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PROTOCOLO DE USO DE LA HEMODILUCIÓN ISOVOLÉMICA

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Sesión de Formación Continuada
Valencia 22 de junio de 2010

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HEMODILUCIÓN NORMOVOLÉMICA

HEMO-
QUÉ??

NORMO-
CUALO??



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TRANSFUSIÓN DE HEMODERIVADOS

- En EEUU anualmente:
 - 14 millones de concentrados de hematíes
 - 10 millones de unidades de plaquetas
 - 4 millones de unidades de plasma fresco

- Anestesia: 40% de las transfusiones

TRANSFUSIÓN DE HEMODERIVADOS: RIESGOS INFECCIOSOS

Estimates of The Rate (Per Donor Exposure)
of Transfusion-Transmitted Infectious Disease in North America

DISEASE	RATE
• Hepatitis B (HBV)	1/269,000
• Hepatitis C (HCV)	1/1,600,000
• Human immunodeficiency virus (HIV)	1/1,780,000
• Human T-cell lymphotropic virus (HTLV)	1/2,900,000
• West Nile Virus (WNV)	Indeterminate/very low
• Cytomegalovirus (CMV)—Nonleukoreduced random donor	7%
• Leukoreduced random donor	2–4%
• CMV seronegative donor	1–2%
• Epstein-Barr virus (EBV)	0–5%
• Chagas'; malaria; other parasites	< 1/1,000,000
Bacterial sepsis	
• Platelets (apheresis, culture tested)	1/50,000
• Platelets (whole-blood derived, surrogate tested)	1/33,000
• Platelets (untested)	1/2,500–13,400

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TRANSFUSIÓN DE HEMODERIVADOS: RIESGOS NO INFECCIOSOS

The Noninfectious Adverse Reactions Associated with Blood Product Administration, in the Approximate Order of Their Average Frequencies in the Published Literature

ADVERSE REACTION	INCIDENCE	COMMENT
• TRIM	100%	
• Inflammatory response	(?) 100%	Increases with duration of storage
• Alloimmunization		
• RBCs	0.5%	
• Plts	10%	Reduced by leukoreduction ²⁵
• Minor allergic reactions (urticaria, flushing)	0.5–4%	Plts and FFP > RBCs
• Febrile reactions	0.1–2%	Probably reduced by leukoreduction
• DHTR	1/2,000	Most often Kell, Kidd, and Rhesus (E) antibodies
• TRALI	1/5,000	All plasma containing products; FFP and Plts > PRBCs
• Anaphylactic/toid reactions	1/25,000	Plts > PRBCs IgA deficiency increases risk
• AHTR	1/25,000	Usually patient ID error; 2% mortality; Plasma-incompatible Plts are a rare cause
• GVHD	Rare	Immunocompromised patients, especially marrow transplant recipients

TRIM, transfusion-related immunomodulation; RBCs, red blood cells; Plts, platelets; FFP, fresh-frozen plasma; DHTR, delayed hemolytic transfusion reaction; TRALI, transfusion-related acute lung injury; PRBCs, packed RBCs; IgA, immunoglobulin A; AHTR, acute hemolytic transfusion reaction; ID, identification; GVHD, graft-versus-host disease.

Hazards Associated with Massive Transfusion

- Hypothermia**
- Volume overload**
- Dilutional coagulopathy**
- Reduced oxygen-carrying capacity (decreased 2,3-DPG)**
- Metabolic acidosis/alcalosis metabolica**
- Hyperkalemia, hypocalcemia and hypomagnasemia**

TRANSFUSIÓN DE HEMODERIVADOS: RIESGOS

Objetivos de los protocolos de utilización de hemoderivados

- Transfundir menos
- Transfundir mejor
- Transfundir con menos riesgos
- Transfundir con menos coste

TRANSFUSIÓN DE HEMODERIVADOS: RIESGOS

PROTOCOLO RCOT

CONSULTA DE PREANESTESIA

Tipo de cirugía: RPTR, RPTC , Reartrodesis raquis
Sangrado estimado: 1500cc

Hb < 10g/dl



IC
Hematología
Estudio
anemia

Hb 10-13g/dl



EPO
Fe oral/ev
Folico/B12

Hb > 13g/dl



Fe oral/ev
Folico/B12

**EPO solo con
Autotransfusión**

Asociar antifibrinolíticos intraoperatoriamente

Valorar el uso recuperadores intra/postoperatorios

PROTOSCOLOS DE USO DE HEMODERIVADOS

1.- Transfundir menos

- Optimización preoperatoria
- Indicación de transfusión individualizada
- Técnicas para minimizar hemorragia
- Técnicas de ahorro de sangre

PROTOSCOLOS DE USO DE HEMODERIVADOS

2.- Transfundir mejor

- Conocer la importancia de la hemorragia
- Decidir qué hemoderivado utilizar

PROTOSCOLOS DE USO DE HEMODERIVADOS

3.- Seguridad

- Selección de donantes
- Análisis de laboratorio

TÉCNICAS DE AHORRO DE SANGRE

- Donación autóloga preoperatoria
- Hemodilución normovolémica aguda
- Recuperadores de sangre intraoperatorios
- Recuperadores de sangre postoperatorios
- Fármacos
 - Eritropoyetina
 - Sustitutos sanguíneos: hemoglobina sintética (in progress)
 - Desmopresina
 - Antifibrinolíticos

TÉCNICAS DE AHORRO DE SANGRE



Ventajas

- Evita la transmisión de infecciones de donantes
- Previene la aloinmunización
- Sangre compatible para pacientes con aloanticuerpos
- Previene de ciertas reacciones transfusionales

TÉCNICAS DE AHORRO DE SANGRE

Inconvenientes

- Riesgo de contaminación bacteriana
- No elimina la posibilidad de incompatibilidad ABO por ERROR TRANSFUSIONAL
- Provoca anemia perioperatoria
- No uso de sangre alogénica almacenada
- Mayor coste que la transfusión alogénica



HEMODILUCIÓN NORMOVOLÉMICA (HNV)

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NORMOVOLEMIC HEMODILUTION en MEDLINE

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23. Management of A2B blood group in a patient for hypothermic cardiopulmonary bypass surgery--a case report. Azarfarin R, Alizadeh A. Middle East J Anesthesiol. 2009 Feb;20(1):101-3. PMID: 19266835 [PubMed - indexed for MEDLINE][Related citations](#)
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31. A prospective randomized trial of acute normovolemic hemodilution compared to standard intraoperative management in patients undergoing major hepatic resection. Jarnagin WR, Gonen M, Maithel SK, Fong Y, D'Angelica MI, Dematteo RP, Grant F, Wuest D, Kundu K, Blumgart LH, Fischer M. Ann Surg. 2008 Sep;248(3):360-9. PMID: 18791356 [PubMed - indexed for MEDLINE][Related citations](#)
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HEMODILUCIÓN NORMOVOLÉMICA

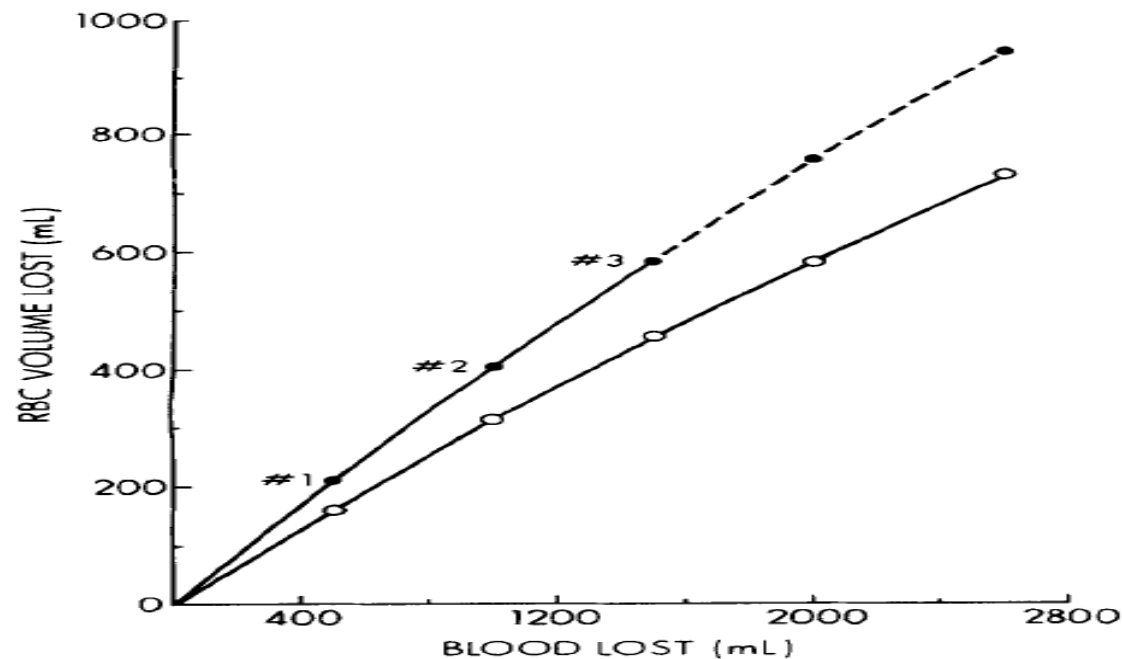
Extracción de un volumen de sangre del paciente en el intraoperatorio, previa a importante hemorragia, con reposición simultánea del volumen.

- El paciente perderá sangre con pobre hematocrito.
- El paciente se transfundirá con su propia sangre.

Acute Preoperative Hemodilution in Patients Undergoing Radical Prostatectomy: A Case Study Analysis of Efficacy

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ANESTH ANALG
1994;78:932-7

Figure 1. The relationship between whole blood volume (mL) lost (abscissa) and red blood cell (RBC) volume lost (ordinate) for Patient 10. RBC volume lost with 2600 mL of whole blood lost intraoperatively after hemodilution of 1500 mL of whole blood (○—○); RBC volume lost with 2600 mL of whole blood lost during hemodilution at each of three 500-mL volumes removed (●—●); cumulative RBC volume lost intraoperatively, derived for 2600 mL of whole blood lost if hemodilution had not been performed (●—●). A net reduction of 204 mL in RBC volume lost with hemodilution is illustrated by the divergence of the two curves.

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Table 16.1 Criteria for selection of patients for perioperative hemodilution

- Estimated blood loss > 1500 ml**
 - Preoperative hemoglobin concentration > 12 g/dl**
 - Normal ECG and normal myocardial function**
(no signs of ischemia, no ST-deviation, no unstable angina pectoris, no congestive heart failure, no ventricular ejection fraction < 50%)
 - Absence of restrictive and/or obstructive lung disease** (preoperative chest X-ray, respiratory functional testing)
 - Absence of renal disease** (normal serum urea/creatinine, no oliguria; no signs of single kidney dysfunction)
 - Absence of untreated hypertension** (systolic arterial pressure > 160 mmHg, diastolic arterial pressure > 100 mmHg)
 - Absence of liver cirrhosis** (plasma clotting factors within reference, serum albumin within reference)
 - Absence of coagulation disorders** (*in vivo* clotting time, plasma clotting factors within reference, no history of hereditary coagulopathy, platelet count > 150 000/ μ l)
 - Absence of infection** (no fever, no leucocytosis/penia, no systemic inflammatory response syndrome, no invasive local infection)
-

Modified from Kreimeier and **Messmer**, 2002.

HEMODILUCIÓN NORMOVOLÉMICA

Indicaciones

- Hemoglobina inicial >12 g/dL.
- Pérdida sanguínea estimada >1500 mL.

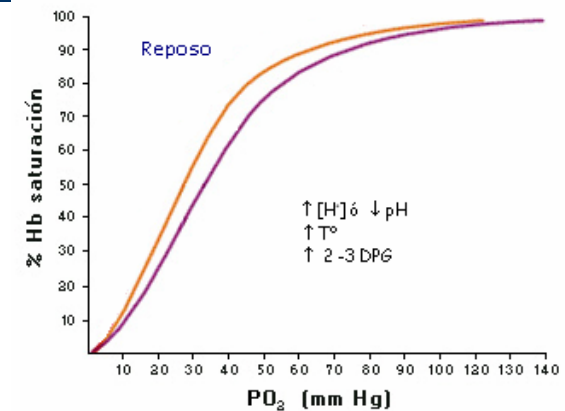
Kreimeier U, Messmer K. Perioperative hemodilution. Transfus Apher Sci. 2002 Aug;27(1):59-72.

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¿Qué ocurre cuando hemodiluímos?

Mecanismos compensadores

1. Aumento del gasto cardíaco
2. Redistribución del gasto cardíaco
3. Aumento de la extracción tisular de oxígeno
4. Cambios en la afinidad de la hemoglobina



¿Cuánto hemodiluimos?

Volumen extraíble

Fórmula de Bourke

Gross JB. Estimating allowable blood loss: correct

$$V_L = EBV \times \frac{H_O - H_F}{H_O}$$

Am J Surg;58(3):277-80.

Fórmula de Dubousset

$$VE = \text{Peso}/13 \times [\text{Hto inicial} - \text{Hto final} / (\text{Hto inicial} + \text{Hto final})/2]$$

Al volumen extraíble se le resta un 25 % y un 20 % más para seguridad
Extracción 450 ml. de sangre en 10 - 15 min.

Adición a la bolsa de sangre (de 400 a 500 cc) 63 cc de CPD.

¿Cómo hemodiluimos?

Relleno o Reemplazamiento

- Con cristaloides: infusión del 3 a 5 ml por ml de sangre extraído.
- Con coloides: infusión del 1,2 a 1,5 ml por ml de sangre extraído.

Etiquetado de las bolsas con todos los datos.

Almacenaje a 4° C y preferible uso antes de 4 horas

Monitorización

Table 16.2 Hemodilution: monitoring variables in the perioperative period

Hemodilution to Hct 20–25%		Hemodilution to Hct below 20–25%	
Continuous monitoring	Intermittent monitoring	Additional (highest priority)	Facultative (acc. to target Hct)
ECG-monitor (lead II or V)		ECG-monitor (lead II and V)	On-line ST-segment analysis
Arterial blood pressure (invasive)		Arterial blood pressure (invasive)	Pulmonary arterial catheter (CO, PCWP, continuous S_vO_2)
Central venous pressure (curve display)			Arterial pulse contour analysis (CO, GEDV, SVV)
Pulse oximetry	Blood gas analysis (PaO_2 , SaO_2 , BE, pH, Hb, CaO_2)	Blood gas analysis; central venous or mixed venous (PvO_2 , SvO_2 , CvO_2)	O_2 transport indices (DO_2I , VO_2I , O_2 ER)
Urinary output	Cumulative urinary output (hourly)		
	Blood chemistry (K^+ , Cl^- , Na^+ , Ca^{++} , blood glucose, coagulation status, fibrinogen, platelet count)	Blood chemistry (arterial lactate, serum albumin)	Bedside Hb-test (Hemocue), thrombelastography

Stroke Volume Variation During Acute Normovolemic Hemodilution

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Vol. 109, No. 6, December 2009.

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DISCUSSION

These observed changes suggest that SVV may have clinical utility as a real-time monitor to guide intraoperative fluid management. This potential role is supported by the correlation between increasing SVV and decreasing LVEDV as measured by TEE,

HNV en COT

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Shuulman G, Solanki DR, Hadjipavlou AG. Augmented autologous transfusions in major reconstructive spine surgery. *J Clin Apheresis* 1998;13:62-8.

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Dubousset AM, Dubousset J, Losse JP. [Autotransfusion with acute hemodilution in the surgical treatment of scoliosis]. *Rev Chir Orthop Reparatrice Appar Mot* 1981;67:609-15.

Pouliquen-Evrard M, Mangin F, Pouliquen JC, et al. [Autotransfusion and hemodilution in orthopedic surgery in children]. *Rev Chir Orthop Reparatrice Appar Mot* 1989;75:11-8.

Olsfanger D, Jedeikin R, Metser U, et al. Acute normovolemic haemodilution and idiopathic scoliosis surgery: Effects on homologous blood requirements. *Anaesth Intensive Care* 1993;21:429-31.

Haberkern M, Dangel P. Normovolemic haemodilution and intraoperative auto-transfusion in children: Experience with 30 cases of spinal fusion. *Eur J Pediatr Surg* 1991;1:30-5.

HNV en cirugía cardíaca

Virmani S, Deepak K, Bhuvan C, Amandeep S, Vishnu D, et al. Acute normovolemic hemodilution is not beneficial in patients undergoing primary elective valve surgery. *Ann Card Anaesth* 2010;13:34-8.

Mahoori A, Heshmati F, Noroozinia H, Mehdizadeh H, Salehi S, Rohani M. Intraoperative minimal acute normovolemic hemodilution in patients undergoing coronary artery bypass surgery. *Middle East J Anesthesiol.* 2009 Oct;20(3):423-9.

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Stein JI, Gombotz H, Rigler B, et al. Open heart surgery in children of Jehovah's Witnesses: Extreme hemodilution on cardiopulmonary bypass. *Pediatr Cardiol* 1991;12:170-4.

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HNV en cirugía mayor abdominal

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Schaller RT, Schaller J, Furman EB. The advantages of hemodilution anesthesia for major liver resection in children. *J Pediatr Surg* 1984;19:705-10.

Schaller RT, Schaller J, Morgan A, et al. Hemodilution anesthesia: A valuable aid to major cancer surgery in children. *Am J Surg* 1983;146:79-84.

HNV en cirugía urológica

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Eficacia

- Modelos matemáticos:

Hemodilución a Hto. < 20% acompañada de pérdidas sustanciales son necesarias para lograr “ahorro de sangre” clínicamente importante.

Brecher ME, Rosenfeld M. Mathematical and computer modeling of acute normovolemic hemodilution. Transfusion 1994;34:176-179.

- Estudios clínicos:

Con hemodilución a Hto. 28% (extracción 3 CH)

↪ **ahorro de 215 mL. = 1 concentrado de hematías.**

Ventajas de la HNV sobre resto de técnicas de ahorro de hemoderivados

- No errores transfusionales
- Más económica que el resto de técnicas

CRÍTICAS A LA HNV

- 1.- Existencia de factores de confusión
- 2.- Monitorización de parámetros clínicos indirectos
- 3.- Déficit de estudios órgano-específicos

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BLOOD CONSERVATION AND TRANSFUSION ALTERNATIVES

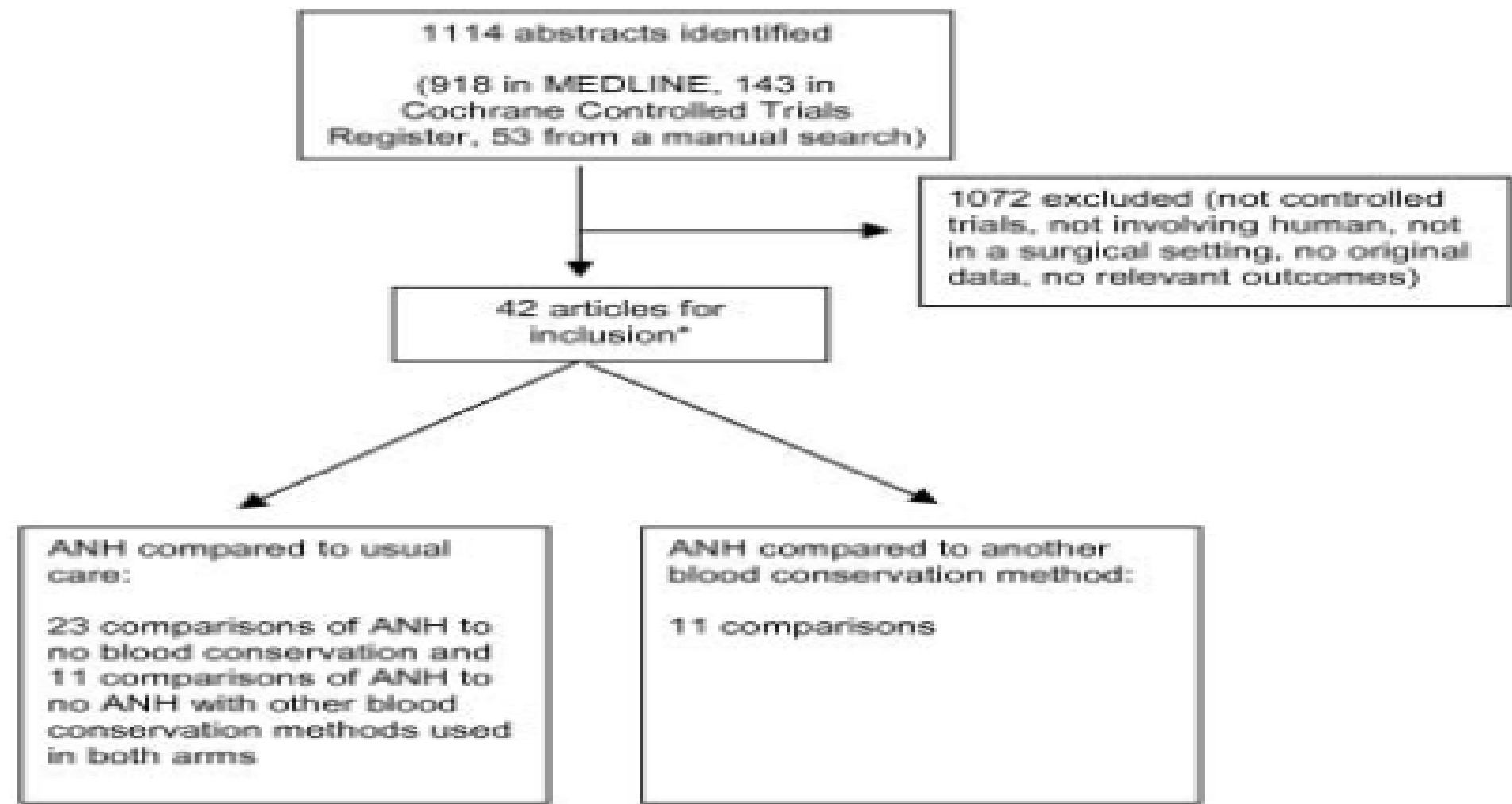
Preoperative acute normovolemic hemodilution: a meta-analysis

Jodi B. Segal, Elena Blasco-Colmenares, Edward J. Norris, and Eliseo Guallar

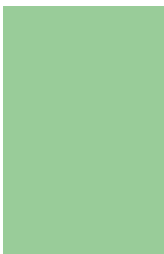
TRANSFUSION 2004;44:632-644.



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The 42 included studies were published between 1972 and 2002;



The total number of enrolled patients included in our analyses is 2233;

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DISCUSSION

Current evidence does not support a reduction in the risk of allogeneic transfusion in the perioperative period with use of ANH.

The volume of allogeneic blood transfused in the ANH groups was less than that transfused in the comparison groups, by 1 to 2 units.

It has been suggested that ANH can only be expected to be efficacious when there is substantial intraoperative blood loss.¹⁵ Interestingly, in the studies we reviewed, the mean amount of intraoperative blood loss in the ANH arms was highly correlated with the mean volume of blood removed by hemodilution.

PROTOCOLO ?



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*Our own blood is still the best thing
to have in our veins.*

T. Frenzel

*'Cause I got too much life,
running through my veins.*

R. Williams