



# LE SFIDE DEL TRAPIANTO DI FEGATO NEL 2023

Loc. Ciocco **Lucca**  
14-15 Aprile 2023

con la sponsorizzazione non condizionante di

**KEDRION**  
B I O P H A R M A



UOC Anestesia e Rianimazione Trapianti  
Università di Pisa

## SESSIONE 1

Le sfide del trapianto di fegato tra sostenibilità, equità e impiego di risorse

*Moderatori:* P. De Simone, S. Faggiuoli, A. Marzano

**12:30-13:30** Progetto "Costi Trapianto"  
B. Canali, F. Fiorentino

**13:30-14:30** *Lunch*

**14:30-15:30** Progetto "Costi Trapianto"  
B. Canali, F. Fiorentino  
*Discussant:* S. Ginanni Corradini, M. Vivarelli

**15:30-16:00** Le esigenze trasfusionali del trapianto di fegato: quali strategie?  
C. Biancofiore

**16:00-16:30** Trapianto di fegato in pazienti high-MELD  
A. Avolio

**16:30-16:45** *Coffee break*

# Le esigenze trasfusionali nel TdF: quali strategie



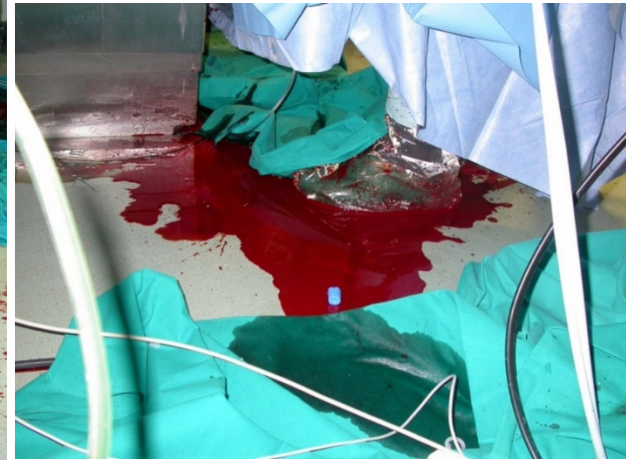
## Dichiarazione di Conflitto di Interessi:

*Sono un Anestesista Rianimatore !!*

Nessun conflitto di interessi commerciale

# Le esigenze trasfusionali nel TdF: quali strategie

*“in liver transplantation significant decreases in the use of blood components were of greater magnitude than in other fields (orthopedic, cvs, urologic surgery) and mainly related to the improvement in surgical technique and anesthetic management, as well as a better understanding and management of coagulation disorders”* Sakai T *Transfusion* 2020;60:61-69






# Le esigenze trasfusionali nel TdF: quali strategie

## 1 variabilità centro-specifica



Earlier studies of average blood usage in liver transplant suggest it was typical for patients to require massive transfusion (e.g. >1 blood volume in 24 h) [6–9]. Towards the turn of the century, significantly lower utilization rates were reported, but there was still significant interinstitutional variation and apparently large standard deviation within institutions

**VoxSanguinis**  International Society of Blood Transfusion  
The International Journal of Transfusion Medicine

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**ORIGINAL PAPER** Vox Sanguinis 2018;113:421-29

**A data-driven patient blood management strategy in liver transplantation**

R. A. Metcalf,<sup>1,2</sup>  M. B. Pagano,<sup>3</sup>  J. R. Hess,<sup>3,4</sup> J. Reyes,<sup>5</sup> J. D. Perkins<sup>5</sup> & M. I. Montenegro<sup>5</sup>



# Le esigenze trasfusionali nel TdF: quali strategie

## 2 *il setting*

### **Peri-operative blood transfusion in elective major surgery: incidence, indications and outcome – an observational multicentre study**

Dilek Unal<sup>1</sup>, Yesim Senayli<sup>2</sup>, Reyhan Polat<sup>1</sup>, Donat R. Spahn<sup>3</sup>, Fevzi Toraman<sup>4</sup>, Neslihan Alkis<sup>5</sup> for the Turkish Society of Anaesthesiology and Reanimation Patient Blood Management Group and the Turkish National Perioperative Transfusion Study Investigators (the collaborators are listed in the Appendix 1)

Blood Transfus 2020;18:261-79



*“Operatory theatres, ICUs and surgical wards are places where blood products are still frequently misused”*

# Le esigenze trasfusionali nel TdF: quali strategie

## 3 rischio trasfusionale

*in TdF, entità trasfusioni correla con:*

- prolungamento degenza ospedaliera [1]
- necessità di re-intervento [2]
- incidenza di AKI e necessità CRRT postoperatorie [3]
- infezioni della ferita chirurgica [4]
- riduzione della sopravvivenza sia a breve che a lungo termine [5-6]
- rischio di decesso entro 1 anno 4.2 volte > per trasfusione di almeno 4 U GRC [7]

1. Busutil RW et al *J Am Coll Surg* 2013; 216: 902-7

2. Hendricks HG et al *Transpl Int* 2005; 17: 673-9

3. Freire MP et al *Liver Transpl* 2013; 19: 1011-19

4. Reichert B et al *Langenbecks Arch Surg* 2014 2014;399:429–40

5. Cywinski J et al *Liver Transplant.* 2013;19:1181–8

6. Tan L et al *Int. J. Med. Sci.* 2021;18:3780-3787




7. Massicotte L et al *Anesth Analg* 2004;98:1245–51

# Le esigenze trasfusionali nel TdF: quali strategie

## 4 Il paziente cirrotico chirurgico

Guideline

### Guidance document: risk assessment of patients with cirrhosis prior to elective non-hepatic surgery

Nadir Abbas,<sup>1,2</sup> Jonathan Fallowfield,<sup>3</sup> David Patch,<sup>4</sup> Adrian J Stanley,<sup>5</sup> Raj Mookerjee ,<sup>6</sup> Emmanouil Tsochatzis,<sup>6</sup> Joanna A Leithead ,<sup>7,8</sup> Peter Hayes,<sup>9</sup> Abhishek Chauhan,<sup>1,2</sup> Vikram Sharma,<sup>10</sup> Neil Rajoriya ,<sup>1,2</sup> Simon Bach,<sup>11</sup> Thomas Faulkner,<sup>12</sup> Dhiraj Tripathi<sup>2,13</sup>

*“Well-recognised risks include those of general anaesthesia, **bleeding**, infections, impaired wound healing, acute kidney injury and cardiovascular compromise”*

BMJ Journals

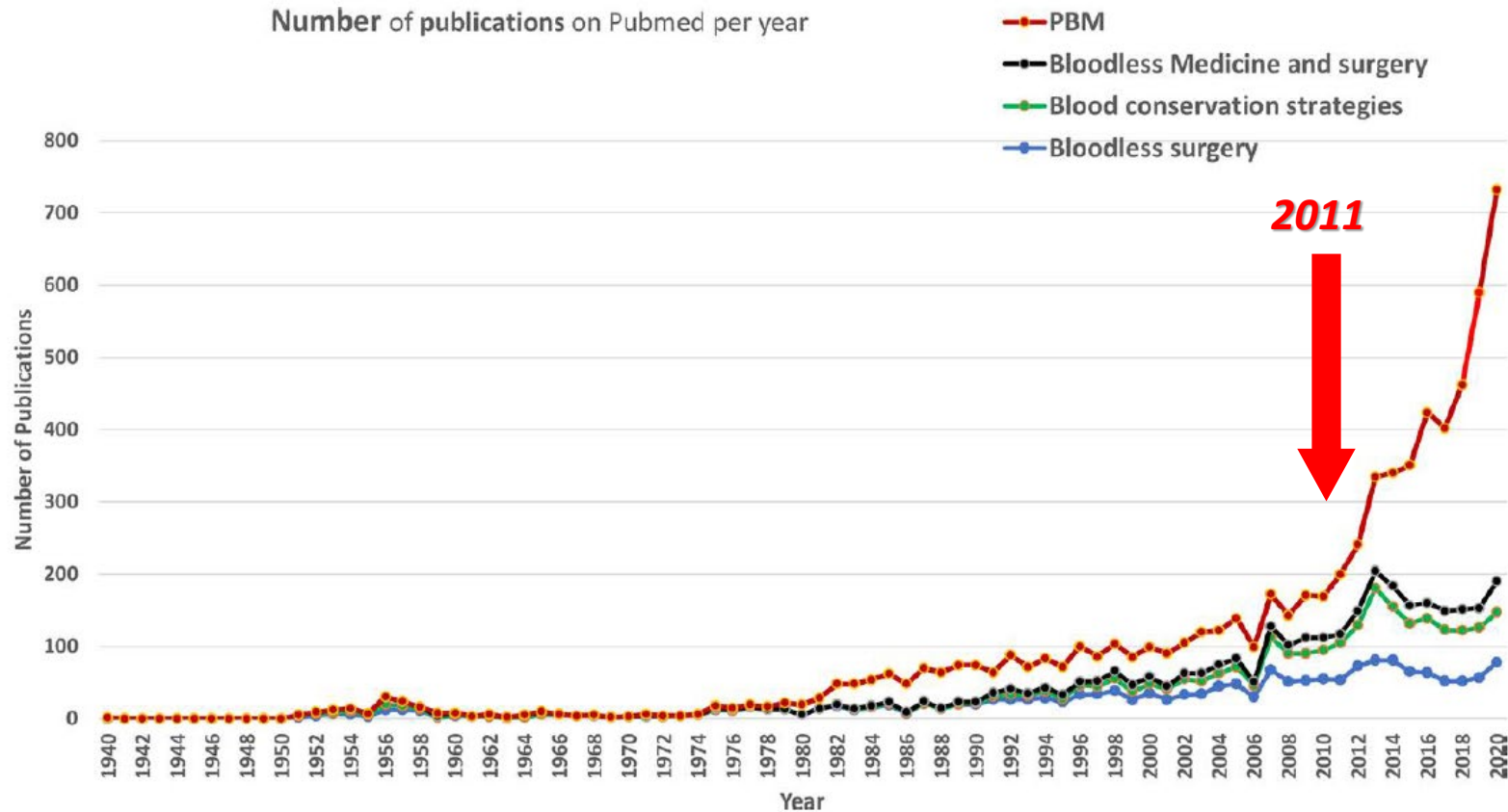
Frontline  
Gastroenterology

2023 epub



# Le esigenze trasfusionali nel TdF: quali strategie

## Patient Blood Management (PBM)



**Figure.** Growth in the annual number of publications indexed in PubMed focusing on PBM and related disciplines. PBM indicates patient blood management.

# Le esigenze trasfusionali nel TdF: quali strategie

GUIDELINES

## The Italian Regulatory Guidelines for the implementation of Patient Blood Management

Stefania Vaglio<sup>1,2</sup>, Sara Gentili<sup>1</sup>, Giuseppe Marano<sup>1</sup>, Simonetta Pupella<sup>1</sup>, Daniela Rafanelli<sup>3</sup>, Gianni Biancofiore<sup>4</sup>, Paola Antonioli<sup>5</sup>, Claudio Velati<sup>6</sup>, Giancarlo M. Liumbruno<sup>1</sup>

Blood Transfus 2017; 15: 325-8

## Patient Blood Management (PBM)

Pacchetto di interventi multidisciplinare e multimodale basata su strategie EBM che ha l'obiettivo di **gestire l'anemia** insieme ai **fattori di rischio trasfusionale modificabili in modo personalizzato** ancor prima che sia necessario prendere in considerazione il ricorso alla terapia trasfusionale

*Questa strategia si propone di ridurre in modo significativo l'utilizzo dei prodotti della banca del sangue*

Mueller M et al *JAMA*. 2019;321:983-997



Società Italiana per lo Studio dell'Emostasi e della Trombosi



SOCIETÀ ITALIANA  
DI ORTOPEDIA  
E TRAUMATOLOGIA



SIMTI

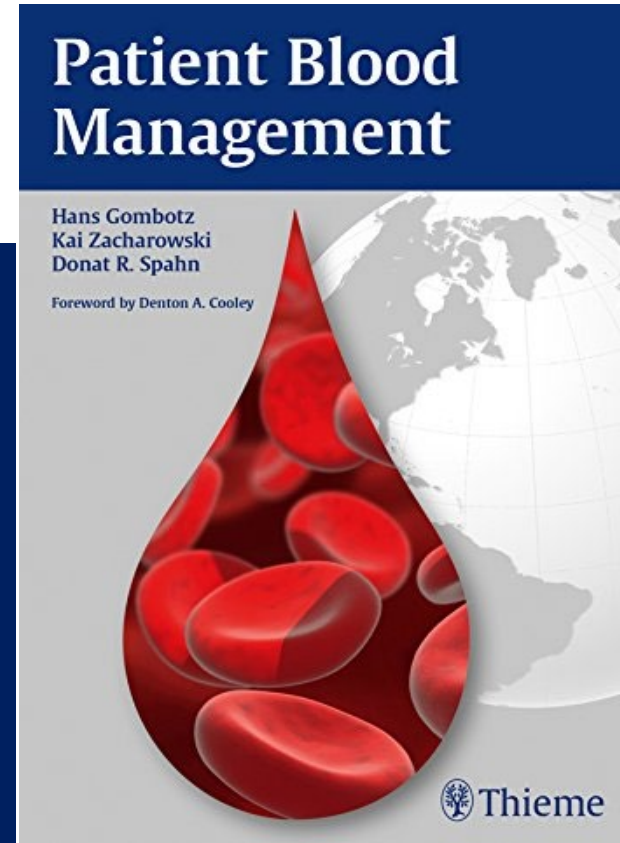
Società Italiana  
di Medicina Trasfusionale  
e Immunoematologia

# Le esigenze trasfusionali nel TdF: quali strategie

*“A comprehensive PBM program may include **more than 100 different measures/tasks**, divided into 4 bundle blocks”*

## **4 principi cardine:**

- 1. Gestione dell’anemia**
- 2. Strategie multidisciplinari per il risparmio del sangue**
- 3. Ottimizzazione dell’emostasi**
- 4. Centralità del paziente**



**Il PBM nel TdF**



# PBM in TdF

## 1. Gestione dell'anemia

2. Strategie per il risparmio

3. Ottimizzazione dell'emostasi

## Gestione preop di Anemia








Pazienti anemici: 324/494



MELD dei pazienti anemici: (12 ± 4)



### Prevalence of and risk factors for anaemia in patients with advanced chronic liver disease

Bernhard Scheiner<sup>1,2</sup>  | Georg Semmler<sup>1,2</sup>  | Florian Maurer<sup>1,2</sup> | Philipp Schwabl<sup>1,2</sup>  
Theresa A. Bucsics<sup>1,2</sup>  | Rafael Paternostro<sup>1,2</sup>  | David Bauer<sup>1,2</sup> |  
Benedikt Simbrunner<sup>1,2</sup>  | Michael Trauner<sup>1</sup> | Mattias Mandorfer<sup>1,2</sup>  |  
Thomas Reiberger<sup>1,2</sup>  *Liver International*. 2020;40:194–204

#### Key points

- Anaemia is found in two-thirds of patients with advanced chronic liver disease (ACLD) including 7% with severe anaemia defined by haemoglobin levels <8 mg/dL.
- The most common causes for anaemia in ACLD are gastrointestinal blood loss and iron deficiency anaemia (IDA).
- Severity of anaemia is closely linked to hepatic dysfunction (reflected by MELD) and severity of portal hypertension (HVPG).
- The presence of anaemia is associated with worse clinical outcomes such as a higher rate of hepatic decompensation, hospitalization, acute-on-chronic liver failure (ACLF) as well as increased overall and liver-related mortality.

# PBM in TdF

1. Gestione dell'anemia

## 2. Strategie per il risparmio

3. Ottimizzazione dell'emostasi

- emorecupero
- omeostasi
- minimizzazione perdite
  - Tecniche chirurgiche
  - Tecniche anestesiol.

VVBP



# F.P.: i principi cardine del PBM

1. Gestione dell'anemia

## 2. Strategie per il risparmio

3. Ottimizzazione dell'emostasi

- emorecupero
- riscaldamento
- omeostasi
- minimizzazione perdite
  - VVB
  - Tecnica chirurgica
  - Tecnica anestesiol.

REVIEW ARTICLE/BRIEF REVIEW

Can J Anesth 2020;67:109-27

### Restrictive fluid management strategies and outcomes in liver transplantation: a systematic review

### Stratégies de prise en charge liquidienne restrictive et pronostics en transplantation hépatique : une revue systématique

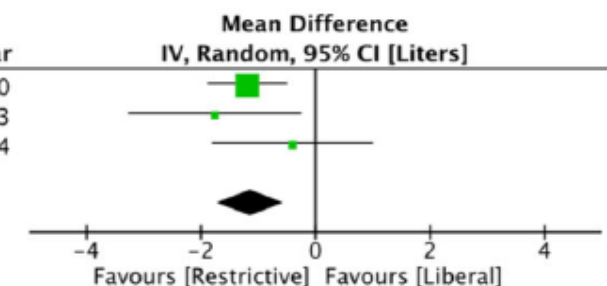
François Martin Carrier, MD MSc FRCPC · Michaël Chassé, MD PhD FRCPC · Han Ting Wang, MD MSc FRCPC · Pierre Aslanian, MD FRCPC · Stéphanie Iorio · Marc Bilodeau, MD FRCPC · Alexis F. Turgeon, MD MSc FRCPC

#### (d) Bleeding

Study or Subgroup	Restrictive			Liberal			Weight	Mean Difference IV, Random, 95% CI [Liters]	Year
	Mean [Liters]	SD [Liters]	Total	Mean [Liters]	SD [Liters]	Total			
Feng 2010	1.92	1.43	43	3.11	1.83	43	68.8%	-1.19 [-1.88, -0.50]	2010
Wang 2013	3.89	2.72	33	5.65	3.44	32	14.5%	-1.76 [-3.27, -0.25]	2013
Sahmeddini 2014 (2)	2.1	2.96	37	2.5	3.26	38	16.7%	-0.40 [-1.81, 1.01]	2014
<b>Total (95% CI)</b>			<b>113</b>			<b>113</b>	<b>100.0%</b>	<b>-1.14 [-1.72, -0.57]</b>	

Heterogeneity:  $\tau^2 = 0.00$ ;  $\chi^2 = 1.73$ ,  $df = 2$  ( $P = 0.42$ );  $I^2 = 0\%$

Test for overall effect:  $Z = 3.88$  ( $P = 0.0001$ )



“Based on low or very low levels of evidence, intraoperative restrictive fluid management strategies might have protective effects on blood loss”



# F.P.: i principi cardine del PBM


1. Gestione dell'anemia

## 2. Strategie per il risparmio

3. Ottimizzazione dell'emostasi

- emorecupero
- riscaldamento
- omeostasi
- minimizzazione perdite
  - VVB
  - Tecnica chirurgica
  - Tecnica anestesiol.

### Association of intraoperative hypotension with postoperative morbidity and mortality: systematic review and meta-analysis

M. Wijnberge <sup>1,2,3</sup>, J. Schenk<sup>1</sup>, E. Bulle<sup>1,2</sup>, A. P. Vlaar<sup>2,3</sup>, K. Maheshwari<sup>4</sup>, M. W. Hollmann<sup>1,3</sup>, J. M. Binnekade<sup>2</sup>, B. F. Geerts<sup>1,\*</sup> and D. P. Veelo<sup>1</sup>

BJS Open 2021;5(1)

**130.862 pazienti**

*'Intraoperative hypotension during non-cardiac surgery is associated with postoperative cardiac and renal morbidity, and mortality'*

# F.P.: PBM in pratica

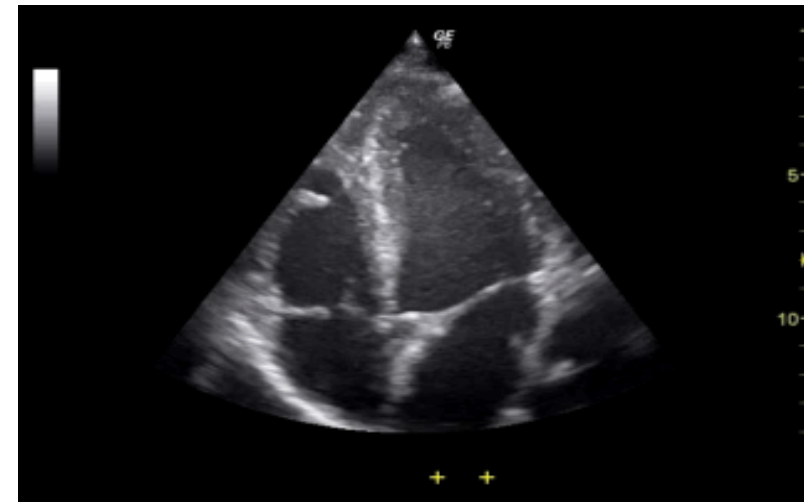
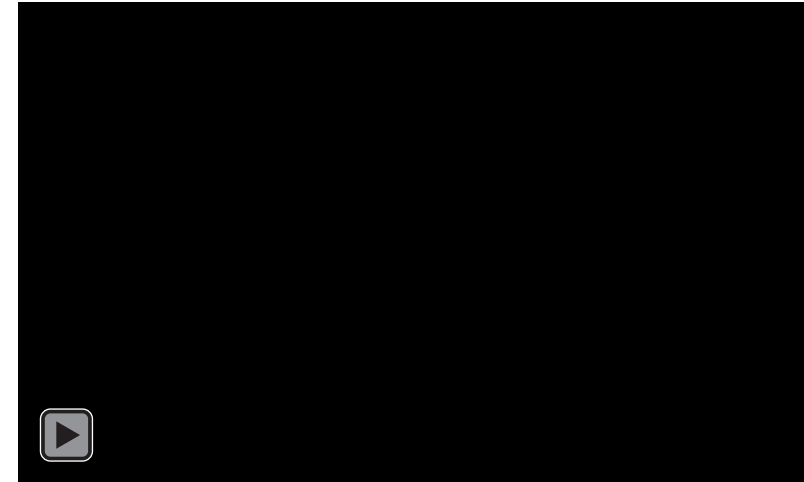
1. Gestione dell'anemia

## 2. Strategie per il risparmio

3. Ottimizzazione dell'emostasi

- emorecupero
- riscaldamento
- omeostasi
- minimizzazione perdite
  - VVB
  - Tecnica chirurgica
  - Tecnica anestesiol.

Quale  
monitoraggio ?



# PBM in TdF

1. Gestione dell'anemia
2. Strategie per il risparmio

## 3. Ottimizzazione dell'emostasi

The NEW ENGLAND JOURNAL of MEDICINE

### The Coagulopathy of Chronic Liver Disease

Armando Tripodi, Ph.D., and Pier Mannuccio Mannucci, M.D.

N Engl J Med 2011;365:147-56

*“cirrhotic patients do not have an inherent bleeding diathesis but rather a **rebalanced status** since both PRO and ANTI coagulant drivers are reduced”*

# 1

*“Coagulation laboratory tests are not reliable in assessing the risk of surgical bleeding”*

#### Goal-directed Management of Coagulation: The Right Treatment, the Right Patient, the Right Time

Yanik J. Bababekov, MD, MPH,<sup>1</sup> Trevor L. Nydam, MD,<sup>2</sup> James J. Pomposelli, MD, PhD,<sup>2</sup> and Hunter B. Moore, MD<sup>2</sup>

Transplantation. 2018;102:e303-e304

# 2

*“The concept of rebalanced hemostasis in patients with liver disease has, to some extent, led to enormous changes in hemostatic management both in prophylaxis and therapy”*

#### Treatment of bleeding in patients with liver disease

Patrick G. Northup<sup>1</sup> | Ton Lisman<sup>2</sup> | Lara N. Roberts<sup>3</sup>

Thromb Haemost. 2021;19:1644-1652



# PBM in TdF

1. Gestione dell'anemia
2. Strategie per il risparmio

## 3. Ottimizzazione dell'emostasi



*“Unlike conventional coagulation tests (CCTs), viscoelastic monitoring (VEM) can provide an accurate, real-time, point-of-care assessment of coagulation status during LT and hence has become an invaluable tool for anesthesiologists and intensive care physicians. However, it remains an enigmatic subject for transplantation surgeons who are more conversant with CCTs.”*

# PBM in TdF

1. Gestione dell'anemia
2. Strategie per il risparmio

## 3. Ottimizzazione dell'emostasi

Linee di condotta:

- diagnosi rapida
- trattamento mirato
- enfasi su indicazioni cliniche

### Haemostatic alterations and management of haemostasis in patients with cirrhosis

Ton Lisman<sup>1\*</sup>, Stephen H. Caldwell<sup>2</sup>, Nicolas M. Intagliata<sup>2</sup>

*J Hepatol* 2022;76:1291-1305

### Thromboelastography-Guided Therapy Enhances Patient Blood Management in Cirrhotic Patients: A Meta-analysis Based on Randomized Controlled Trials

Jan Hartmann, MD<sup>1</sup> Joao D. Dias, PhD<sup>1</sup> Evan G. Pivalizza, MD<sup>2</sup> Guadalupe Garcia-Tsao, MD<sup>3,4</sup>

*Semin Thromb Hemost* 2022 epub

*'Coagulation monitoring with **TEG/TEM** eliminates empirical therapy allowing specific management of coagulation defects at an early stage'*

1. *"wait-and-see" policy* preferred over prophylactic blood component transfusion
2. *TEG/TEM goal-directed therapy* when *'pathological' bleeding is noticed*
3. *Continuous dialogue btwn surgeon & anesth.*

#### EXPERTS' OPINION

Perioperative hemostatic management in the cirrhotic patient: a position paper on behalf of the Liver Intensive Care Group of Europe (LICAGE)

Gianni BIANCOFIORE<sup>1\*</sup>, Annabel BLASI<sup>2</sup>, Marieke T. DE BOER<sup>3</sup>, Massimo FRANCHINI<sup>4</sup>, Matthias HARTMANN<sup>5</sup>, Ton LISMAN<sup>3</sup>, Giancarlo M. LIUMBRUNO<sup>6</sup>, Robert J. PORTE<sup>3</sup>, Fuat SANER<sup>7</sup>, Marco SENZOLO<sup>8</sup>, Maureen J. WERNER<sup>3</sup>

*Minerva Anestesiol* 2019;85:782-98

#### CLINICAL PRACTICE GUIDELINES

AGA Clinical Practice Guideline on the Management of Coagulation Disorders in Patients With Cirrhosis

Robert S. O'Shea,<sup>1</sup> Perica Davitkov,<sup>2</sup> Cynthia W. Ko,<sup>3</sup> Anita Rajasekhar,<sup>4</sup> Grace L. Su,<sup>5,6</sup> Shahnaz Sultan,<sup>7</sup> Alina M. Allen,<sup>8</sup> and Yngve Falck-Ytter<sup>2</sup>

*Gastroenterology* 2021;161:1615-1627

# PBM in TdF

1. Gestione dell'anemia
2. Strategie per il risparmio

## 3. Ottimizzazione dell'emostasi

Thromboelastography does not reduce transfusion requirements in liver transplantation: A propensity score-matched study

Rita Gaspari <sup>a,c,1</sup>, Luciana Teofili <sup>b,c,1</sup>, Paola Aceto <sup>a,c,\*</sup>, Caterina G. Valentini <sup>b</sup>,  
Giovanni Punzo <sup>a</sup>, Liliana Sollazzi <sup>a,c</sup>, Salvatore Agnes <sup>c,d</sup>, Alfonso W. Avolio <sup>c,d</sup>

J Clin Anesth 2021;69:110154

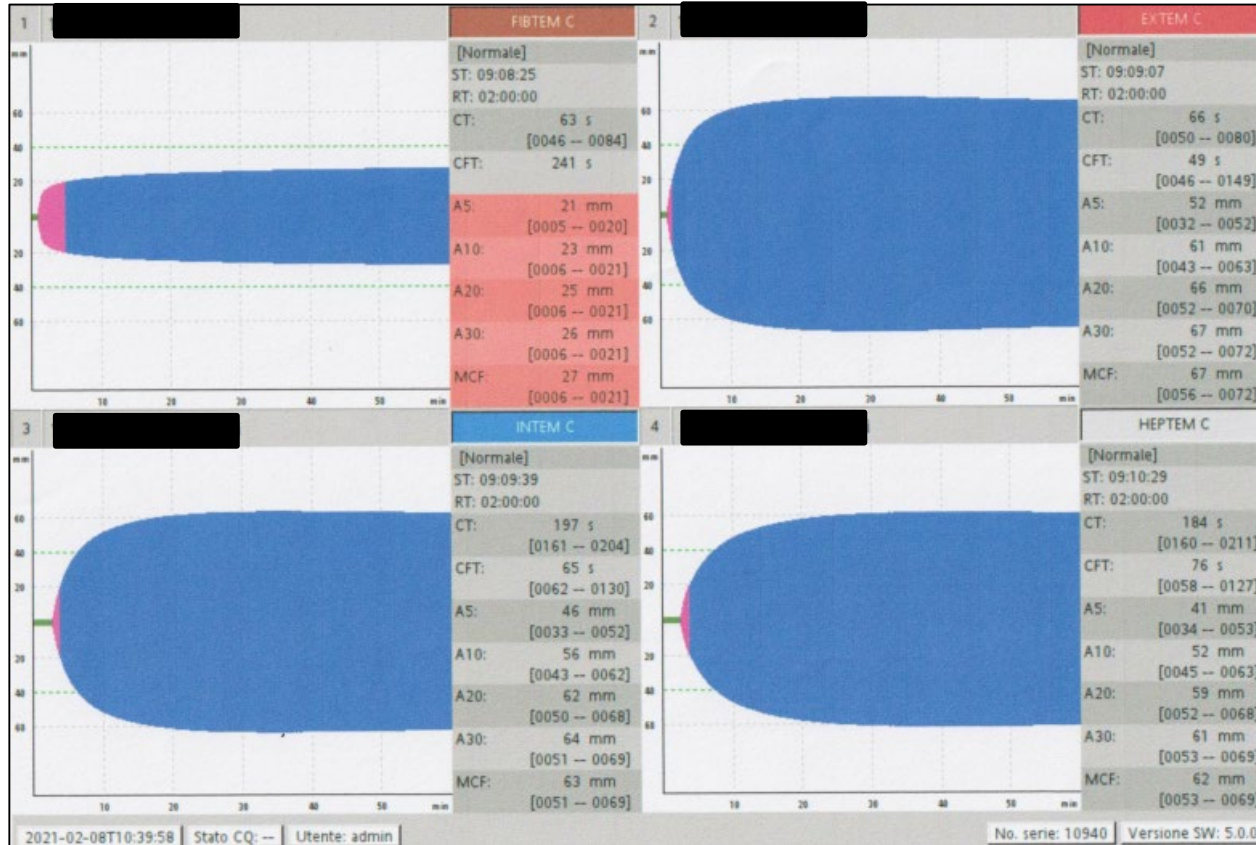
*Main results:* The preliminary analysis showed that patients in the TEG group received fewer total blood products (RBC + FFP + PLT;  $p = 0.001$ , FFP ( $p = 0.001$ ), and RBC ( $p = 0.001$ ). After PSM, 89 CCT patients were selected and matched to the 90 TEG patients. CCT and TEG matched patients received similar amount of total blood products. In a subgroup of 39 patients in the top MELD quartile (MELD  $\geq 25$ ), the TEG use resulted in lower

# F.P.: PBM in TdF

1. Gestione dell'anemia
2. Strategie per il risparmio

## 3. Ottimizzazione dell'emostasi

- TEG è in grado di individuare i soggetti con tendenza ad ipercoagulazione
- L'identificazione del rischio di complicanze trombotiche post-operatorie può suggerire un uso più frequente di tromboprolifassi



F.P: POD 1 dopo TdF

INR: 1.9

PLT: 32.000

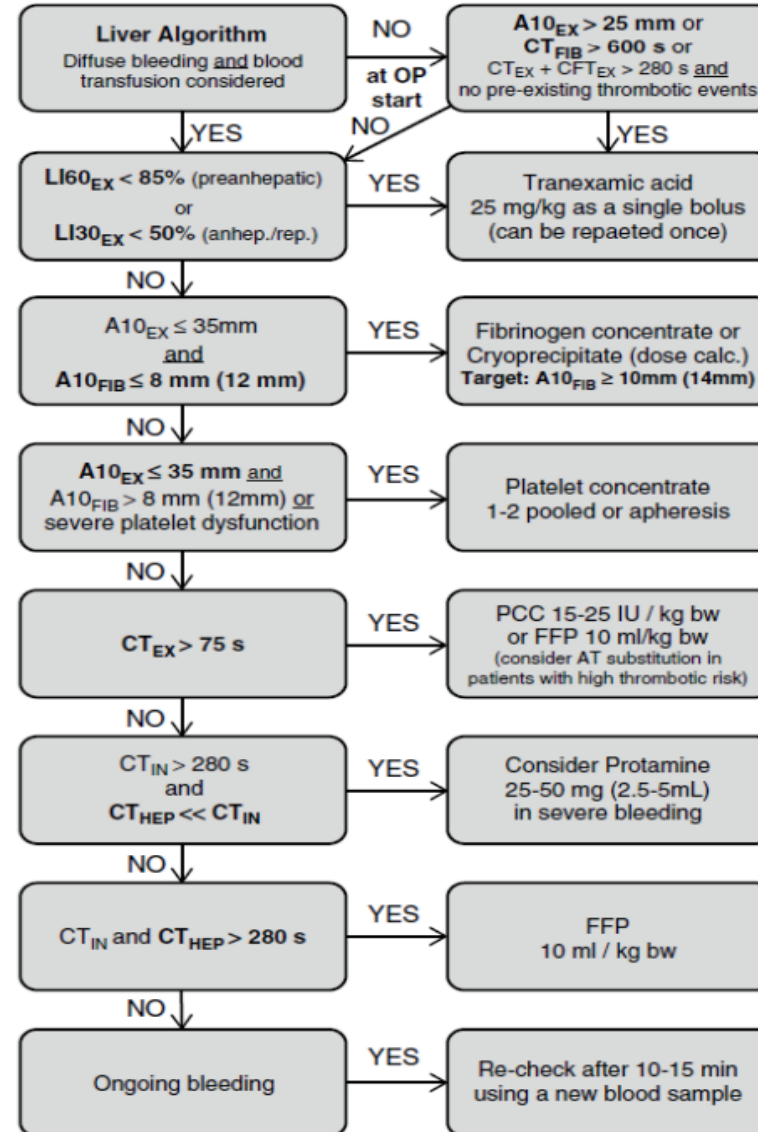
# Le esigenze trasfusionali nel TdF: quali strategie



## Algoritmo

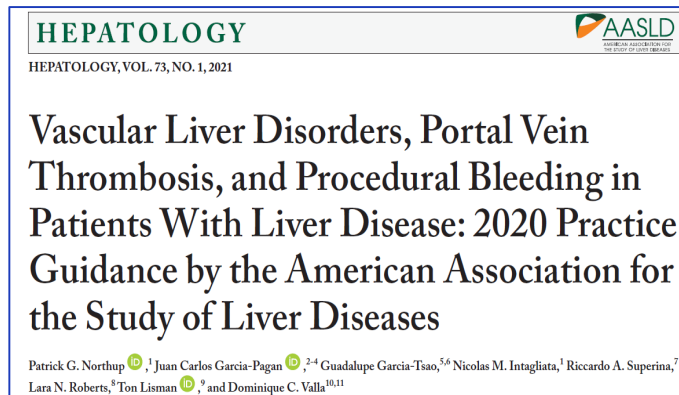
- *cosa*
- *quanto*
- *quando*

TEG®

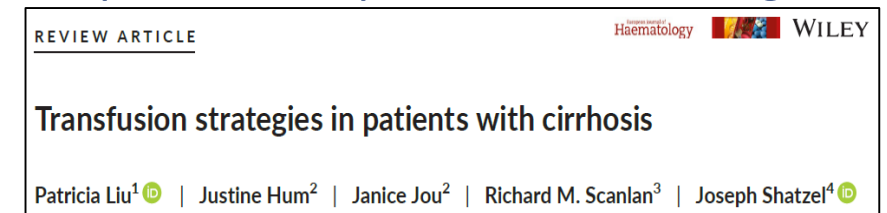




- \* mantenere livelli di fibrinogeno superiori a 100-120 mg/dL è una misura proposta da diverse società e gruppi di esperti nell'ambito di emorragia acuta nel cirrotico
- \* *Sul campo, la disponibilità di concentrati di **Fibrinogeno** rende spesso questo la prima scelta (efficacia/volume) Vs PFC*
- \* Ruolo dei **PCC** non ancora ben definito in pazienti con cirrosi
- \* PROTON Trial in Corso (studio randomizzato-controllato: PCC Vs placebo in profilassi emorragia in Tx Fegato)



## Diffusione VETs Uso farmaci “pro-coagulanti”



*Eur J Haematol.* 2020;104:15–25

### GUIDANCE STATEMENTS

- Low fibrinogen levels have been associated with increased bleeding risk in critically ill patients with cirrhosis.
- Cryoprecipitate and fibrinogen factor replacements are low-volume products effective at increasing fibrinogen levels.

Prothrombin complex concentrates targeting both the deficiency of the procoagulant system as well as the acquired deficiency of the innate anticoagulant system are under study in patients with liver disease,<sup>(85,86)</sup> but efficacy and safety data are lacking to date.

# Le esigenze trasfusionali nel TdF: quali strategie

*“Liver transplant patients represent a unique challenge for predicting significant haemorrhage and transfusion needs”*

## Predictive Modeling of Massive Transfusion Requirements During Liver Transplantation and Its Potential to Reduce Utilization of Blood Bank Resources

Aliaksei Pustavoitau, MD, MHS,\* Maggie Lesley, MD,\* Promise Ariyo, MD, MPH,\* Asad Latif, MD, MPH,\* April J. Villamayor, MD,\* Steven M. Frank, MD,\* Nicole Rizkalla, MD,\* William Merritt, MBA, MD,\* Andrew Cameron, MD, PhD,† Nabil Dagher, MD,† Benjamin Philosophe, MD, PhD,† Ahmet Gurakar, MD,‡ and Allan Gottschalk, MD, PhD\*

Anesth Analg 2017;124:1644–52

## Derivation of a Risk Index for the Prediction of Massive Blood Transfusion in Liver Transplantation

Stuart A. McCluskey,<sup>1,2</sup> Keyvan Karkouti,<sup>1,3</sup> Duminda N. Wijesundera,<sup>1</sup> Karen Kakizawa,<sup>1</sup> Mohammed Ghannam,<sup>1</sup> Ahmed Hamdy,<sup>1</sup> David Grant,<sup>2</sup> and Gary Levy<sup>2</sup>

<sup>1</sup>Department of Anesthesia and Pain Management, <sup>2</sup>Multivisceral Transplant Program, University Health Network, and <sup>3</sup>Health Policy, Management, and Evaluation, University of Toronto, Toronto, Ontario, Canada

*Liver Transpl* 2006;12:1584-93

Variable	Description
Age (yr)	> 40
Hemoglobin (g/dL)	<10.0 g/L
INR	>2.0
	1.2-2.0
Platelet ( $\times 10^9/L$ )	$\leq 70$
Creatinine ( $\mu\text{mol/mL}$ )	Women > 110
	Men > 120
Albumin (g/L)	$\leq 24$
Repeat transplantation	

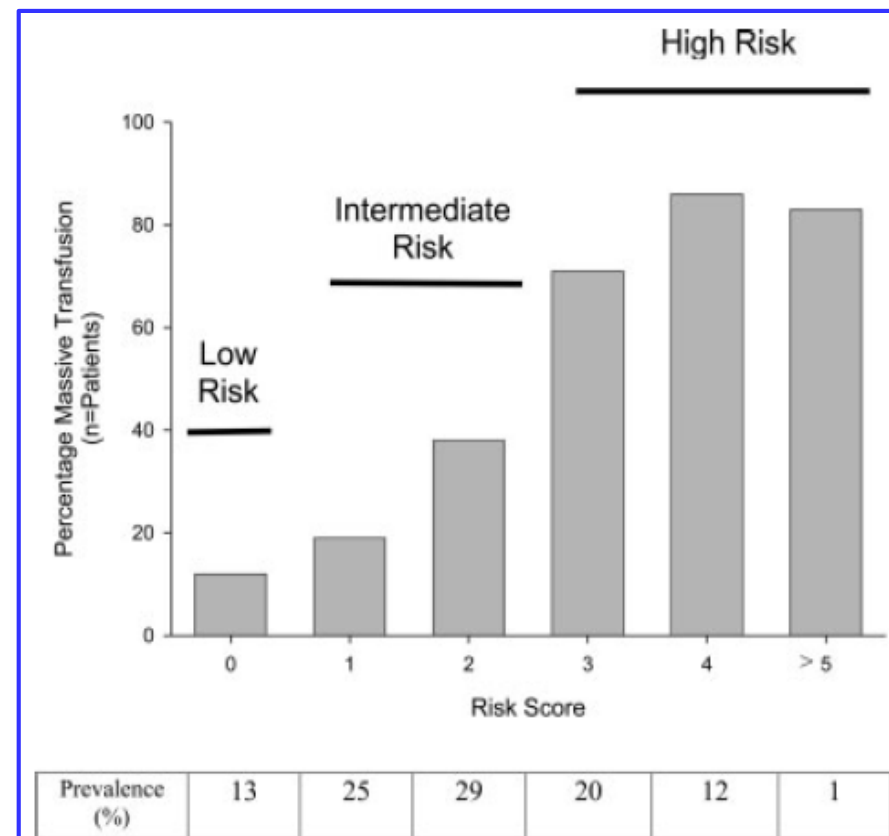


Figure 2. Rate of massive RBC transfusion ( $\geq 6$  units) within the first 24 hours from skin incision, and risk index (n = 460).

## Independent Validation of a Model Predicting the Need for Packed Red Blood Cell Transfusion at Liver Transplantation

*Luc Massicotte,<sup>1,4</sup> Umberto Capitanio,<sup>2</sup> Danielle Beaulieu,<sup>1</sup> Jean-Denis Roy,<sup>1</sup> André Roy,<sup>3</sup> and Pierre I. Karakiewicz<sup>2</sup>*




[Transplantation](#). 2009;88:386–91

## Predictive Modeling of Massive Transfusion Requirements During Liver Transplantation and Its Potential to Reduce Utilization of Blood Bank Resources

Aliaksei Pustavoitau, MD, MHS,\* Maggie Lesley, MD,\* Promise Ariyo, MD, MPH,\* Asad Latif, MD, MPH,\* April J. Villamayor, MD,\* Steven M. Frank, MD,\* Nicole Rizkalla, MD,\* William Merritt, MBA, MD,\* Andrew Cameron, MD, PhD,† Nabil Dagher, MD,† Benjamin Philosophe, MD, PhD,† Ahmet Gurakar, MD,‡ and Allan Gottschalk, MD, PhD\*

[Anesth Analg](#). 2017;124(5):1644–52.

## Blood products and liver transplantation: A strategy to balance optimal preparation with effective blood stewardship

Christopher J. Little<sup>1</sup>  | Glen E. Levenson<sup>2</sup> | Laura L. Hammel<sup>3</sup> | Joseph P. Connor<sup>4</sup>  | David P. Al-Adra<sup>1</sup> 

[Transfusion](#). 2022;62:2057–2067.

## M&M:

- 660 pazienti sottoposti a TdF a Pisa
- periodo dello studio: 2018-2022
- dataset: matrice di 670x43 variabili

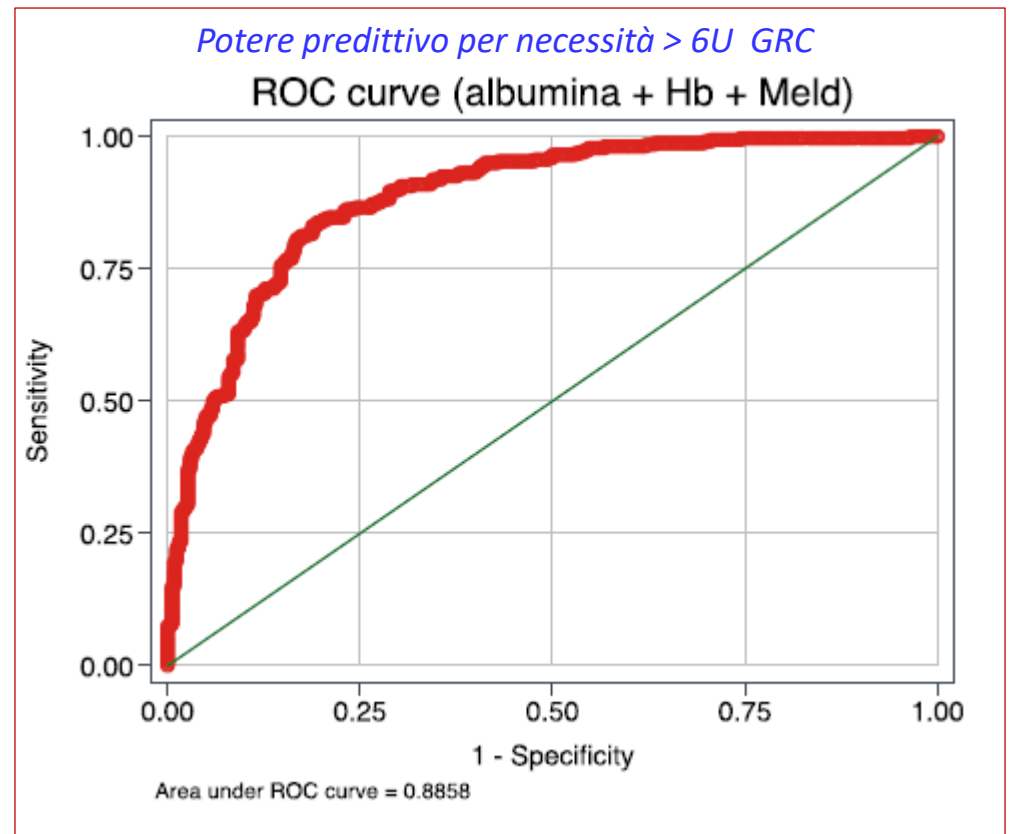


```
. logistic MBT_group Meld albumine Hb
```

```
Logistic regression      Number of obs   =      660
                          LR chi2(3)              =     351.44
                          Prob > chi2              =     0.0000
Log likelihood = -281.45502  Pseudo R2       =     0.3844
```

MBT_group	Odds Ratio	Std. Err.	z	P> z	[95% Conf. Interval]	
Meld	1.145659	.0270991	5.75	0.000	1.093758	1.200022
albumine	.5286992	.0926066	-3.64	0.000	.3750703	.7452544
Hb	.5872653	.0346183	-9.03	0.000	.5231877	.6591909
_cons	770.537	775.2319	6.61	0.000	107.252	5535.813

## McCluskey Risk Index 'Pisa modified'







Original Investigation | Surgery

## Development and Validation of a Prediction Model for Need for Massive Transfusion During Surgery Using Intraoperative Hemodynamic Monitoring Data

Seung Mi Lee, MD, PhD; Garam Lee, PhD; Tae Kyong Kim, MD, PhD; Trang Le, PhD; Jie Hao, PhD; Young Mi Jung, MD; Chan-Wook Park, MD, PhD; Joong Shin Park, MD, PhD; Jong Kwan Jun, MD, PhD; Hyung-Chul Lee, MD, PhD; Dokyoon Kim, PhD

### Preoperative Features

Preoperative features, such as patient demographic information and preoperative  
were also collected from EHRs. The preoperative features used for model construction  
baseline demographic factors, including age, sex, weight, height, underlying medical  
as hypertension, diabetes, tobacco use, prior disease, chronic obstructive pulmonary  
asthma, heart disease, thyroid disease, renal disease, hematologic disease, neurological  
neurologic disease or pregnancy, and the American Society of Anesthesiologists physical  
classification; (2) features associated with the operation, including department of  
planned type of anesthesia; and (3) preoperative laboratory tests, including hemoglobin  
platelet counts, albumin, alanine aminotransferase, aspartate aminotransferase, electrolytes,  
glucose, high-density lipoprotein, blood urea nitrogen, creatinine, prothrombin time,  
partial thromboplastin time, and the estimated glomerular filtration rate.

### Intraoperative Features

Among intraoperative vital sign records from VitalDB, 3 types of data sources were utilized: (1) intra-arterial blood pressure waveforms; (2) oxygen saturation (SpO<sub>2</sub>) from the patient monitor (Solar 8000 M, GE Healthcare); (3) The ST segment elevation read from electrocardiography waveforms.

From the intra-arterial waveform, we used the waveform factorization algorithm publicly provided by VitalDB. The following measures were calculated from the arterial pressure waveform (Figure 2): (1) blood pressure (BP): systolic BP, diastolic BP, and the mean BP; (2) heart rate; and (3) the area under the arterial waveform in each cardiac beat.

During the operation, hematocrit levels were measured at the discretion of the anesthesiologist. The baseline hematocrit levels and intraoperative hematocrit levels were also used to develop the prediction model.

from many data sets.<sup>24-26</sup> Therefore, an appropriate algorithm developed by machine learning may be able to detect early alterations in patterns of patients' continuous hemodynamic signals prior to an event necessitating massive transfusion, which may sometimes be too large to be processed by humans.



December 14, 2022

## Novel Use of a Real-Time Prediction Model to Enhance Early Detection of Need for Massive Transfusion—Artificial Intelligence Behind the Drapes

Joshua A. Villarreal, MD<sup>1</sup>; Joseph D. Forrester, MD, MSc<sup>1</sup>

Author Affiliations | Article Information

<sup>1</sup>Department of Surgery, Stanford University, Stanford, California

## Applicazione modelli AI + ML

Intraoperative massive hemorrhage can be associated with high mortality if not treated promptly.<sup>1</sup> Lee et al<sup>2</sup> conducted a prognostic study incorporating intraoperative hemodynamic monitoring data into a validated artificial intelligence (AI)-assisted massive transfusion prediction model. The authors compared the ability of an AI prediction model using intraoperative hemodynamic monitoring with a current reference-standard model (using only preoperative data) to detect need for massive transfusion intraoperatively—10 minutes before the need for massive transfusion occurred.<sup>2</sup> The massive transfusion index prediction model outperformed the standard model in the internal and external validation single-center cohorts (area under the receiver operating characteristic curve, 0.972 vs area under the curve, 0.824).<sup>2</sup> The authors' novel use of real-time intraoperative data to predict upcoming need for a massive transfusion is intriguing and pushes the limits of most current AI clinical applications.

# Le esigenze trasfusionali nel TdF: quali strategie



omogeneità di gestione



aumento appropriatezza



riduzione sprechi



contenimento consumi da CT



miglioramento esiti globali di TdF

## Il PBM nel TdF

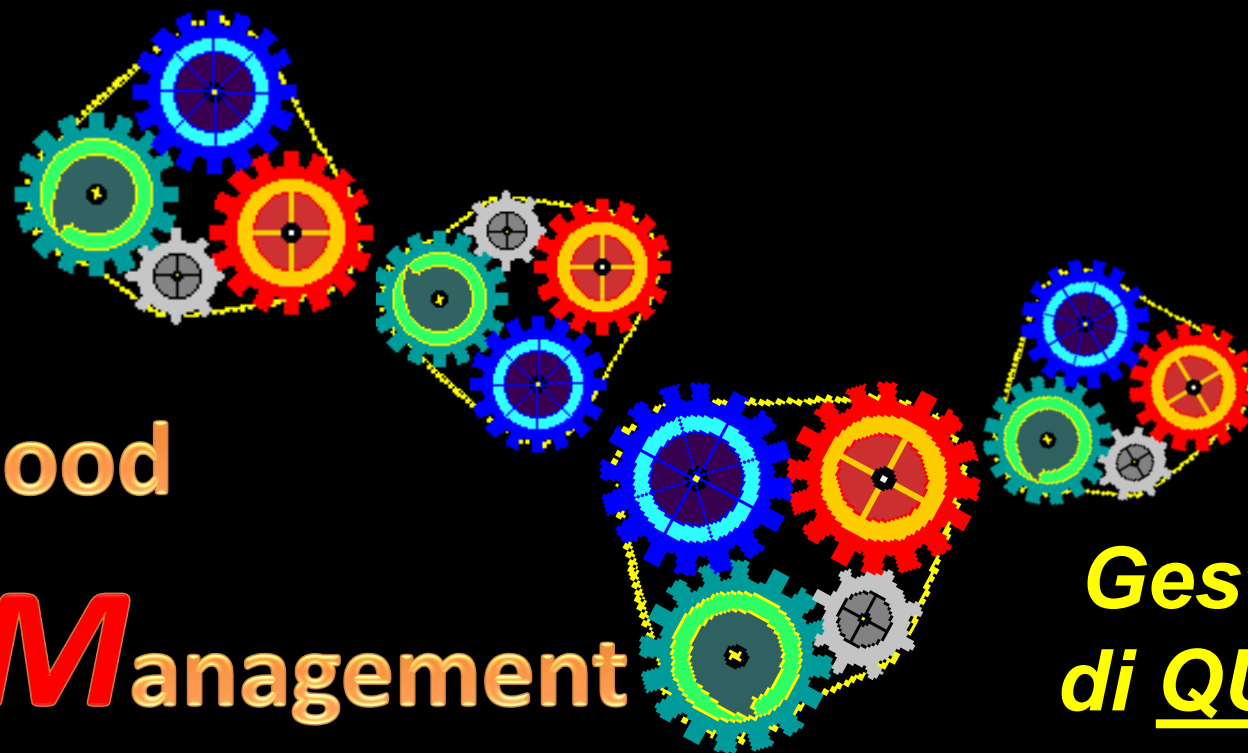
# Le esigenze trasfusionali nel TdF: quali strategie

**Evidenze/Conoscenze EBM**

**P**atient

**B**lood

**M**anagement



**Gestione clinica  
di QUEL paziente**

**Il PBM nel TdF**

nel TdF l'implementazione del PBM non è nè semplice nè facile e necessita di:

- impegno (*istituzionale & personale*)
- **attitudine**





# Le esigenze trasfusionali nel TdF: quali strategie

- Anemia nel candidato a TdF
- Tecniche per il risparmio di sangue
  - Chirurgiche (VVBP)*
  - Anestesiologiche (monitoraggio)*
- Approccio *goal-directed* alla coagulopatia
- Intelligenza Artificiale

**Il PBM nel TdF: spunti per la discussione**





The NEW ENGLAND JOURNAL of MEDICINE

## The Coagulopathy of Chronic Liver Disease

Armando Tripodi, Ph.D., and Pier Mannuccio Mannucci, M.D.

N Engl J Med 2011;365:147-56

*“cirrhotic patients do not have an inherent bleeding diathesis but rather a **rebalanced status** since both PRO and ANTI coagulant drivers are reduced”*

1

*“Coagulation laboratory tests are not reliable in assessing the risk of surgical bleeding”*

### Goal-directed Management of Coagulation: The Right Treatment, the Right Patient, the Right Time

Yanik J. Bababekov, MD, MPH,<sup>1</sup> Trevor L. Nydam, MD,<sup>2</sup> James J. Pomposelli, MD, PhD,<sup>2</sup> and Hunter B. Moore, MD<sup>2</sup>

Transplantation. 2018;102:e303-e304

2

*“The concept of rebalanced hemostasis in patients with liver disease has, to some extent, led to enormous changes in hemostatic management both in prophylaxis and therapy”*

### Treatment of bleeding in patients with liver disease

Patrick G. Northup<sup>1</sup> | Ton Lisman<sup>2</sup> | Lara N. Roberts<sup>3</sup>

Thromb Haemost. 2021;19:1644–1652