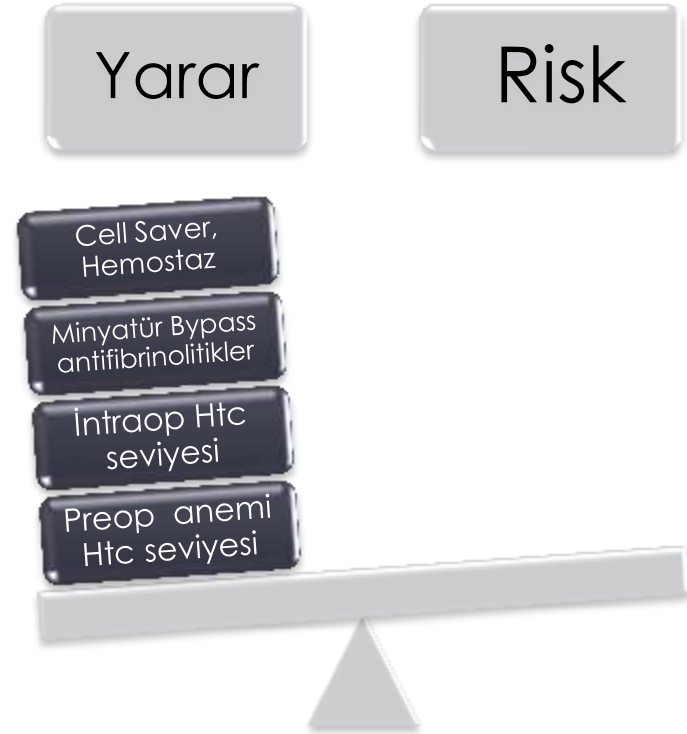
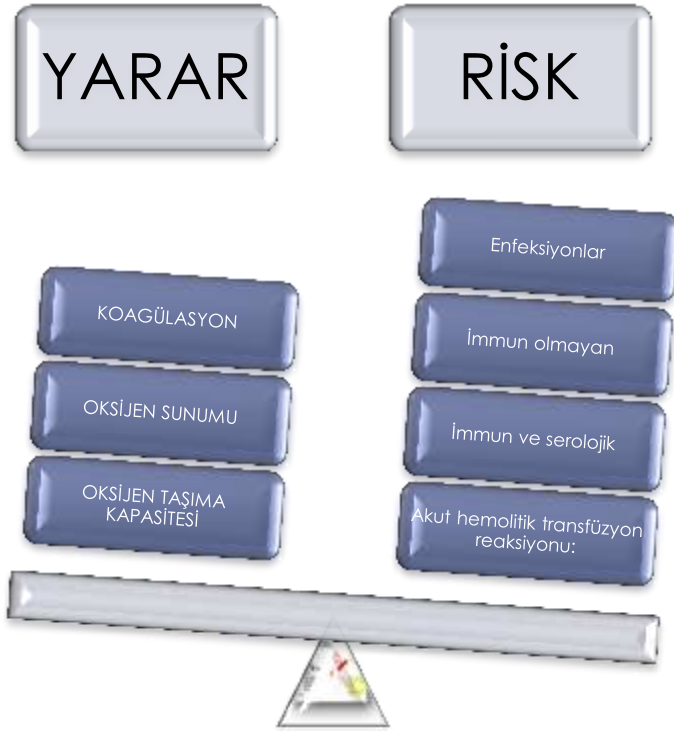
Table 2 Transfusion reactions

Immune-mediated	Nonimmune-mediated
Alloimmunization to: red blood cell antigens and HLA antigens	Infectious
Hemolytic transfusion reactions: acute and delayed	Volume overload
Febrile nonhemolytic transfusion reactions	Massive transfusion: metabolic, hypothermia, dilution and pulmonary microembolization
Allergic transfusion reactions	Miscellaneous: transfusion hemosiderosis, plasticizers
Posttransfusion purpura	
Transfusion-related acute lung injury	
Transfusion-associated graft versus host disease	
Transfusion-related immunomodulation	

Volume 48, January 2008 TRANSFUSION

- Yanlış Hasta, yanlış kan
 - Başlıca ölüm sebebi
 - 250 olgu bildirilmiş
- İmmun ve serolojik reaksiyon
- Transfüzyon ile geçen enfeksiyon
 - HIV ve Hepatit artış göstermesine rağmen
 - Ölümlerin %10u bakteriyel enf sbp

Kırmızı kan hücrelerini korumak



Preoperatif Önlemler

6 ANAEMIA MANAGEMENT

6.1 Preoperative correction of anaemia

6.1.1 Introduction

Perioperative anaemia increases the risk of numerous complications such as cardiac events, pneumonia and postoperative delirium.^{190,191} Associations between anaemia and higher rates of both morbidity and mortality are well established for patients undergoing cardiac surgery.^{192,193} A recent, large cohort study demonstrated that these associations also apply to non-cardiac surgery; the odds ratio for mortality among patients with anaemia versus those without was 1.42.¹⁹⁴ Preoperative anaemia has been shown to be predictive for perioperative transfusion of allogeneic blood products such as red blood cells, which itself carries a significant risk of adverse events and mortality.^{192,195,196} There is some tolerance to postoperative anaemia among patients without cardiovascular disease, but for each 1 g dl^{-1} decrease in postoperative haemoglobin concentration below 7 g dl^{-1} , mortality has been shown to increase by a factor of 1.5.¹⁹¹ Estimates of the prevalence of anaemia in surgical patients range widely, from 5% to 76%.¹⁹⁷ High rates have been reported in cancer patients (e.g. breast cancer, colon cancer), while lower rates have been observed in orthopaedic patients.^{197,198}

- Perop **anemi** kan transfüzyonu ihtiyacını artırarak istenmeyen olayları ve mortaliyeti artırır



JAMA Pediatr. 2016 Sep 1;170(9):855-62. doi: 10.1001/jamapediatrics.2016.1032.

Association of Preoperative Anemia With Postoperative Mortality in Neonates.

Goobie SM¹, Faraoni D¹, Zurakowski D¹, DiNardo JA¹.

Author information

¹ Department of Anesthesiology, Perioperative and Pain Medicine, Boston Children's Hospital, Harvard Medical School, Boston, Massachusetts.

Abstract

IMPORTANCE: Neonates undergoing noncardiac surgery are at risk for adverse outcomes. Preoperative anemia is a strong independent risk factor for postoperative mortality in adults. To our knowledge, this association has not been investigated in the neonatal population.

OBJECTIVE: To assess the association between preoperative anemia and postoperative mortality in neonates undergoing noncardiac surgery in a large sample of US hospitals.

DESIGN, SETTING, AND PARTICIPANTS: Using data from the 2012 and 2013 pediatric databases of the American College of Surgeons National Surgical Quality Improvement Program, we conducted a retrospective study of neonates undergoing noncardiac surgery. Analysis of the data took place between June 2015 and December 2015. All neonates (0-30 days old) with a recorded preoperative hematocrit value were included.

EXPOSURES: Anemia defined as hematocrit level of less than 40%.

MAIN OUTCOMES AND MEASURES: Receiver operating characteristics analysis was used to assess the association between preoperative hematocrit and mortality, and the Youden J Index was used to determine the specific hematocrit cutoff point to define anemia in the neonatal population. Demographic and postoperative outcomes variables were compared between anemic and nonanemic neonates. Univariate and multivariable logistic regression analyses were used to determine factors associated with postoperative neonatal mortality. An external validation was performed using the 2014 American College of Surgeons National Surgical Quality Improvement Program database.

RESULTS: Neonates accounted for 2764 children (6%) in the 2012-2013 American College of Surgeons National Surgical Quality Improvement Program databases. Neonates included in the study were predominately male (64.5%), white (66.3%), and term (69.9% greater than 36 weeks' gestation) and weighed more than 2 kg (85.0%). Postoperative in-hospital mortality was 3.4% in neonates and 0.6% in all age groups (0-18 years). A preoperative hematocrit level of less than 40% was the optimal cutoff (Youden) to predict in-hospital mortality. Multivariable regression analysis demonstrated that preoperative anemia is an independent risk factor for mortality (OR, 2.62; 95% CI, 1.51-4.57) in neonates. The prevalence of postoperative in-hospital mortality was significantly higher in neonates with a preoperative hematocrit level less than 40%; being 7.5% (95% CI, 1%-10%) vs 1.4% (95% CI, 0%-4%) for preoperative hematocrit levels 40%, or greater. The relationship between anemia and in-hospital mortality was confirmed in our validation cohort (National Surgical Quality Improvement Program 2014).

CONCLUSIONS AND RELEVANCE: To our knowledge, this is the first study to define the incidence of preoperative anemia in neonates, the incidence of postoperative in-hospital mortality in neonates, and the association between preoperative anemia and postoperative mortality in US hospitals. Timely diagnosis, prevention, and appropriate treatment of preoperative anemia in neonates might improve survival.

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Perioperative anemia: an independent risk factor for infection, mortality, and re [J Surg Res. 2002]

Preoperative anemia and perioperative outcomes in patients who und [Spine (Phila Pa 1976). 2013]

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Preoperative Anemia and Neonates.

[JAMA Pediatr. 2016]

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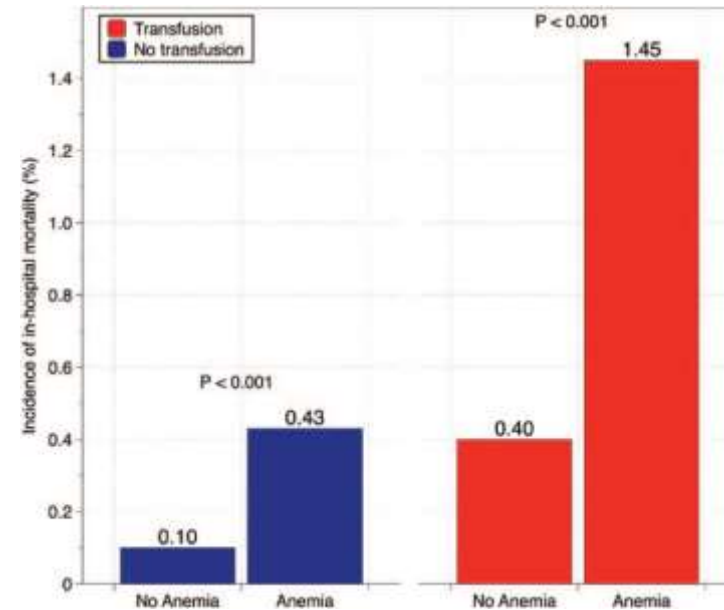
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27428875[uid]

Preoperatif Hgb Değeri

- 1-2 y:Hct<%33
- 2-4 y:Hct<%34
- 4-7 y:Hct< %35
- 7-18y:Hct<%36
- 12-18:Hct< %38





Preoperatif RBC

- Optimize preoperatif Hgb
 - Vakit varsa anemiye düzelt
 - Human recombinant EPO (rEPO)
 - Eritropoezi uyarır
- Demir preparatları
 - Oral veya intravenöz
- Antitrombosit ve antikoagulan kullanımını sorgula
- Preoperatif otolog donasyon (PAD)

Intraoperatif:KPB: RBC eřiđi

- Optimum Hgb eřiđi **belirsizdir**
 - Mazine et al, 2015
- **Siyanotik kalp hastalarında** hgb eřik deđeri daha yksek tutulmaktadır
 - (Du Pont-Thibodeau et al, 2014).
- **5** gnden daha **eski** kan kullanılmamalıdır
 - (kanıt dzeyi dřk)
 - Hipokalsemi ve hiperpotasemi
 - KPB prime hasta ile birleřtirilmeden kontrol
 - Hall et al, 1993; Lee et al, 2014

Intraoperatif:KPB: Prime Volüm



- Redlin ve ark.
RBC ihtiyacının hemen tamamen ortadan kalktığı bildirilse de günlük pratiğimizde henüz bu derece **minyatürüze sistemleri** kullanmıyoruz
- Pompa başının hastaya yaklaşması (mast-mount pump)
- KPB hattının yüzel alanı küçülür
- Hatlar incelir ve kısalmır
- Yeni jenerasyon oksijenatörler (düşük PV)

Routine Application of Bloodless Priming in Neonatal Cardiopulmonary Bypass: A 3-Year Experience

Wolfgang Boettcher¹ · Nicodine Sivarobhanvya¹ · Oliver Miera² · Matthias Redlin³ · Frank Dehmel¹ · Mi-Young Cho¹ · Peter Marini¹ · Felix Berger² · Joachim Photiadis¹

Intraoperatif:KPB: Kansız Prime

Received: 30 November 2016 / Accepted: 2 February 2017
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Abstract A restrictive transfusion strategy led us to routinely try to conduct donor-blood free open-heart surgery even in neonates. The cardio-pulmonary bypass (CPB) circuit was minimized by priming volumina at 73 ml for the smallest patients with body weight up to 2.5 kg and 85–95 ml for those with body weight of more than 2.5 kg, and by positioning the console as close as possible to operation table. Measures were applied to save blood during the procedure. Transfusion threshold of 8g/dl hemoglobin was retained. Effort was made to avoid transfusion while on CPB or to postpone transfusion towards CPB end. From 2013 to 2015, 149 consecutive neonates underwent 150 open-heart procedures without blood in priming volume. Weight was lower than 2.5 kg in five instances. The most frequent operations were arterial switch operation ($n=54$) and Norwood procedure ($n=17$). Transfusion-free operation was achieved in 44 procedures. The great majority ($42/44=95\%$) involved biventricular repair and included 50% ($27/54$) of arterial switch operations. 106 patients were transfused: 63 mostly towards CPB end, and 43 after coming off bypass. Transfusion-free procedures were associated with postoperative lower lactate concentration ($p=0.0013$) and shorter duration of mechanical ventilation ($p=0.0009$). Seven patients were discharged from hospital

without getting any transfusion of blood or blood products. In conclusion, routine application of bloodless priming in neonatal cardiopulmonary bypass is safe and beneficial. It results into a good number ($29\%= 44/150$) of transfusion-free operations. Postponing transfusion towards CPB end favors an overall restrictive transfusion strategy for all patients.

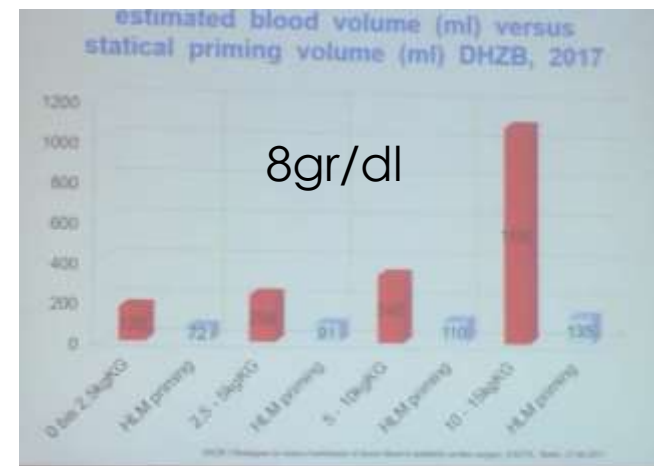
Keywords Cardio-pulmonary bypass · Restrictive blood transfusion · Neonates · Congenital heart surgery

Introduction

Cardio-pulmonary bypass (CPB) is known to induce deleterious effects more frequently in neonates than in older children. This is partly due to transfusion of blood or blood products that, for a long time, have been deemed to be indispensable and inevitable for a safe CPB in these low-weight patients.

In year 2003, we reported on our efforts to minimize CPB circuit and adapt the perfusion strategy to the goal of transfusion-free bypass in a newborn that underwent the arterial switch operation [1]. Our strategy has since evolved

2.5 kg'dan daha düşük bebekler için 73ml
2.5 kg'dan daha fazla bebeklerde 90 ml
Hastaların yaklaşık 1/3 transfüzyonsuz



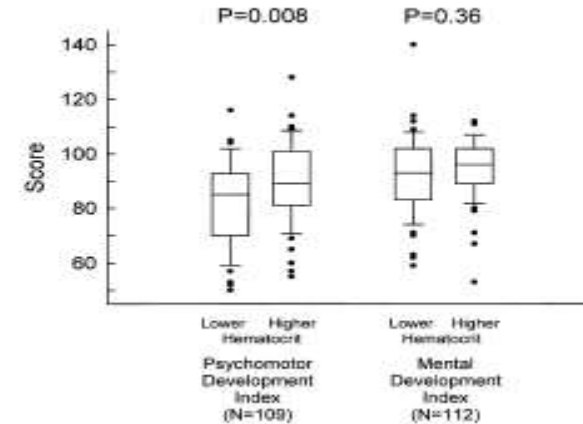
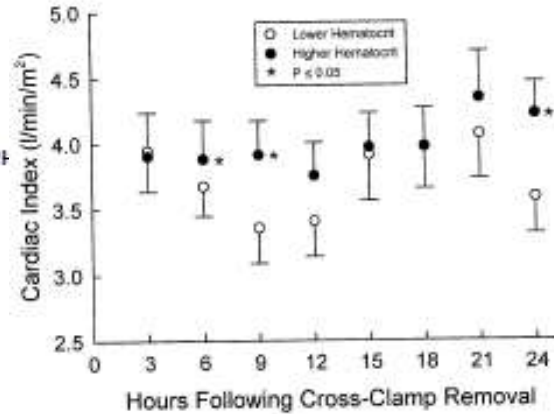
Intraoperatif:KPB:RBC eřiđi

- **Siyanotik ve YD olmayan** çocuk hastalarda 80 g/l transfüzyon eřiđi güvenlidir
 - (Gast-Bakker et al (2013).
- **Siyanotik olan ve YD olmayan** çocuk hastalarda ~85 g/l transfüzyon eřiđi
 - KPB dönemi ve sonrası (1 yıllık nöro-gelişimsel sonuçlar dahil) güvenlidir
 - (Jonas et al,2003; Newburger et al, 2008; Wypij et al, 2008) erişkin için kullanılan eşik değeri için kılavuz henüz çocuklarda yoktur (Curley G. et al, 2014)
- **YD** KPB için henüz uygun rehber yoktur
 - **Siyanotik** çocuk klavuzu

The influence of hemodilution on outcome after hypothermic cardiopulmonary bypass: Results of a randomized trial in infants

Richard A. Jonas, MD^{a,g}
David Wypij, PhD^{b,i,k}
Stephen J. Roth, MD, MPH^b
David C. Bellinger, PhD, MSc^{c,l}
Karen J. Visconti, PhD²
Adre J. du Plessis, MBChB, MPH^{c,j}
Howard Goodkin, MD^{c,j}
Peter C. Laussen, MD^{c,j}
David M. Farrell, MACCP^a
Jodi Bartlett, RN^f
Ellen McGrath, RN^f
Leonard J. Rappaport, MD^{a,h}
Emile A. Bache, MD^{a,g}
Joseph M. Forbess, MD^{a,g}
Pedro J. del Nido, MD^{a,g}
John E. Mayer, Jr, MD^{a,g}
Jane W. Newburger, MD, MPHⁱ

YD düşük akımlı hipotermi: Hct range
mean = 21.5% mean = 27.8%



Kardiyak indeks klemp alındıktan sonra 3 saat daha düşük
Serum laktat KPB sonrası 1. saatte daha yüksek
TBV ilk gün daha yüksek bulunmuştur.
İlave olarak ****1 yaş **Psychomotor Development Index scores** ↓



Intraoperatif: Kan Kaybını Azaltma: Antifibrinolitik ve Diğer Yöntemler

- **Traneksamik asit:** Pediyatrik kalp cerrahisinde rutin
 - kanıtlar güçlendirilmelidir (Faraoni et al, 2012).
- Optimum doz: Bolus dozu ...infüzyon
 - (Wesley et al, 2015)
- Yenidoğan ve çocuklarda kanama riski yüksek ise
 - (Kanıt düzeyi1B).
- **Modified ultrafiltration** dilüsyonel koagulopatiji azaltır, hb artırır ve postop kanama-transfüzyonu azaltır
 - (Friesen et al, 1997).
- **Fibrin sealants** : kanamayı ve transfüzyon ihtiyacını ↓
 - (Codispoti & Mankad, 2002; Carless et al, 2003)

KPB Sonrası: Hemostaz

- KPB sonrası klinik olarak tespit edilen kanamada Trombosit sayısı $<100 \times 10^9/l$, PT or APTT >1.5 , fibrinogen $<1.5 \text{ g/l}$ **spesifik komponent** (2C).
- **Thrombelastometry ve thromboelastography** pediatrik KPB sonrası hemoraji geliştiğinde uygun tedavi uygulanmasını desteklemektedir (Moganasundram et al, 2010).
- Konvansiyonel testlere göre **üstünlüğü henüz belirsiz**
 - Erken ve daha hızlı sonuç vermesi avantaj
- **YD lardaki datalar yetersiz**

Blood Transfusions After Pediatric Cardiac Operations: A North American Multicenter Prospective Study

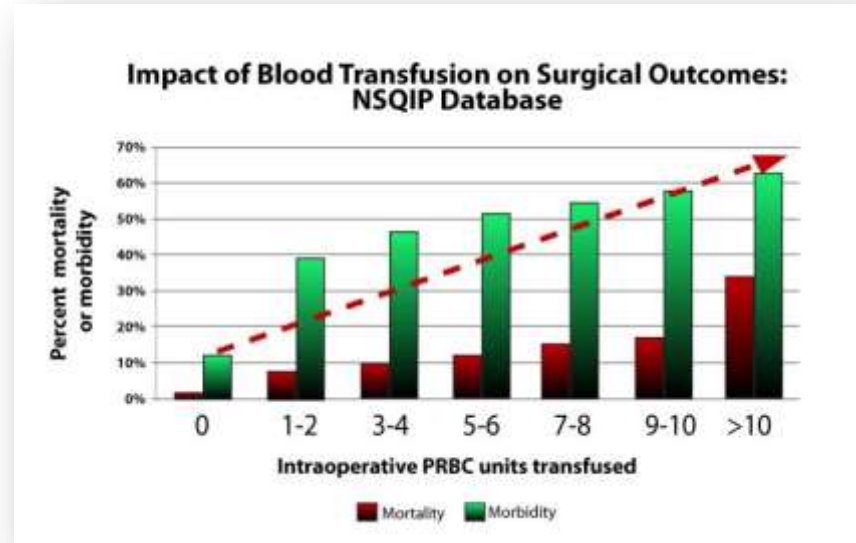
(Ann Thorac Surg 2015;100:671-7)
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Amine Mazine, MS, Soha Rached-D'Astous, MD, Thierry Ducruet, MS, Jacques Lacroix, MD, FRCPC,[‡] and Nancy Poirier, MD, FRCSC,[‡] on behalf of the Pediatric Acute Lung Injury and Sepsis Investigators Network

Departments of Cardiac Surgery, Pediatrics and Biostatistics, Centre hospitalier universitaire (CHU) Sainte-Justine, Université de Montréal, Montréal, Québec, Canada

- KPB Sonrası Optimum transfüzyon eşiği belirsiz
- Doz-outcome ilişkisi
 - Mortalite ↑
 - Mediastinit ↑
 - NEC ↑



KPB Sonrası

- TRIPICU çalışması: 125 **neonatal ve siyanotik olmayan** hasta: Liberal:95 g / l, restriktif **70 g/l** : Organ disfonksiyonu: restriktif güvenli
 - Willems et al, 2010
- **Neonatal ve siyanotik olmayan** hasta: restrictive (**80 g/l**) and liberal (108 g/l : restriktif güvenli. Hastanede kalış
 - Gast-Bakker et al (2013)
- **Tek ventrikül, siyanotik:** 30 restriktif **90 g/l** and 30 liberal 130 g/l: restriktif güvenli
 - Lactate concentration, arteriovenous and arteriocerebral oxygen content and length of hospital stay
 - (Cholette et al, 2011).
- **Neonatal veya siyanotik ya da siyanotik olmayan kanamalı hastalarda** eşik bilinmiyor

KPB Sonrası:Cell Salvage



- Cerrahiyi takiben ilk 48 saatte bypass hattından gelen residüel volum toplanıp yıkandıktan sonra kullanılır. **Allojenik kan transfüzyonu** ↓ (Cholette et al, 2013),
- cell salvage ile **postop renal yetmezlik, göğüs tüpü drenajı** ↓, postop hct daha yüksek bulunmuş. (Ye et al, 2013).

Red cell salvage KPB ile kalp cerrahisi yapılan tüm YD ve çocuklara uygulanmalıdır (1B).

Transfüzyon önleme pratiğimiz

📍 Farmakolojik

📍 Traneksamik asit

📍 Prime ↓

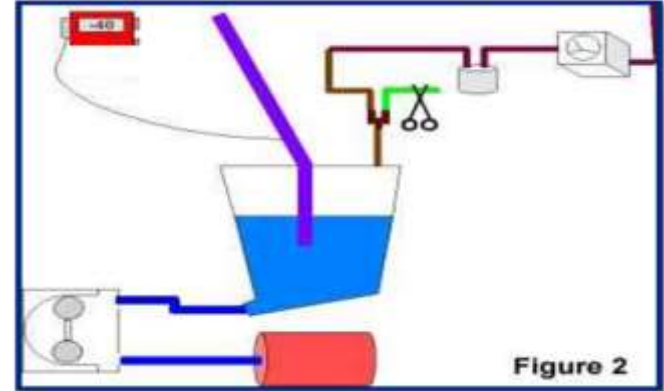
📍 Vakum venöz drenaj

📍 Ultrafiltration

📍 Conventional UF

📍 Modified UF

📍 Cell salvage



Sonuç

- Preoperatif anemiği düzeltmeliyiz
- İntraoperatif
 - Düşük prime volüm
 - Antifibrinolitik: Traneksamik asit
 - Doku Oksijen sunumu monitörizasyonu
 - Cell Salvage (redo ve kanama riski fazla)
- Postoperatif
 - Hastanın **linik durumuna** göre **minimum** kan transfüzyonu

Hürriyete Doğru

Orhan Veli Kanık



Özgürlük

Doğukan Eftal Türköz / Prep J / 185





Lökositler

- Bağışıklık sisteminde önemli değişiklikler..
- Lökositler
 - $<5 \times 10^6$ WBCs per unit, filtre kullanılması RBC canlılığı
 - Artışı ve aşağıdaki komplikasyonların önlenmesi için önerilmektedir
 - Febril reaksiyonlar
 - immün modülasyon,
 - Sitomegalovirüs

GWH

- Baęışık donör T lenfositleri
- Baęışıklık sistemi bu lenfositleri baskılayamayan alıcı ile karşılaştığında GWH reak oluşur.
- Gama irradyasyonla önlenir
- Di-George ve yakın akrabalarından kan alan çocuklar risk altındadır.

TRALI

- that develops during or within 6 h of transfusion of a plasma-containing blood product (19).
- Mekanizma: anti-leukocyte antibody in the donor plasma that is transferred to the recipient upon transfusion. Indeed
- In the pediatric cardiac surgery population, TRALI is often underdiagnosed because clinical signs

Doku oksijenasyonu

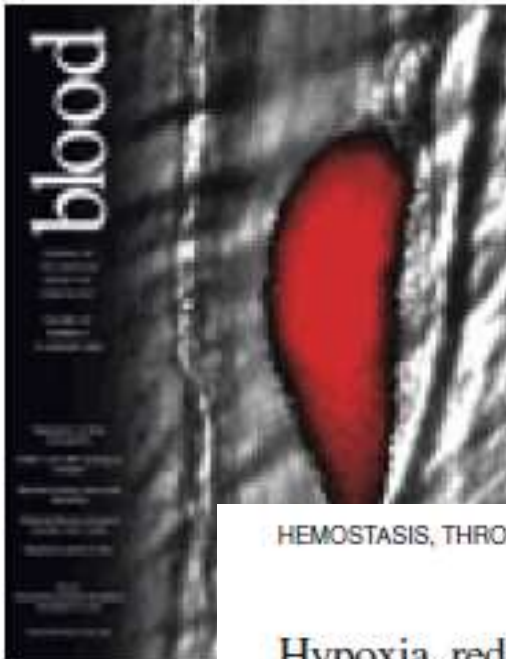
- Depolama sırasında
 - RBC miktar ve kalitesinde zamana baęlı deęişiklikler
 - Transfüze edilen kanın hipoksik dokuya Oksijeni verme yeteneęini etkileyebilir.
 - Artan depolama süresi
 - ile **adenosin Trifosfat düzeyinin azalması** sonucu zarda Lipit içerięi ve RBC **şekil ve rijitliğinin** deęişmesine neden olur
 - Deformabilitede azalma, mikro-dolaşımda oklüzyona ve Doku iskemisine neden olur
 - **2,3-difosfogliserat , fosfat Deoksijenlenmiş hemoglobine bağlanır ve Dokulara oksijen salınmasını kolaylaştırır.** Zamanla azalır ve 1 hafta sonra tespit edilemez
 - 1 haftadan daha uzun süre beklemiş olan RBC'lerin hipoksik dokulara oksijen salınımı azalacağı şüphesi vardır ancak çalışmalar desteklememiştir.

Koagülasyon

- platelet–endothelial interaction artırır (12)
- by promoting the release of the dense granule components thus enhancing platelet aggregation at the site of the developing thrombus (13)
- RBC varlığında three time the amounts of serotonin and serotonin and six times the amount of adenosine diphosphate (14)

Erythrocytes Metabolically Enhance Collagen-Induced Platelet Responsiveness Via Increased Thromboxane Production, Adenosine Diphosphate Release, and Recruitment

By Juana Valles, M. Teresa Santos, Justo Aznar, Aaron J. Marcus, Vicenta Martinez-Sales, Manuel Portoles, M. Johan Broekman, and Lenore B. Safier



- Fizyolojik hematokrit hem
- Doku kan dolaşımı otheregölasyonu ve trombosit fonksiyonu saęlar

HEMOSTASIS, THROMBOSIS, AND VASCULAR BIOLOGY

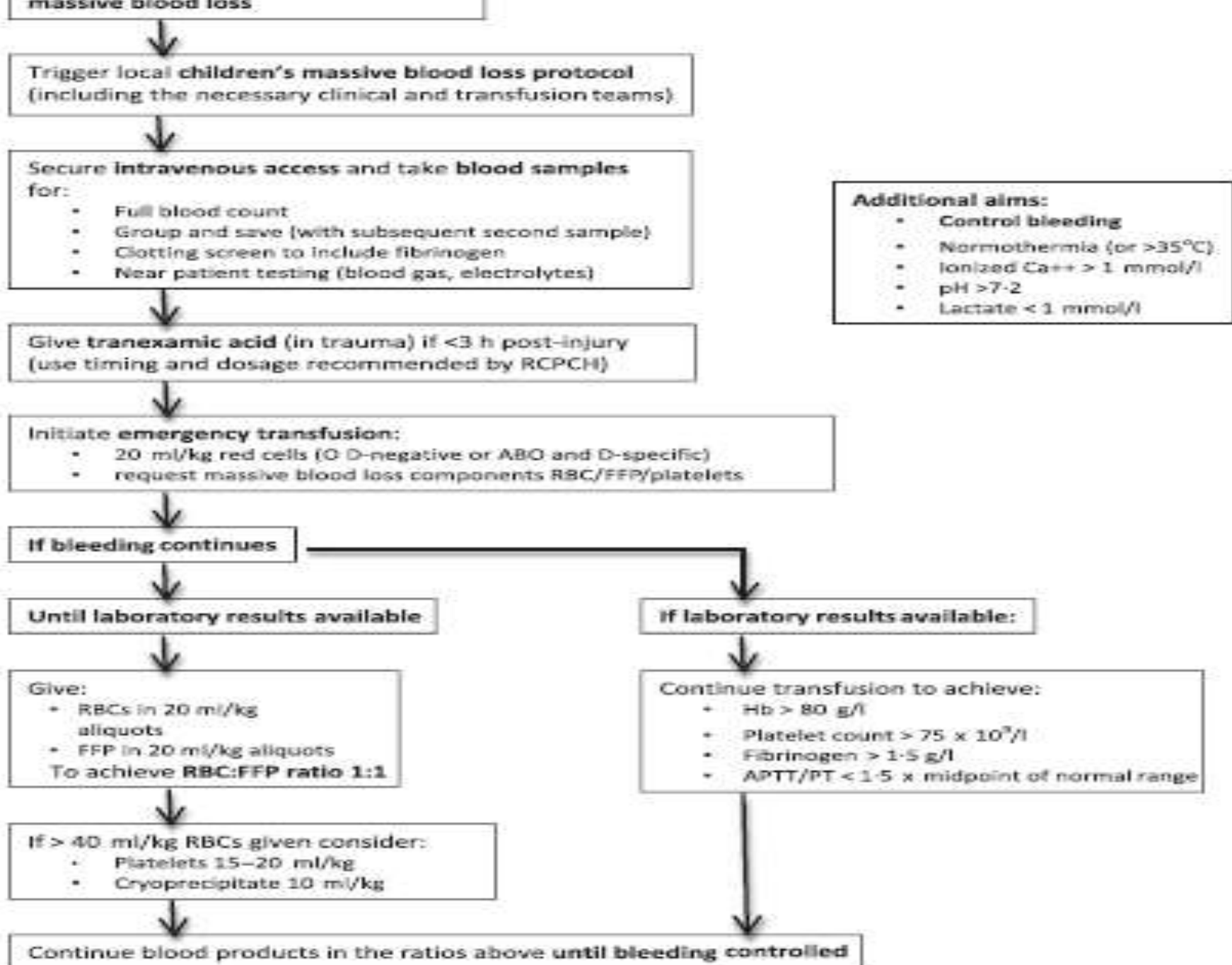
BLOOD, 15 JANUARY 2006 • VOLUME 107, NUMBER 2

Hypoxia, red blood cells, and nitrite regulate NO-dependent hypoxic vasodilation

Jack H. Crawford, T. Scott Isbell, Zhi Huang, Sruti Shiva, Balu K. Checko, Alan N. Schechter, Victor M. Darley-Usmar, Jeffrey D. Kerby, John D. Lang Jr, David Kraus, Chien Ho, Mark T. Gladwin, and Rakesh P. Patel

Massive blood loss may be defined as either 80 ml/kg in 24 h, 40 ml/kg in 3 h or 2–3 ml/kg/min

Pediatric cardiac surgery related clinical significant bleeding, DSÖ 3-4 class can be defined. Certain congenital heart diseases, T cell immunodeficiency (Di George syndrome included) are related and if suspected, radiation exposed cellular blood components should be avoided until the syndrome is diagnosed. Diagnosis is excluded by testing.



GOALS OF PERIOPERATIVE FLUID THERAPY

- Urine output 1 – 3 ml/kg/hr.
- Allow a weight loss 1 – 2% / day in 1st wk.
- Absence of Edema / Dehydration/ Hepatomegaly
- Urine Sp. gravity 1005 – 1015
- Euglycaemia 75 – 100 mg / dl
- Normonatremia 135 - 145 mEq / lit
- Normokalemia 4 – 5 mEq / lit

11. Li L, Li Y, Xu X, et al: Safety evaluation on low-molecular-weight hydroxyethyl starch for volume expansion therapy in pediatric patients: A meta-analysis of randomized controlled trials. Crit Care 19: 79, 2015

- a recent meta- ysis reported decreased platelet count and increased length of ICU stay in association with HES usage in Pediatric patients

Perel P, Roberts I, Ker K: Colloids versus crystalloids for fluid resuscitation in critically ill patients. Cochrane Database Syst Rev 28 (2): CD000567, 2013

10. Navickis RJ, Haynes GR, Wilkes MM: Effect of hydroxyethyl starch on bleeding after cardiopulmonary bypass: A meta-analysis of randomized trials. J Thorac Cardiovasc Surg 144: 223-230, 2012

- HES administration is not recommended intra-operatively due to increased risks of mortality, renal dysfunction, and postoperative bleeding

Open Heart Surgery for Small Children Without Homologous Blood Transfusion by Using Remote Pump Head System

Makoto Ando, MD, Yukihiko Takahashi, MD, and Natsuko Suzuki, MD

Department of Pediatric Cardiac Surgery, Sakakibara Heart Institute, and Department of Pediatrics, Musashino Red Cross Hospital, Tokyo, Japan

Background. To avoid excessive hemodilution, the transfusion of a large amount of homologous blood may be required in open heart surgery for small children, which in turn, can cause a significant immunologic response.

Methods. Cardiopulmonary bypass systems with remote pump heads were used for patients weighing 5 kg or less that were undergoing ventricular septal defect repair. The procedures took place from January 1997 to August 2002. The surgery was started with bloodless prime in 122 out of 158 (77.2%) consecutive patients. Exclusion criteria were a predicted hematocrit after the initiation of bypass of less than 15%, respiratory failure or heart failure (or both), and pulmonary vascular obstructive disease.

Results. The mean age and body weight were 3.8 ± 1.8 months and 4.3 ± 0.5 kg, respectively. The priming volume was 181.0 ± 32.5 (minimum: 130) mL. The hematocrit after cardiopulmonary bypass was initiated was

$16.7\% \pm 2.3\%$. Six patients required subsequent blood transfusion owing to postoperative complications that resulted in compromised hematopoiesis. In the rest, the hematocrit before discharge was $30.6\% \pm 3.0\%$. Renal and liver function tests were maintained within the normal range. Patients were extubated at 5.6 ± 2.8 hours after operation with proper oxygenation. Neurodevelopment was apparently normal. The Japanese psychomotor developmental scale assessment was given to patients without chromosomal abnormality between the ages of 1 and 3 years; the resulting score was 102.2 ± 15.4 (mean = 100 for normal population).

Conclusions. Open heart surgery was achieved without blood transfusion in the selected group of small children. The use of remote pump heads reduced the overall need for blood transfusions and possibly inflammatory reactions.

(Ann Thorac Surg 2004;78:1717-22)

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Kan transfüzyonu risk faktörü mü yoksa risk azaltıcı mı??

Oksijen balansı

- Organa spesifik:
Beyin
 - Doku oksijen ekstrak
 - $S_{cereb}O_2$
- Genel endeksleri
 - SvO_2
 - Kan laktat
 - %o2 ext
 - Baz fazlası

- Transfüzyon eşliğini belirlememize yardım edecek kriterlere ihtiyaç var
- hb düzeyi ile birlikte

