# Atteintes rénales associées aux cardiopathies congénitales

Mirela Bojan, MD. PhD.
Anesthésie et Réanimation
Pôle Cardiopathies Congénitales

*m.bojan@ccml.fr*

Hôpital
Marie Lannelongue

UNIVERSITÉ
PARIS-SUD 11

**Insuffisance rénale aiguë**

**Epidemiologie**

**Physiopathologie**

**Diagnostic**

**Prévention**

**Traitement**

**Insuffisance rénale chronique**

# A CASE OF CRUSH INJURY WITH RENAL FAILURE

BY

D. BEALL, Ph.D.

AND

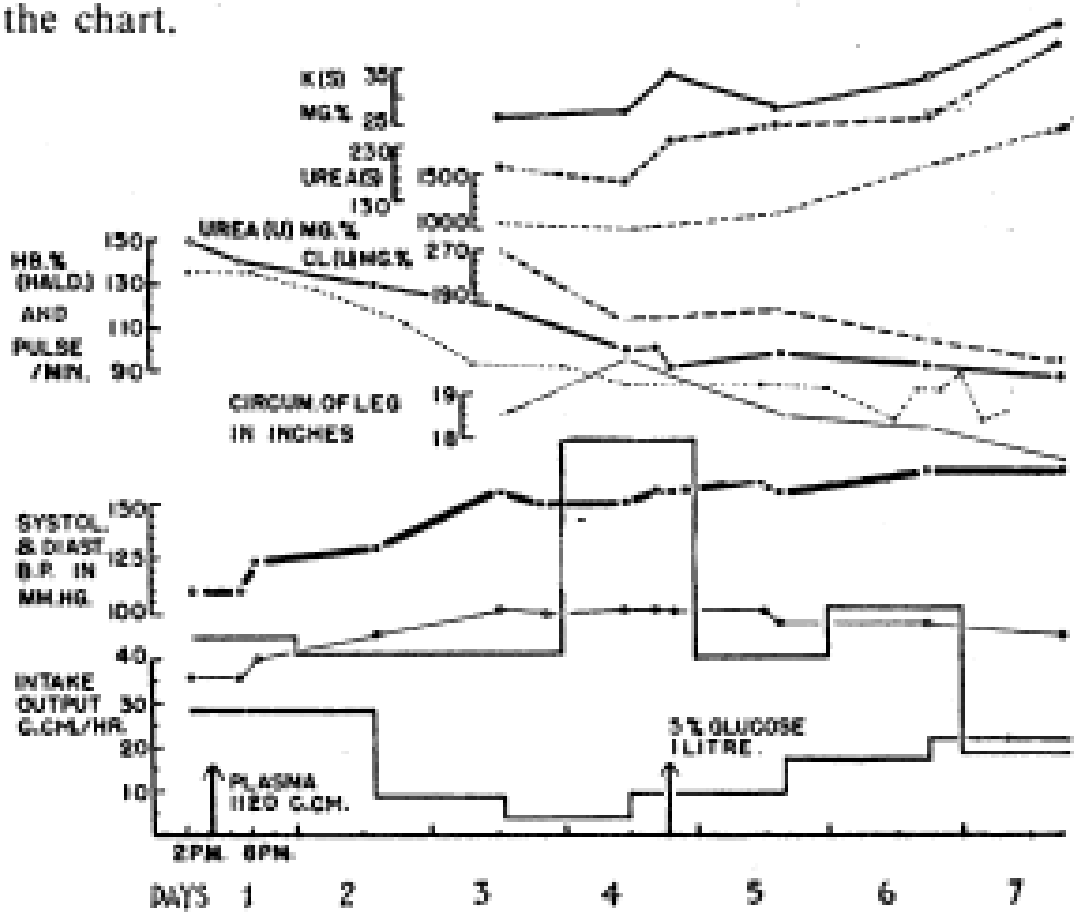
E. G. L. BYWATERS, M.B., M.R.C.P.
*British Postgraduate Medical School*

R. H. R. BELSEY, F.R.C.S.

AND

J. A. R. MILES, M.A., M.B., B.Ch.
*St. Thomas's Hospital*

fluid balance, pulse rate, and blood-pressure readings, in the chart.



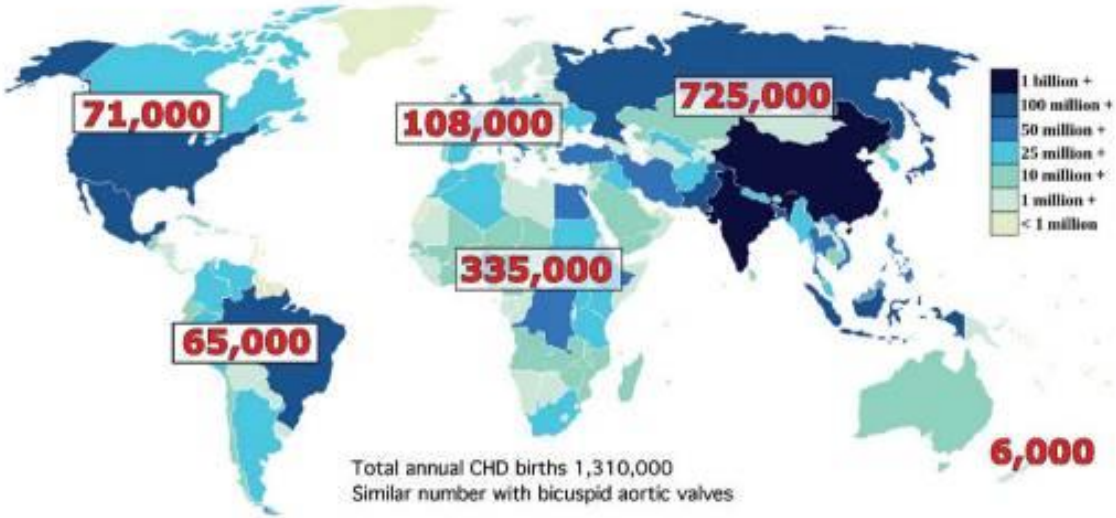



**Fig. 2. Total annual births of children with congenital heart disease by continent, based on Table 1 and data on total births. The panel at the side indicates the population ranges of the different countries.**

L'indidence de l'IRA postopératoire modérée/sévère est ≈ 6 par 1000

*J Hoffman, Cardiovasc J Afr 2013*

## Risk Factors for and Outcomes of Acute Kidney Injury in Neonates Undergoing Complex Cardiac Surgery

264 nouveau-nés avec chirurgie cardiaque
Incidence IRA = **64%**

| Risk factor | Adjusted OR [95% CI] |
|---|---|
| Age at surgery (days) | 0.97 [0.95 – 0.99] |
| Gestational age (weeks) | 0.83 [0.69 – 0.99] |

*Morgan, J Pediatr 2013*

# IRA grave nécessitant le recours à la dialyse

Studies reporting post-operative acute renal failure (ARF) treated with peritoneal dialysis in children operated on for congenital heart disease.

| Reference | Location | Year | ARF (%) | Mortality in ARF patients (%) | *n* | Study design |
|---|---|---|---|---|---|---|
| Rigden et al. (10) | UK, London | 1982 | 5.3 | 50 | 456 | Prospective |
| Baxter et al. (2) | UK, London | 1985 | 4.0 | 72 | 441 | Retrospective |
| Gomez-Campdera et al. (7) | Spain, Madrid | 1988 | 9.0 | 75 | 156 | Retrospective |
| Hanson et al. (8) | USA, Colorado, Denver | 1989 | 7.7 | 67 | 338 | Retrospective |
| Shaw et al. (11)* | UK, Leeds | 1991 | 2.9 | 68 | 1181 | Retro-prospective |
| Vricella et al. (13)† | USA, California | 1992 | 22.0 | 30 | 45 | Retrospective |
| Giuffre et al. (6) | Canada, Toronto and Calgary | 1992 | 1.6 | 58 | 2782 | Retrospective |
| Picca et al. (9) | Italy, Rome | 1995 | 2.7 | 79 | 2262 | Case–control |
| Werner et al. (14) | Canada, Vancouver | 1997 | 5.2 | 47 | 618 | Retrospective |
| Sorof et al. (12) | USA, Texas, Houston | 1999 | 5.0 | 20 | 882 | Retrospective |
| Dittrich et al. (5)‡ | Germany, Berlin | 1999 | 14.0 | 27 | 81 | Prospective |
| Chan et al. (4) | China, Hong Kong | 2003 | 17.0 | 29 | 182 | Retrospective |
| Xinjin et al. (15) | China, Beijing | 2003 | 2.1 | 25 | 576 | Retrospective |
| Boigner et al. (3) | Austria, Vienna | 2004 | 5.4 | 40 | 1141 | Retrospective |
| Baskin et al. (1) | Turkey, Ankara | 2005 | 32.8 | 67 | 64 | Retrospective |
| Present study | Denmark, Aarhus | 2006 | 11.5 | 20 | 1128 | Prospective |

*n*, number of patients included in the study.
*519 were closed heart surgeries. The incidence of ARF after open heart surgery was 3.6%.
†Neonates undergoing heart transplantation.
‡Infants of <1 year using cardiopulmonary bypass during surgery.

*Pedersen, Acta Anaesth Scand 2007*

*Necker : 2000-2008, 3014 interventions concernant 2651 nouveau-nés et nourrissons de moins d'un an, 2176 CEC,115 ARF dialysés (5,2%).*

# L'IRA, est un facteur de risque indépendant de DC postopératoire

**TABLE 3. Factors independently associated with mortality in infants with acute kidney injury**

| Factor | Odds ratio | 95% Confidence interval | *P* value |
|---|---|---|---|
| No AKI | Reference | — | — |
| AKI stage I | 1.3 | 0.4–4.1 | .70 |
| AKI stage II | 5.1 | 1.7–15.2 | .004 |
| AKI stage III | 9.5 | 2.9–30.7 | .0002 |
| Single ventricle | 2.6 | 1.1–6.2 | .03 |
| Circulatory support | 7.0 | 1.8–28 | .006 |

*Blinder, J Cardiovasc Surg 2012*

# Long-term Risk of CKD in Children Surviving Episodes of Acute Kidney Injury in the Intensive Care Unit: A Prospective Cohort Study

| Outcome Variables | AKIN Stage 1 | AKIN Stage 2 | AKIN Stage 3 | Total[a] |
|---|---|---|---|---|
| Microalbuminuria or proteinuria[c] | 2 (4.5) | 5 (10.6) | 5 (14.3) | 12 (9.5) |
| GFR $<$60 mL/min/1.73 $m^{2c}$ | 0 (0) | 0 (0) | 1 (2.9) | 1 (0.8) |
| GFR = 60-90 mL/min/1.73 $m^2$ | 24 (54.5) | 14 (29.8) | 10 (28.6) | 48 (38.1) |
| Hypertension | 0 (0) | 3 (6.4) | 1 (2.9) | 4 (3.2) |
| Hyperfiltration | 1 (2.3) | 6 (12.8) | 4 (11.4) | 11 (8.7) |

*Mammen, Am J Kidney Dis 2012*

Insuffisance rénale aiguë

Epidemiologie

**Physiopathologie**

Diagnostic

Prévention

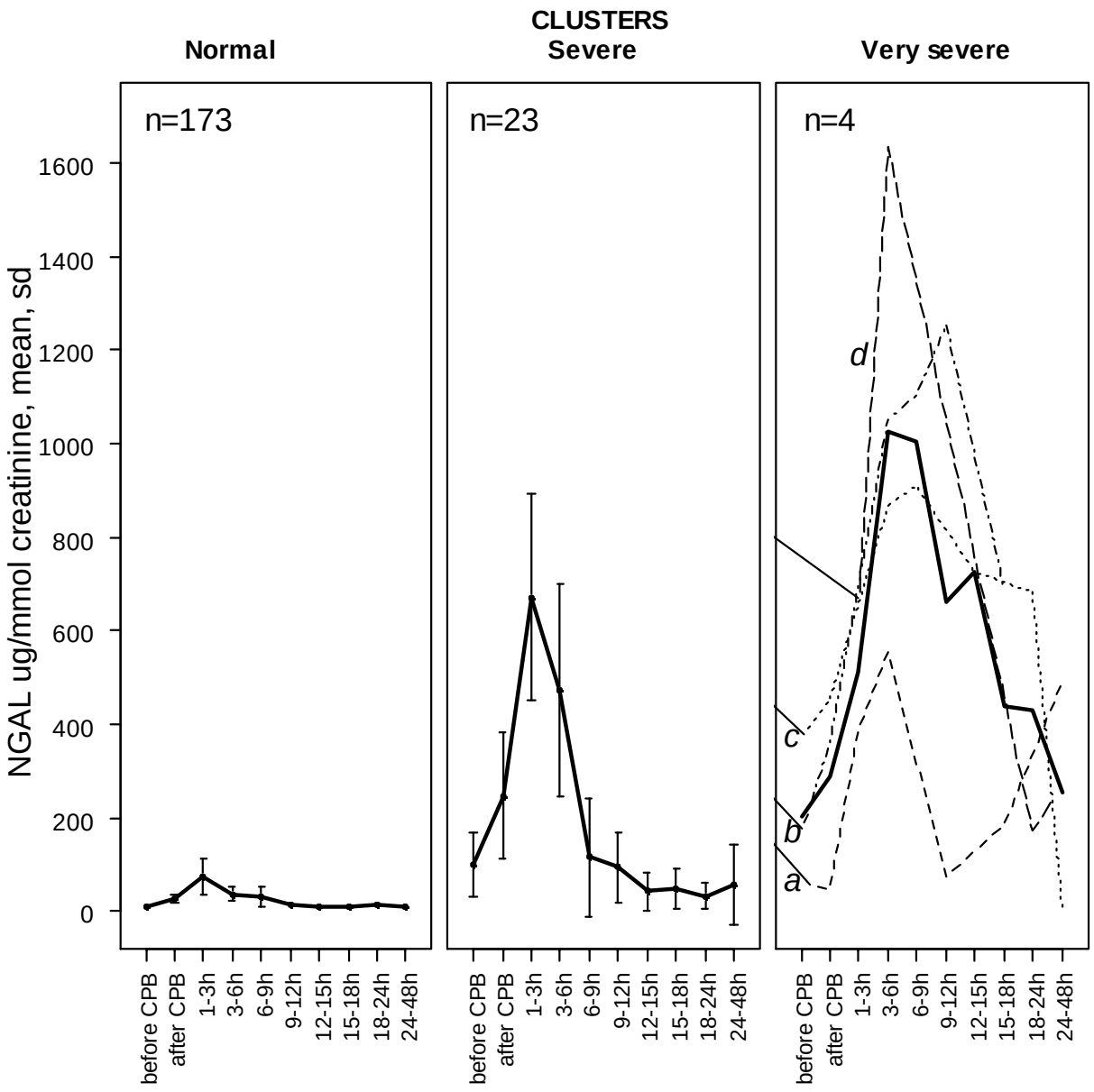
Traitement

Insuffisance rénale chronique

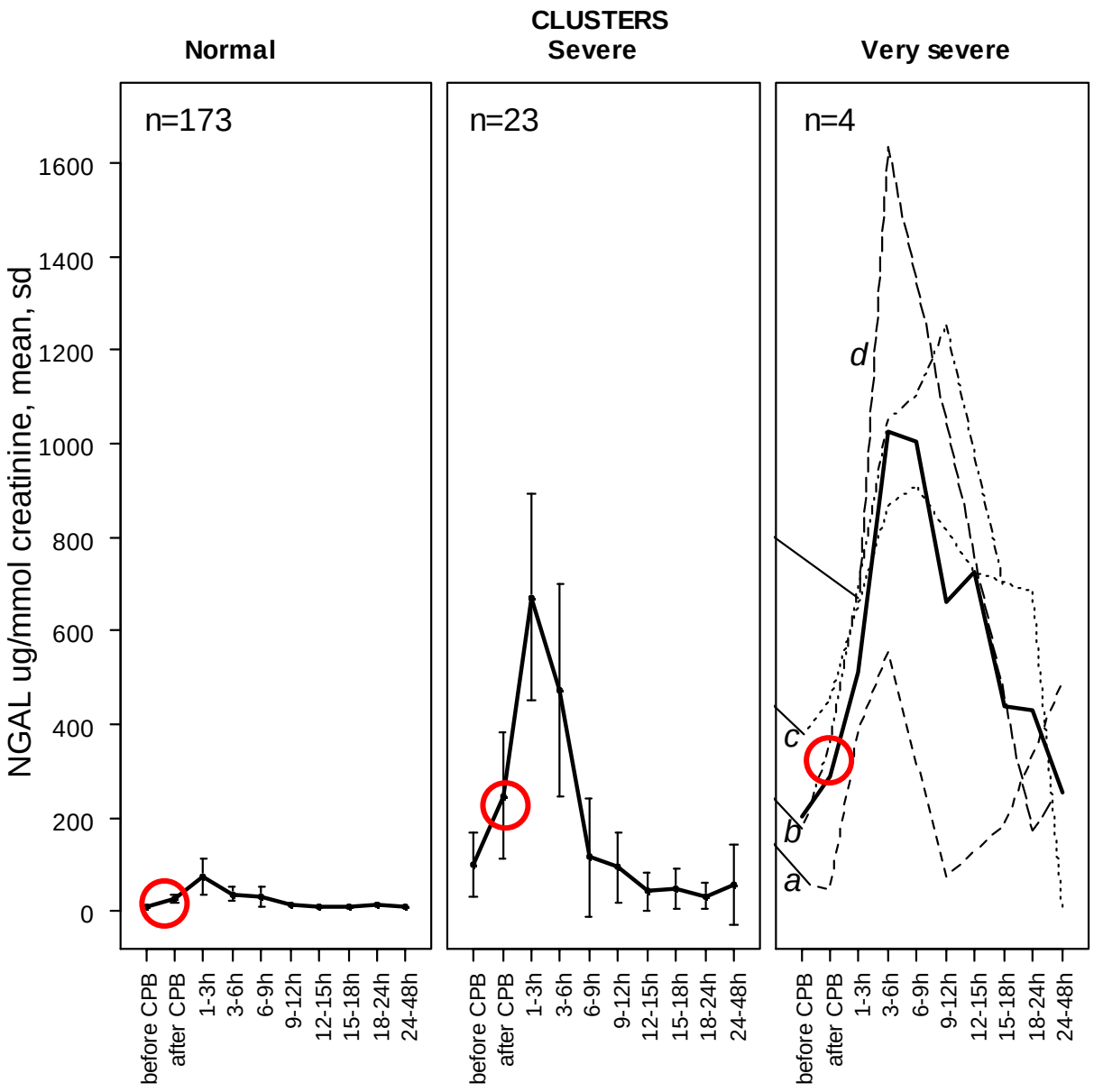
| Glomérule | Tubule rénal |
| --- | --- |
| DFG ≈ filtration d'un volume équivalent à la volémie / 30min | réabsorption tubulaire = 99% du DFG |
| Processus passif (VO2 ↓↓) | représente 90% de la VO2 rénale |
| Débit sanguin cortical / | médullaire ≈ 10 : 1 |
| Ht ≈ Ht systémique | Ht ≈ 50% Ht systémique |
| paO2 = 20-60 mmHg | paO2 = 15-30 mmHg (<15 dans la médullaire profonde) |
| Métabolisme aérobie | Métabolisme anaérobie de la médullaire profonde<br><br>Métabolisme aérobie de la médullaire superficielle -> susceptibilité à l'hypoxie ++++ |

## Adaptation postnatale de la fonction rénale

- Débit sanguin rénal = 10% du débit cardiaque (et de la DO2)
- Fraction d'extraction de l'O2 = 10-15%
- DFG croît de 5 à 40 ml/min/1.73m$^2$ durant la première semaine
- Niveau élevé de l' Angiotensine II et de résistance vasculaire rénale




*Bojan, Clin J Am Soc Nephrol 2014*



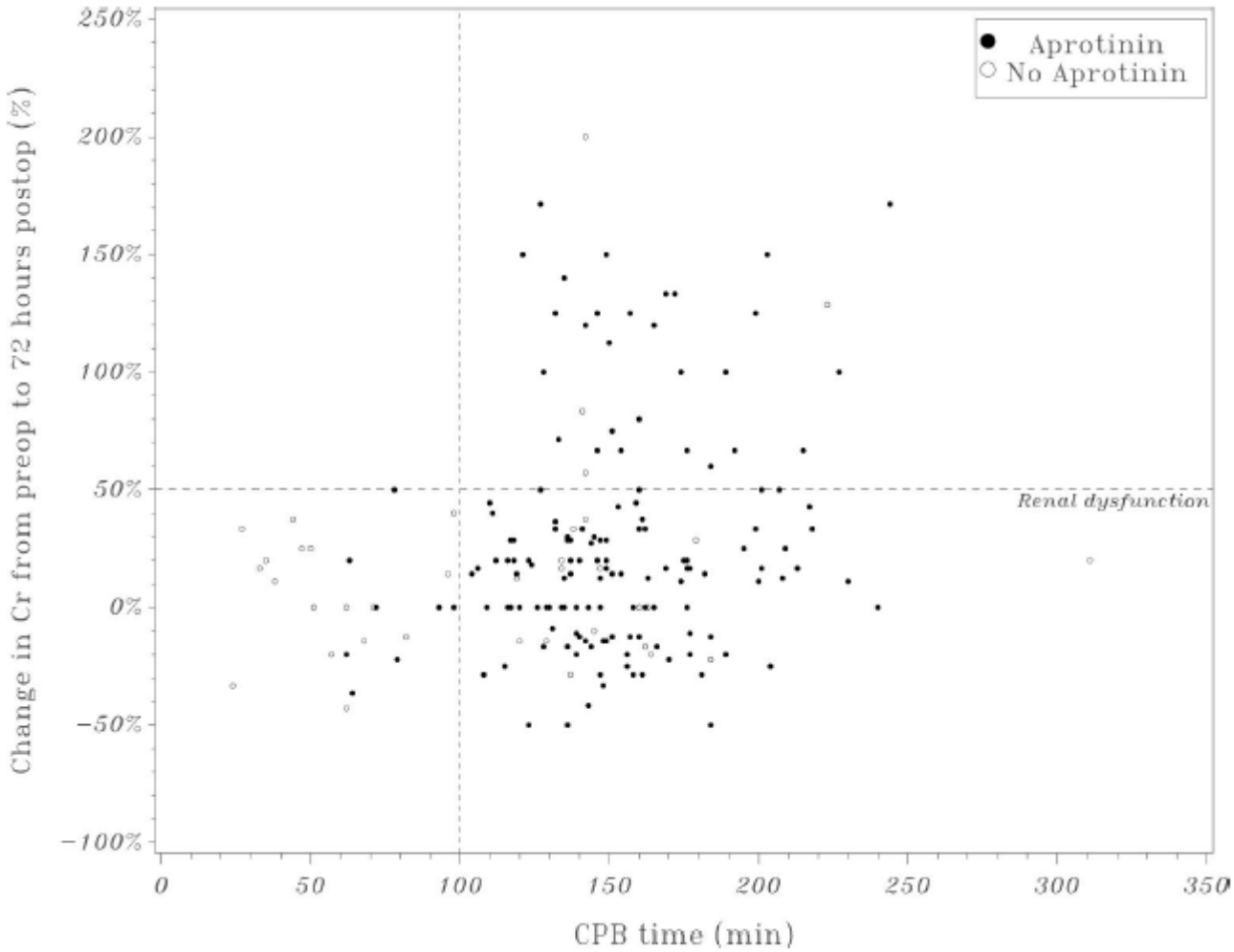

*Bojan, Clin J Am Soc Nephrol 2014*

# Facteurs de risque de l'IRA suivant la chirurgie cardiaque

| Preoperative | Intraoperative | Postoperative |
|---|---|---|
| Lack of renal reserve | Decreased renal perfusion | Systemic inflammation |
| Renovascular disease | hypotension | Reduced LV function |
| Prerenal azotemia | lack of pulsatile flow | Vasoactive agents |
| recent diuresis | vasoactive agents | Hemodynamic instability |
| NPO status | anesthetic effects | Nephrotoxins |
| impaired LV function | Embolic events | Volume depletion |
| ACEI/ARB | CPB-induced inflammation | Sepsis |
| Nephrotoxins | Nephrotoxins | |
| intravenous contrast | free hemoglobin | |
| other medications | | |
| Endotoxemia | | |
| Inflammation | | |

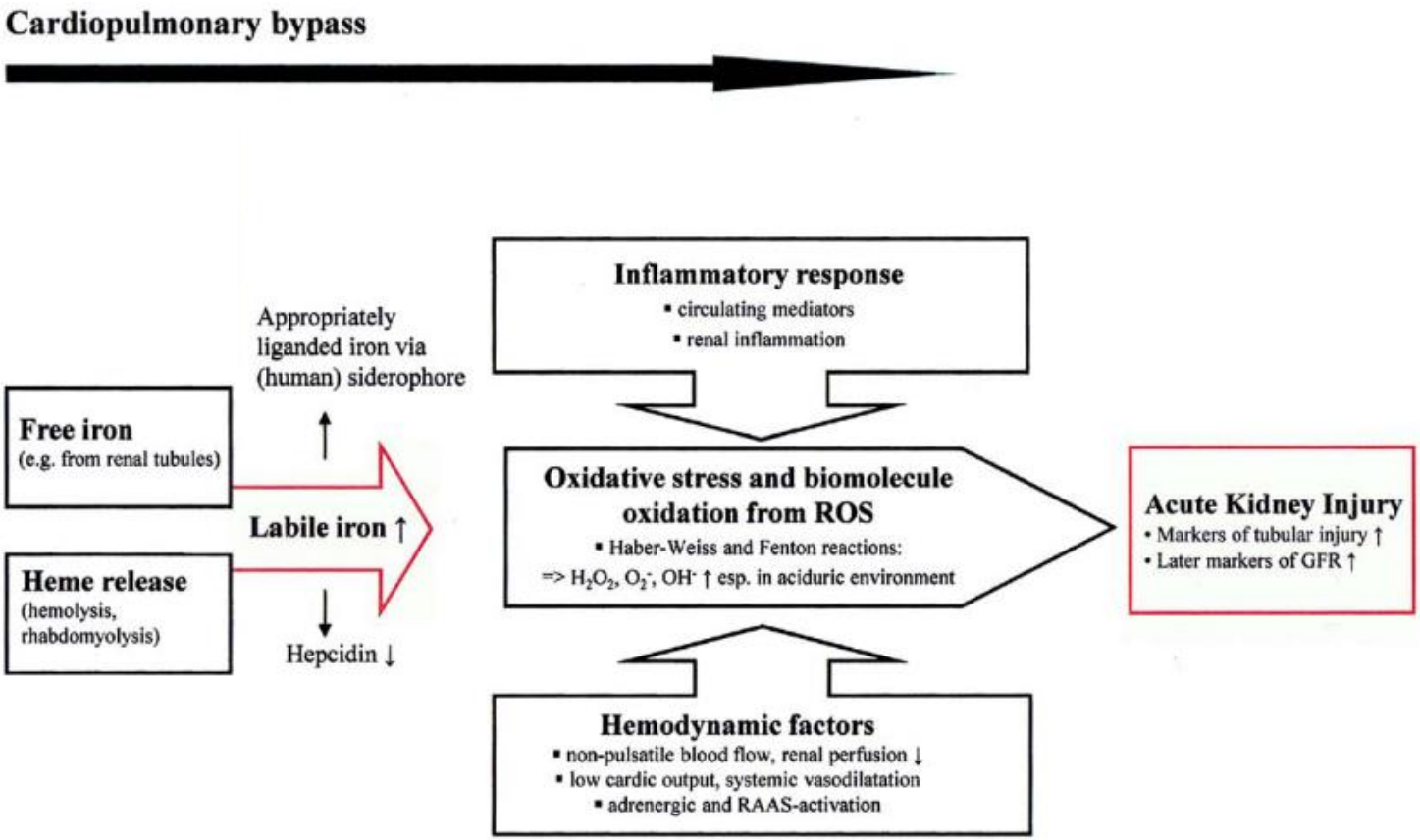
**La lésion initiale est tubulaire**

*Rosner, Clin J Am Soc Nephrol 2006*

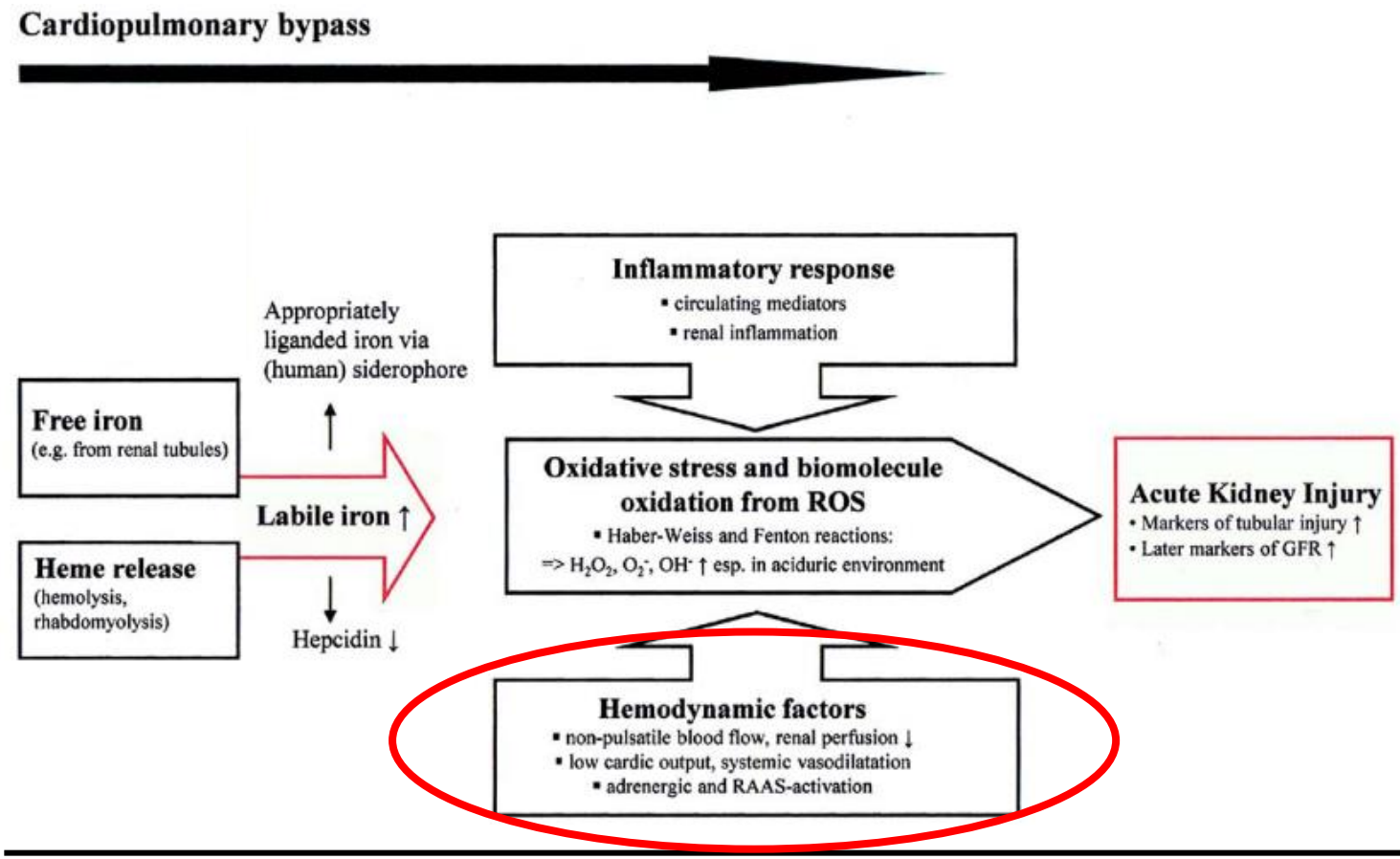



**Adjusted OR of AKI for CPB time : 1.16, 95CI :[1.05-1.29]**

*Guzzetta, Anesth Analg 2009*




Haase, JACC 2010




Haase, JACC 2010

*Am J Physiol Regul Integr Comp Physiol* 292: R1–R17, 2007.
First published September 21, 2006; doi:10.1152/ajpregu.00332.2006.

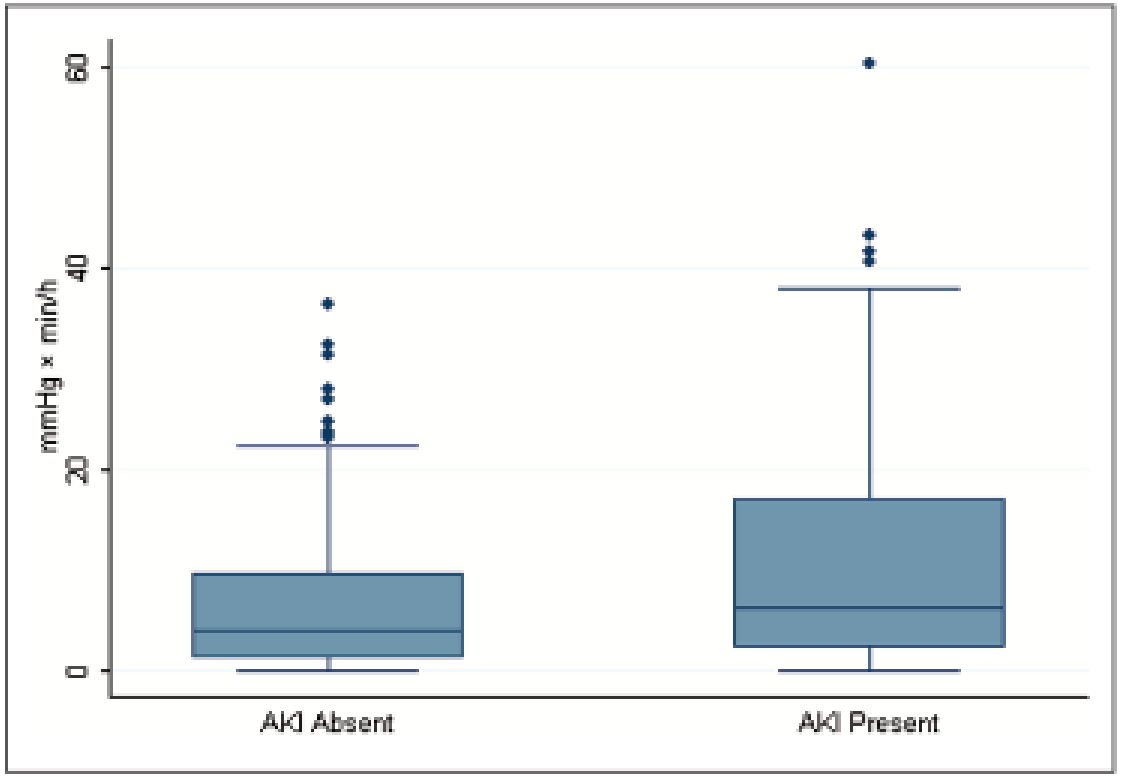
Invited Review

NEW INVESTIGATOR AWARD IN REGULATORY AND INTEGRATIVE PHYSIOLOGY OF THE WATER AND ELECTROLYTE HOMEOSTASIS SECTION, 2006

# Mechanisms of renal blood flow autoregulation: dynamics and contributions

**Armin Just**
*Department of Cell and Molecular Physiology, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina*

| Réponse myogénique | Feedback tubulo-glomérulaire | 3ème mécanisme |
|---|---|---|
| Vasoconstriction de l'artériole afférente en réponse à l'élévation de la pression intraluminale | Vasoconstriction de l'artériole afférente en réponse à l'augmentation de la concentration intraluminale de NaCl au niveau de la macula densa | ?……<br><br>vasodilatation lors de chutes du DSR |
| <10 sec | < 1 min | < 1 min |
| -> régulent la balance hydro-électrolytique<br>-> protègent l'intégrité du glomérule<br>-> régulent la VO2 rénale | | |

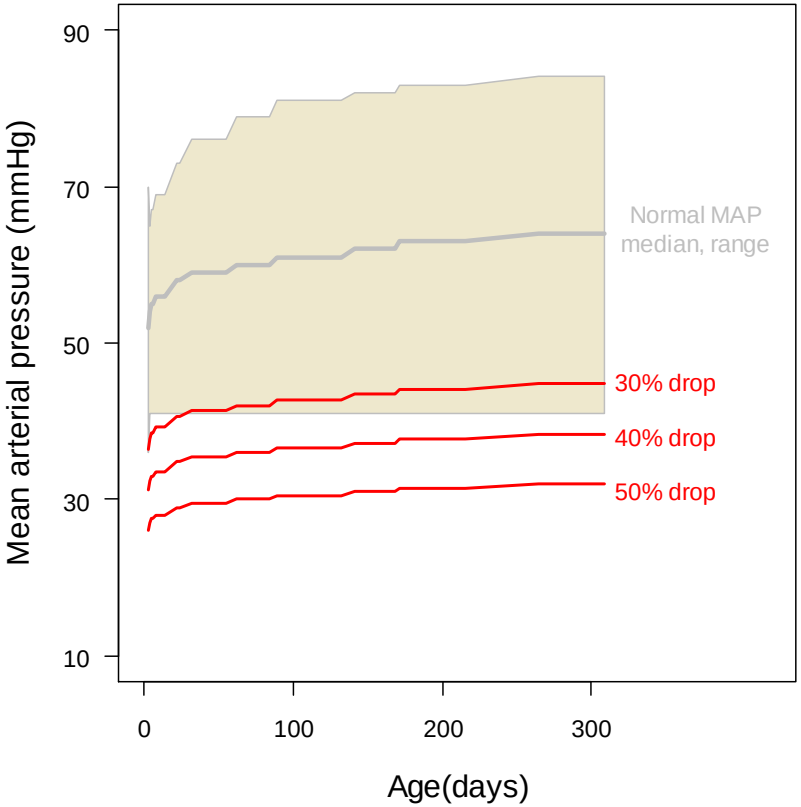



Ono, Crit Care Med 2013

**Low perfusion pressure is associated with renal tubular injury in infants undergoing cardiac surgery with cardiopulmonary bypass**

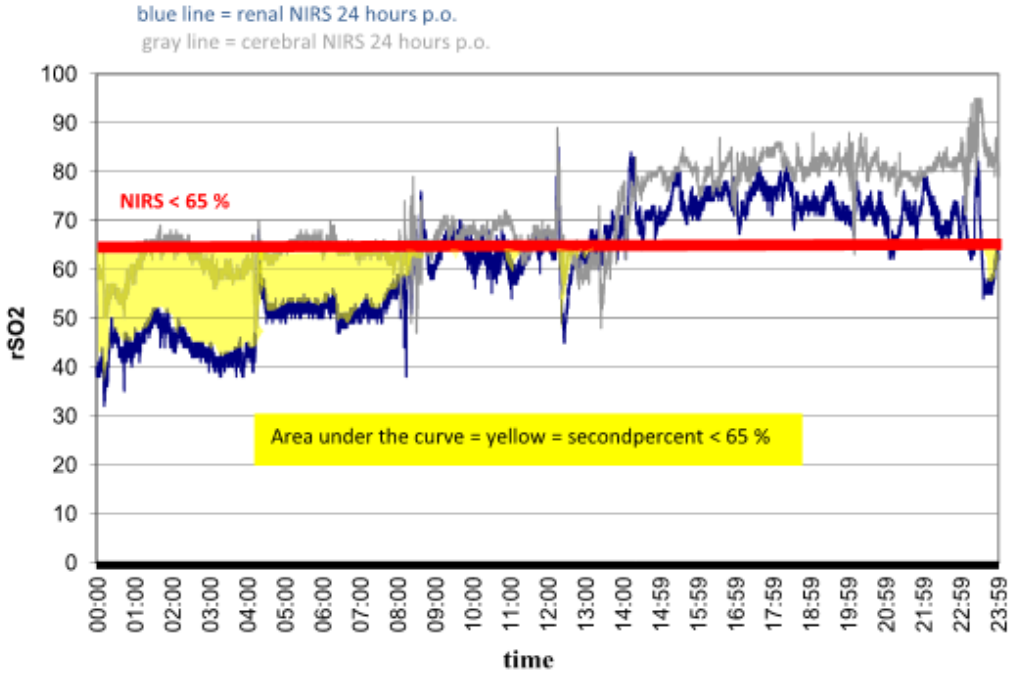
drop. A more than 40% pressure drop for 19.5 min provided a 0.65 negative predictive value for high uNGAL, and a more than 50% pressure drop for 5.4 min provided a 0.67 negative predictive value. The link between uNGAL

$DO_2 = 354.31 \pm 129.84$ ml min$^{-1}$ m$^{-2}$



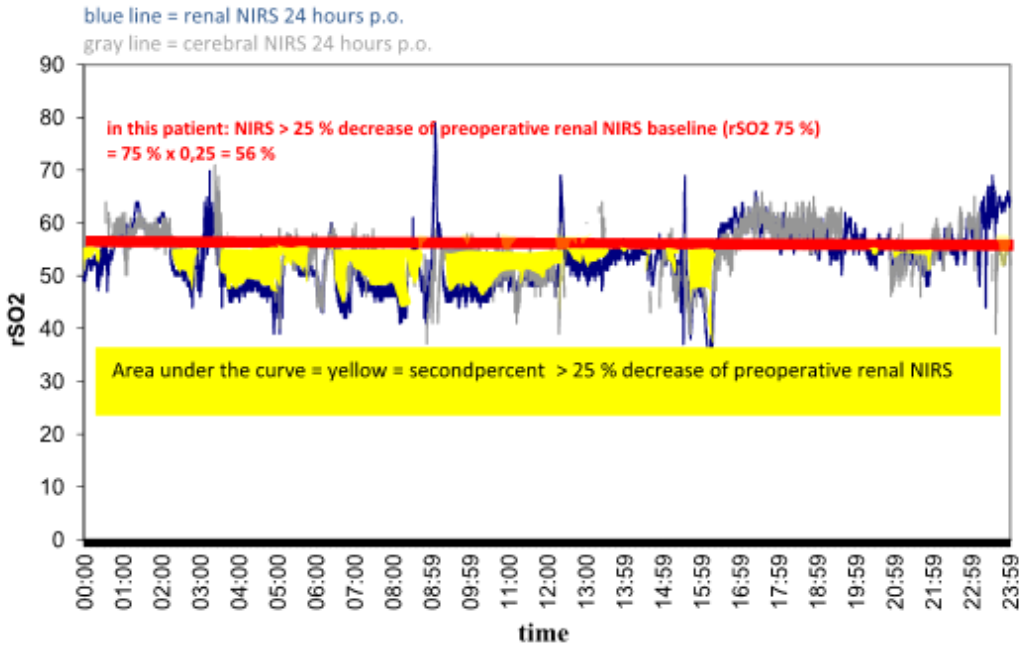

Bojan, Eur J Anesthesiol 2018

Intraoperative renal near-infrared spectroscopy indicates developing acute kidney injury in infants undergoing cardiac surgery with cardiopulmonary bypass: a case–control study



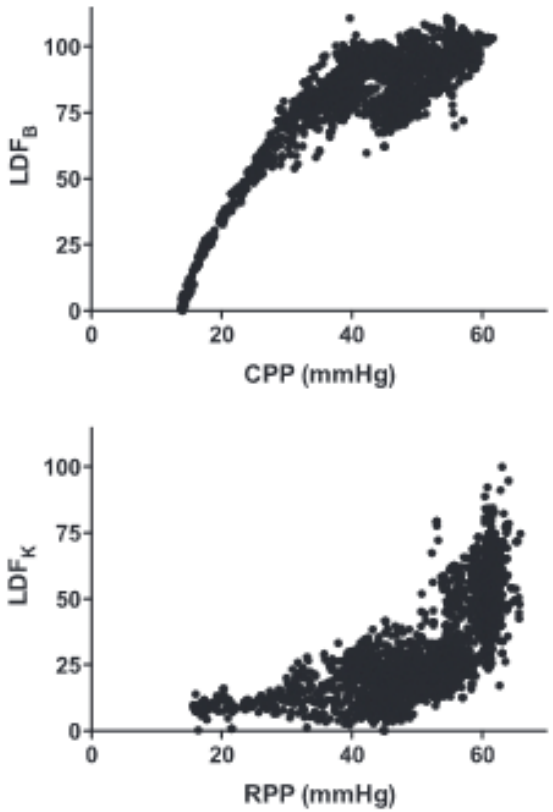

Ruf, Crit Care 2015

Intraoperative renal near-infrared spectroscopy indicates developing acute kidney injury in infants undergoing cardiac surgery with cardiopulmonary bypass: a case–control study



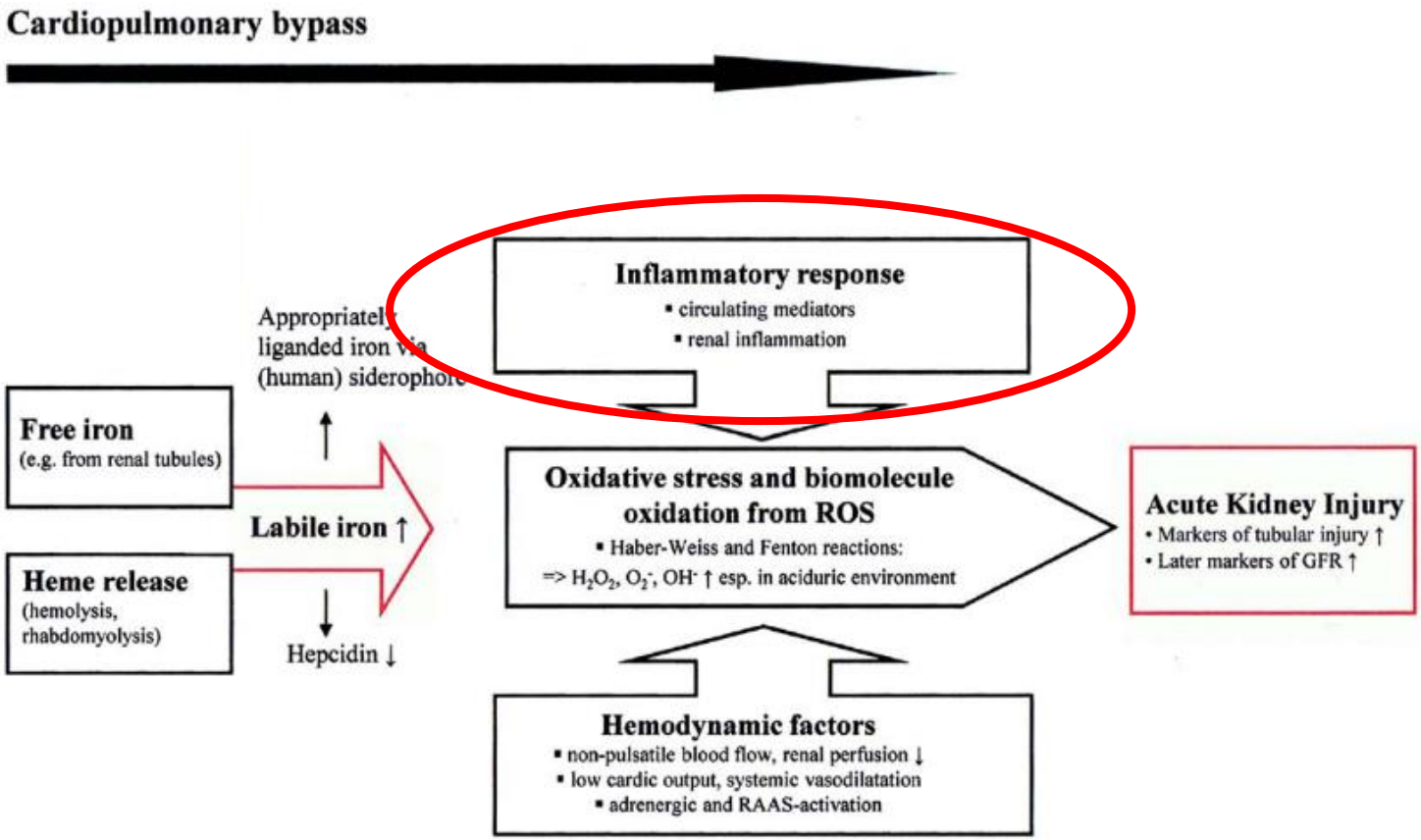

Ruf, Crit Care 2015

Renovascular reactivity measured by near-infrared spectroscopy

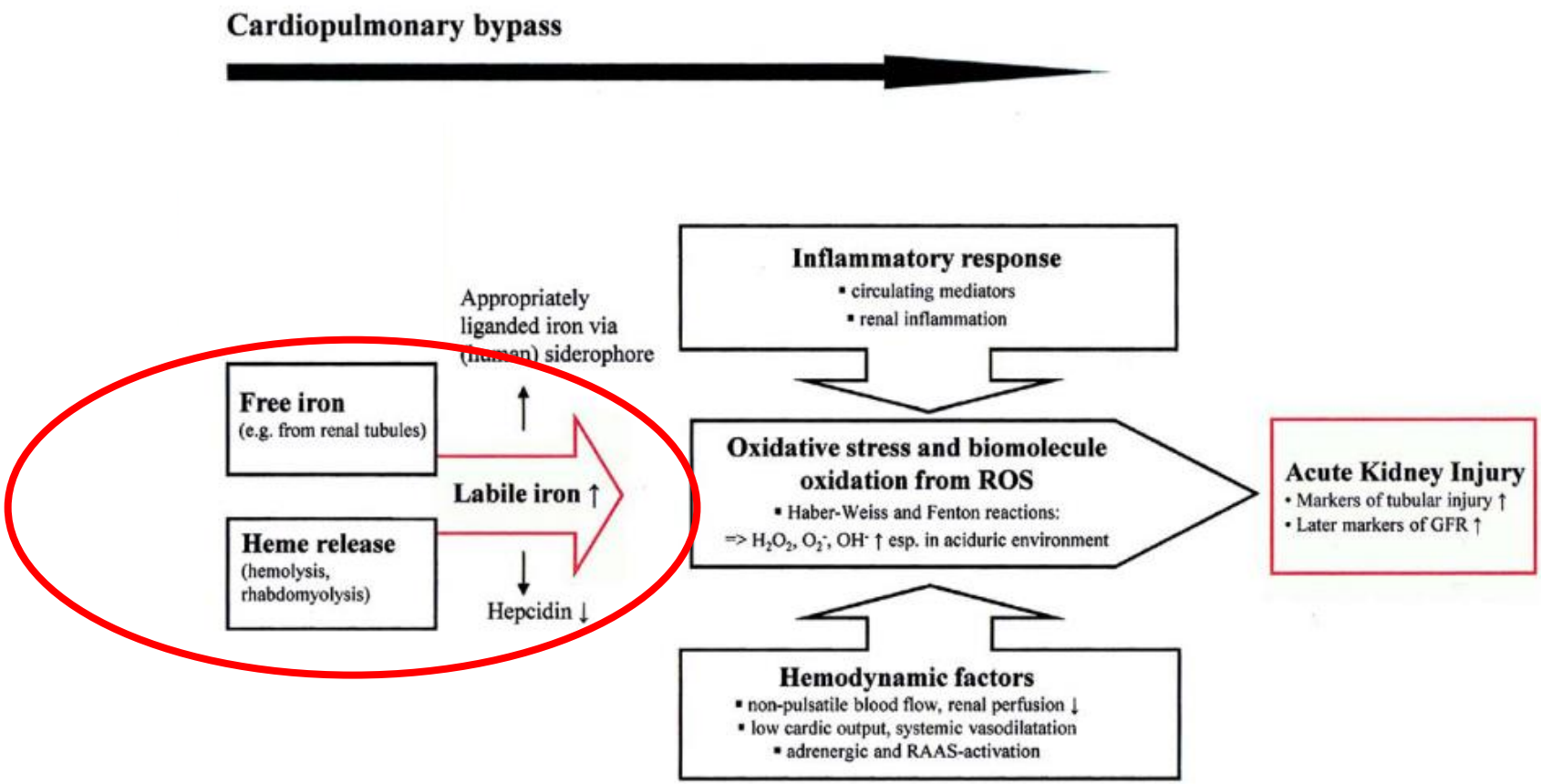



compared with cerebral laser-Doppler measurements. Renal blood flow decreased to 75%, 50%, and 25% of baseline at perfusion pressures of 60, 45, and 40 mmHg, respectively, whereas in the brain these decrements occurred at pressures of 30, 25, and 15 mmHg, respectively. The RVx compared favorably to the renal laser-Doppler

Rhee, J Appl Physiol 2012




Haase, JACC 2010




Haase, JACC 2010

Journal of the American College of Cardiology
Vol. 55, No. 19, 2010
ISSN 0735-1097/$36.00
doi:10.1016/j.jacc.2009.12.046
© 2010 by the American College of Cardiology Foundation
Published by Elsevier Inc.

FOCUS ISSUE: BIOMARKERS IN CARDIOVASCULAR DISEASE

# Novel Biomarkers, Oxidative Stress, and the Role of Labile Iron Toxicity in Cardiopulmonary Bypass-Associated Acute Kidney Injury

Michael Haase, MD,*† Rinaldo Bellomo, MD,† Anja Haase-Fielitz, PHARMD*†

*Melbourne, Australia; and Berlin, Germany*

Pr Fritz Haber, 1868 – 1934
Prix Nobel de chimie de 1918 pour la synthèse de l'NH3

$2O^{2-} + 2H^{+} \rightarrow H_2O_2 + O_2$

Réaction de Haber-Weiss: $H_2O_2 + O^{2-} \rightarrow OH^{-} + OH^{-} + O_2$

Les deux reactions sont catalysées par le Fe ionise et en milieu acide:

Réactions de Fenton : $Fe^{3+} + O^{2-} \rightarrow Fe^{2+} + O_2$

$Fe^{2+} + H_2O_2 \rightarrow Fe^{3+} + OH^{-} + OH^{-}$

Pr Fritz Haber, 1868 – 1934
Prix Nobel de chimie de 1918 pour la synthèse de l'NH3

-> découverte des réactions de péroxydation

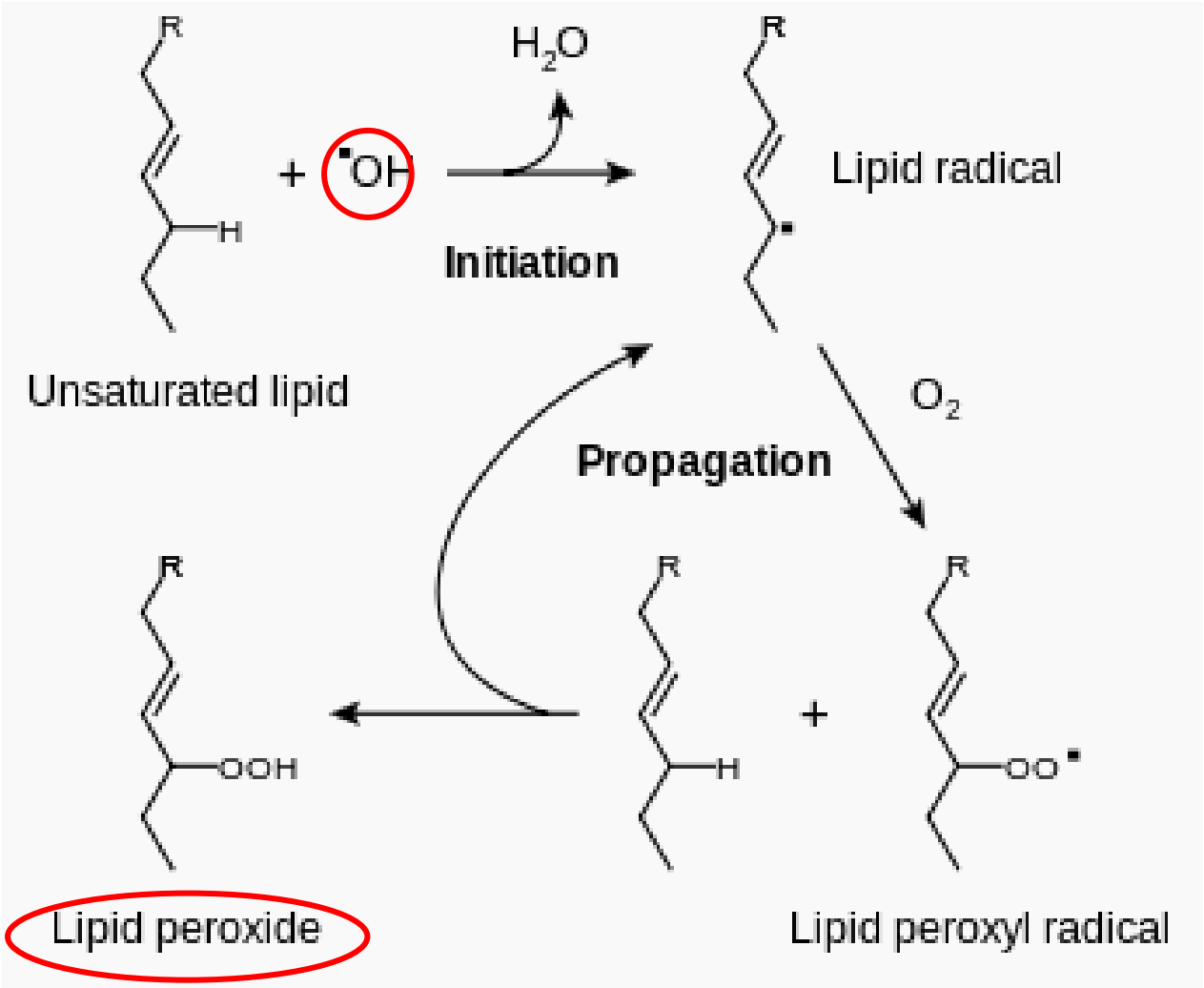
$2O^{2-} + 2H^{+} \rightarrow H_2O_2 + O_2$

Réaction de Haber-Weiss: $H_2O_2 + O^{2-} \rightarrow OH^{-} + OH^{-} + O_2$

Les deux reactions sont catalysées par le Fe ionise :

Réactions de Fenton : $Fe^{3+} + O^{2-} \rightarrow Fe^{2+} + O_2$

$Fe^{2+} + H_2O_2 \rightarrow Fe^{3+} + OH^{-} + OH^{-}$

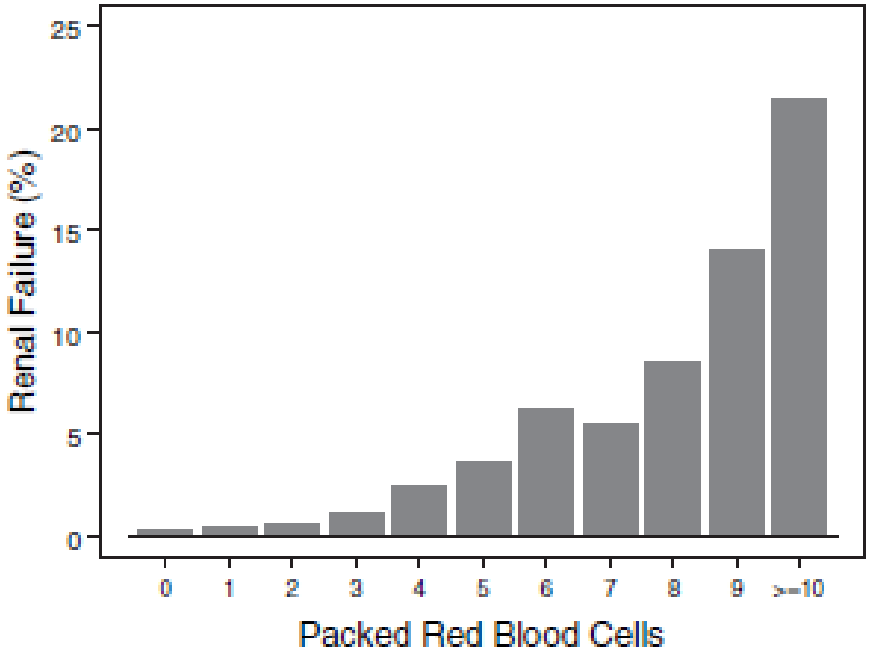

R
H
+ •OH
$H_2O$
Initiation
R
Lipid radical
Unsaturated lipid
$O_2$
Propagation
R
OOH
R
H
+
R
OO•
Lipid peroxide
Lipid peroxyl radical

## Sodium Bicarbonate and Renal Function after Cardiac Surgery

and covariates (odds ratio [OR], 99% confidence interval [CI]: Bicarbonate *vs.* Control, 1.11 [0.77–1.60], $P = 0.45$). There was, however, a significant study-adjusted benefit in elective coronary artery bypass surgery patients in terms of renal replacement therapy (Bicarbonate *vs.* Control, OR: 0.38 [99% CI: 0.25–0.58], $P < 0.0001$) and the development of an Acute Kidney Injury Network grade = 3 (Bicarbonate *vs.* Control, OR: 0.45 [99% CI: 0.43–0.48], $P < 0.0001$).

Bailey, Anesthesiology 2015

# Le risque lié aux transfusions chez l'adulte




OR = 1.22 [1.19–1.26], p < 0.001 pour chaque CGR additionnel

*Furnary, Circulation 2007*

## Duration of red blood cell storage and outcomes in pediatric cardiac surgery: an association found for pump prime blood

**Conclusions** The storage time of the red blood cells used for priming the cardiopulmonary bypass circuit in cardiac operations on newborns and young infants is an independent risk factor for major postoperative morbidity. Pulmonary complications, acute renal failure, and infections are the main complications associated with increased red blood cell storage time.

Ranucci, Critical Care 2009

**Impact of contrast exposure from computed tomography angiography on acute kidney injury after neonatal cardiopulmonary bypass surgery**

**Results:** Fifty-six neonates were analyzed. AKI developed in 42 (75%) of patients; severe AKI (KDIGO stages 2 and 3) occurred in 18 (32%). Patient characteristics were similar at baseline and at time of CTA between those with and without severe AKI. Patients with severe AKI had longer CPB time, lower postoperative urine output, higher peak serum creatinine, and longer hospital length of stay. When considering intervals between CTA and CPB surgery $\leq$1 day (n = 19), $\leq$3 days (n = 28), and >3 days (n = 28); there was no difference in AKI incidence nor postoperative outcomes among these three interval cohorts.

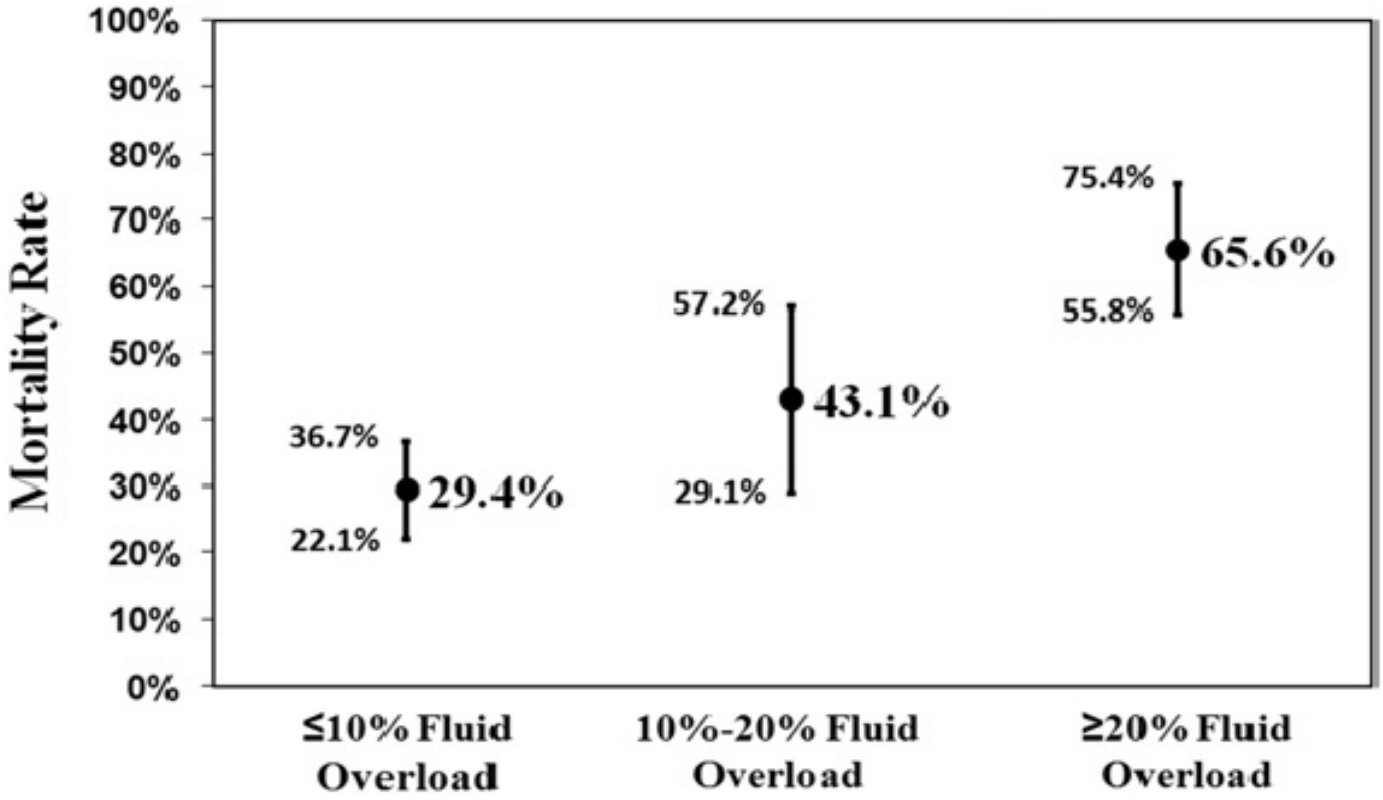
Carlo, Congenital Heart Disease 2017

# Facteurs de risque de l'IRA suivant la chirurgie cardiaque

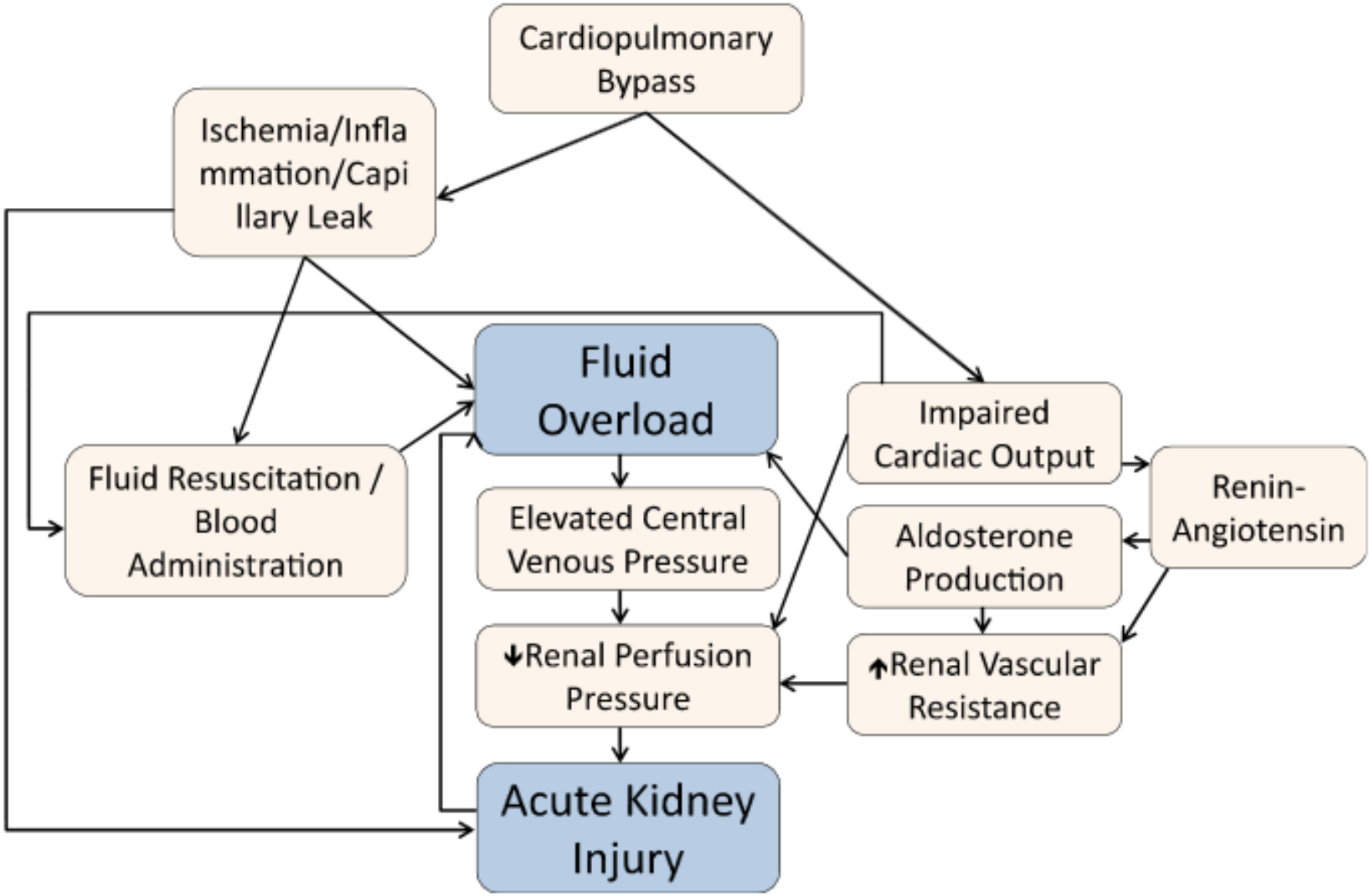
| Preoperative | Intraoperative | Postoperative |
|---|---|---|
| Lack of renal reserve | Decreased renal perfusion | Systemic inflammation |
| Renovascular disease | hypotension | Reduced LV function |
| Prerenal azotemia | lack of pulsatile flow | Vasoactive agents |
| recent diuresis | vasoactive agents | Hemodynamic instability |
| NPO status | anesthetic effects | Nephrotoxins |
| impaired LV function | Embolic events | Volume depletion |
| ACEI/ARB | CPB-induced inflammation | Sepsis |
| Nephrotoxins | Nephrotoxins | |
| intravenous contrast | free hemoglobin | **Surcharge hydrique** |
| other medications | | **Stase VCI** |
| Endotoxemia | | |
| Inflammation | | |

*Rosner, Clin J Am Soc Nephrol 2006*

## Fluid Overload and Mortality in Children Receiving Continuous Renal Replacement Therapy: The Prospective Pediatric Continuous Renal Replacement Therapy Registry




*Sutherland, Am J Kidney Dis 2010*




Kwiatowski, Pediatric Nephrol 2017

# Impact of contrast exposure from computed tomography angiography on acute kidney injury after neonatal cardiopulmonary bypass surgery

**Results:** Fifty-six neonates were analyzed. AKI developed in 42 (75%) of patients; severe AKI (KDIGO stages 2 and 3) occurred in 18 (32%). Patient characteristics were similar at baseline and at time of CTA between those with and without severe AKI. Patients with severe AKI had longer CPB time, lower postoperative urine output, higher peak serum creatinine, and longer hospital length of stay. When considering intervals between CTA and CPB surgery $\leq$1 day (n = 19), $\leq$3 days (n = 28), and >3 days (n = 28); there was no difference in AKI incidence nor postoperative outcomes among these three interval cohorts.

**Conclusion:** Routine exposure to CTA and CPB surgery in close succession does not appear to increase the risk of AKI after neonatal cardiac surgery. Though other risks need to be weighed (eg, sedation, intubation, radiation exposure), this result may enable more liberal utilization of CTA for preoperative surgical planning of congenital heart operations in patients with unclear or complex anatomy.

*Carlo, Congenital Heart Disease 2017*

# Principales anomalies dans l'IRA post-chirurgie cardiaque

1. **Anomalies vasculaires rénales**
   - Augmentation du Ca2+ cytosolique -> vasoconstriction
   - Congestion médullaire -> aggrave l'hypoxémie médullaire

2. **Anomalies tubulaires :** destruction de la bordure en brosse du tubule proximal
   - Débris éliminés dans le tubule
   - Dysfonction de la Na/K ATP-ase tubulaire -> augmentation de la concentration du Na+ intraluminale -> précipite avec la protéine de Tham et Horsfal

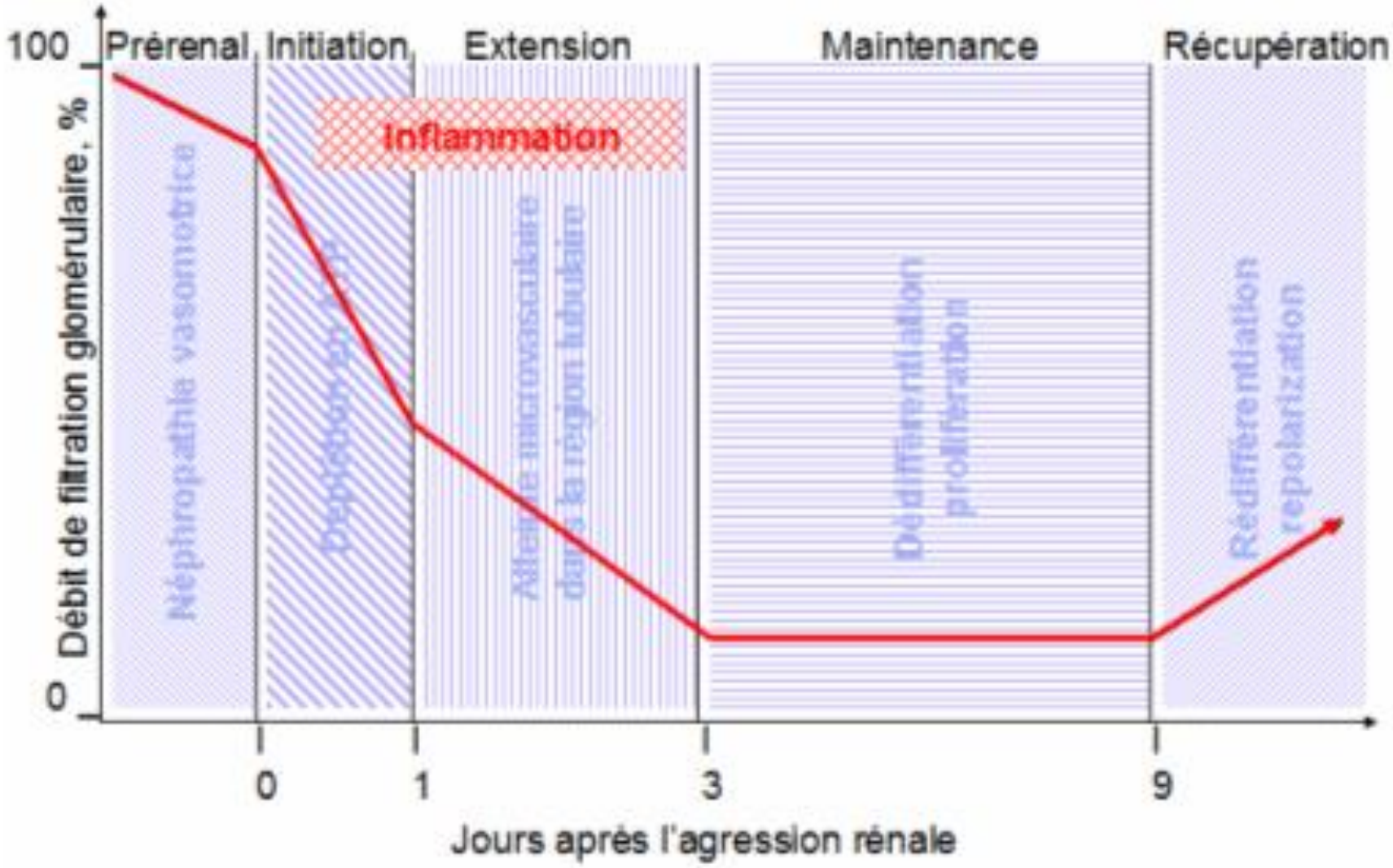
   → obstruction tubulaire → augmentation de la pression intraluminale → diminution du DFG

3. **Inflammation :** Activité accrue de la NOs

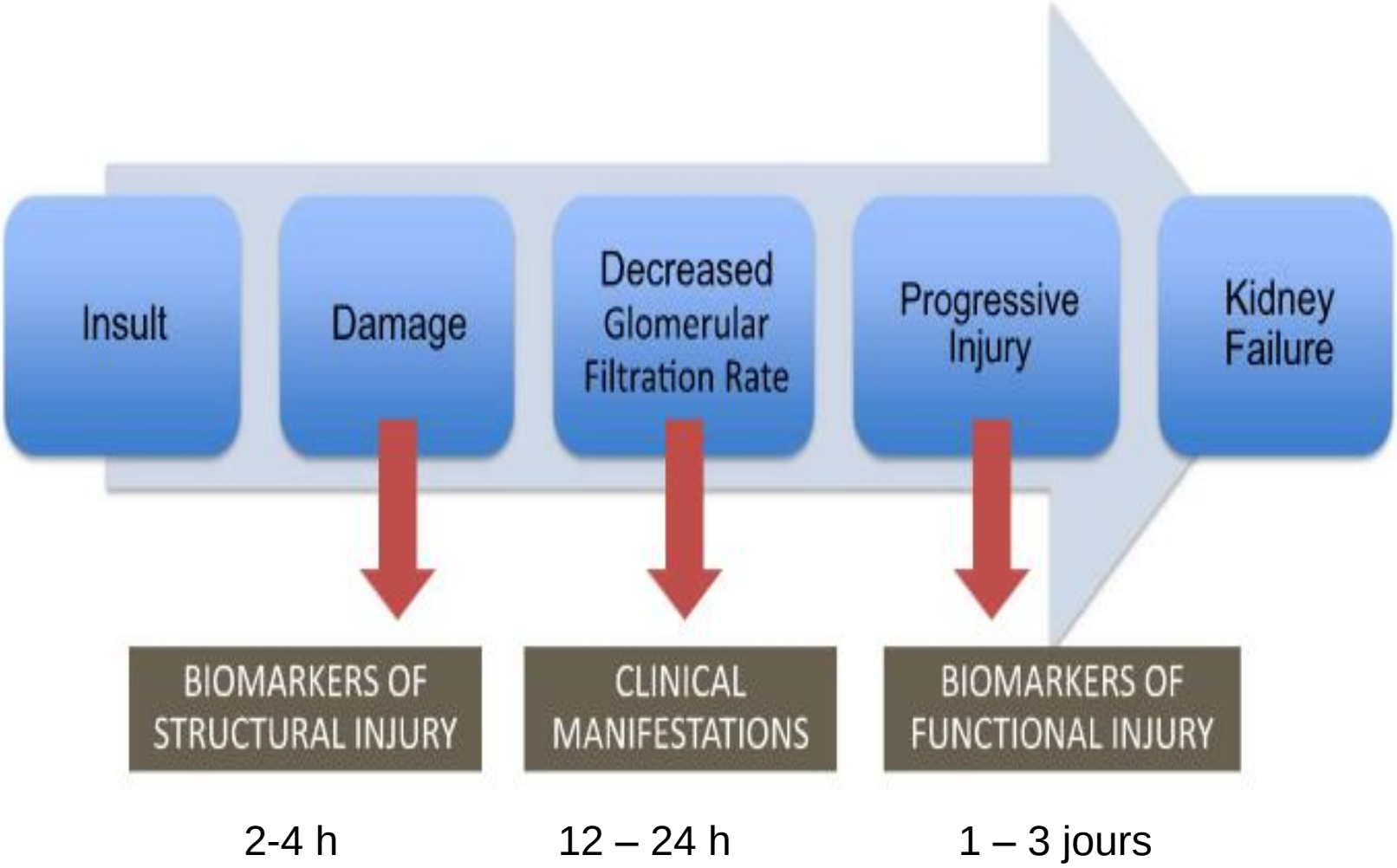
-> rôle protecteur par vasodilatation de l'artériole afférente
-> production de peroxynitrite -> destruction tubulaire

# Evolution de l'IRA par ischémie-reperfusion

La lésion initiale se situe au niveau tubulaire




*Sutton, Kidney Int 2002*




Kwiatowski, Pediatric Nephrol 2017

Insuffisance rénale aiguë

Epidemiologie

Physiopathologie

**Diagnostic**

Prévention

Traitement

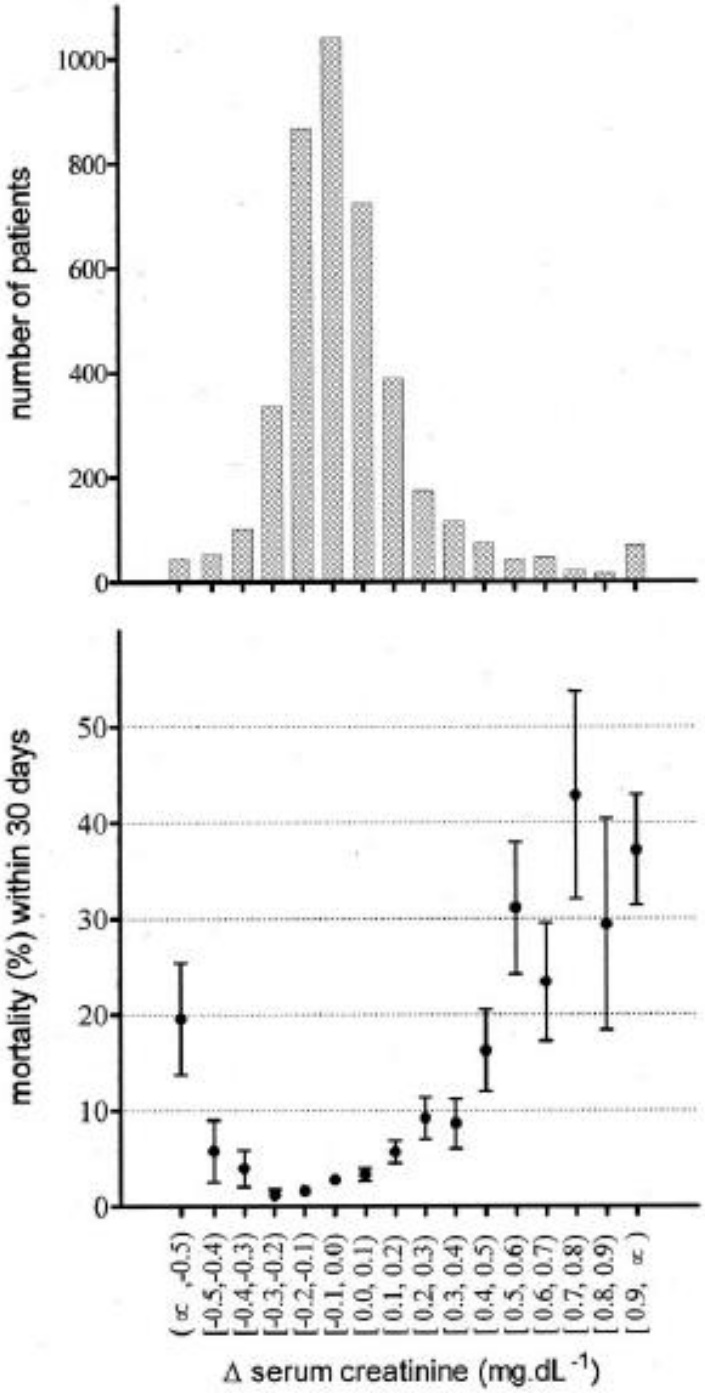
Insuffisance rénale chronique

# Définition IRA

| | Creatinine criteria | | Urine output criteria | |
|---|---|---|---|---|
| | RIFLE | pRIFLE and nRIFLE | RIFLE | pRIFLE |
| Risk | Increased creatinine x1.5 or GFR decreases >25% | Increased creatinine x1.5 or GFR decreases >25% | UO ≤0.5 mL/kg/h × 6 h | UO ≤0.5 mL/kg/h × 8 h |
| Injury | Increased creatinine x2 or GFR decreases >50% | Increased creatinine x2 or GFR decreases >50% | UO ≤0.5 mL/kg/h × 12 h | UO ≤0.5 mL/kg/h × 16 h |
| Failure | Increased creatinine x3 or GFR decreases >75% or creatinine >4 mg/dL (acute rise of >4 mg/dL) | Increased creatinine x3 or GFR decreases >75% or GFR <35 mL/min/1.73 $m^2$ | UO ≤0.3 mL/kg/h × 24 h or anuria × 12 h | UO ≤0.3 mL/kg/h × 24 h or anuria × 12 h |

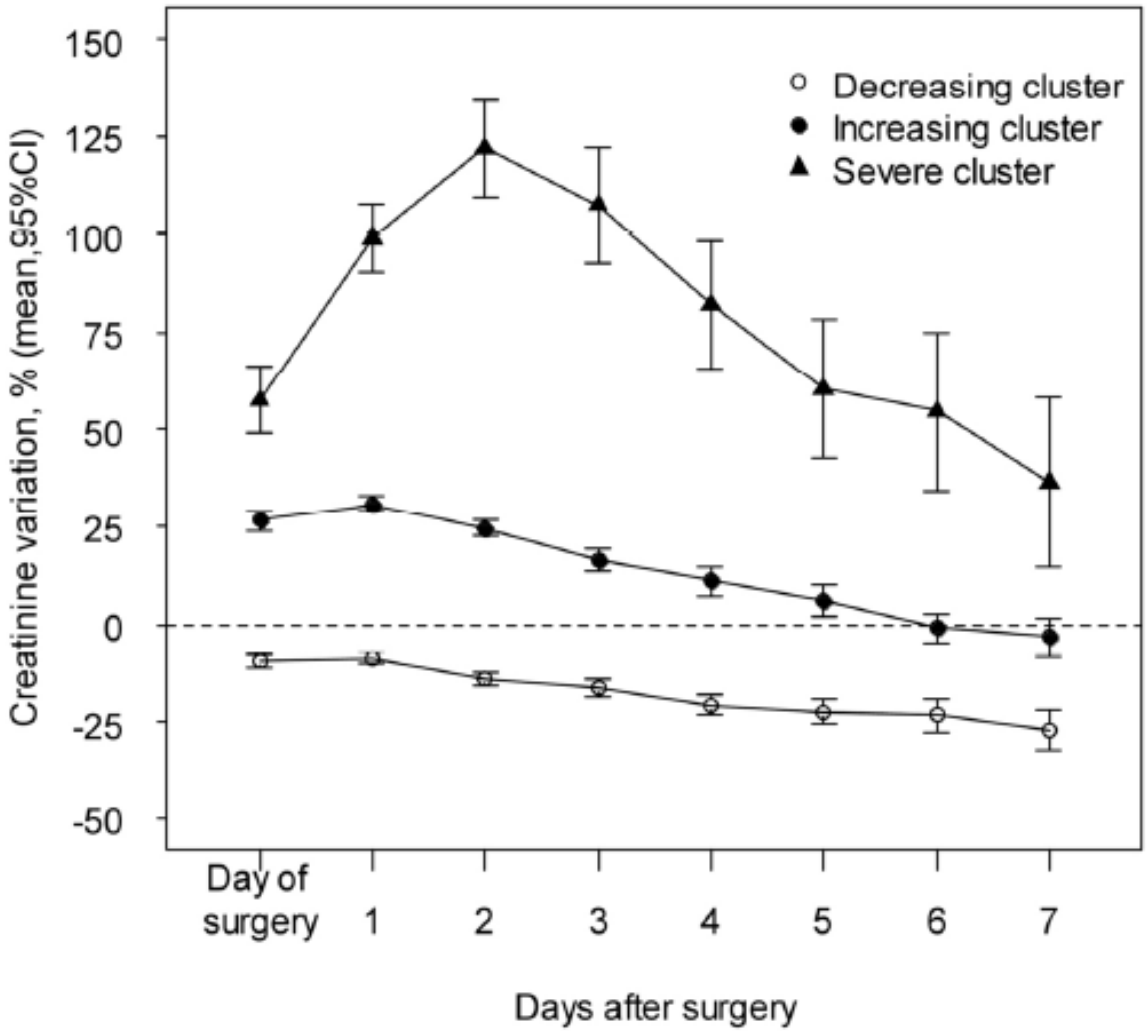
Metha RL, Crit Care 2007, Akcan-Arikan, Kidney Int 2007

## Problèmes posés par la créatinine plasmatique pour le diagnostic de l'IRA chez l'adulte




*Lassnigg, J Am Soc Nephrol, 2004*

# La créatinine plasmatique pour le diagnostic de l'IRA chez le nourrisson




*Necker-Enfants Malades*

| Variable | "Decreasing cluster" (n = 503) | "Increasing cluster" (n = 423) | P-value [a] | "Severe cluster" (n = 90) | P-value [a] |
|---|---|---|---|---|---|
| Number of blood product units on the day of surgery | 3.5 ± 1.3 | 3.7 ± 1.5 | 0.017 | 5.4 ± 2.4 | < 0.001 |
| Required delayed sternal closure | 37 (7.4) | 68 (16.1) | < 0.001 | 54 (60) | < 0.001 |
| Required postoperative ECMO | 3 (0.6) | 6 (1.4) | 0.35 | 6 (6.7) | < 0.001 |
| Required postoperative peritoneal dialysis | 10 (2.0) | 35 (8.3) | < 0.001 | 47 (52.2) | < 0.001 |

# Définition IRA néonatale

| | Creatinine criteria | | Urine output criteria | | |
|---|---|---|---|---|---|
| | RIFLE | pRIFLE and nRIFLE | RIFLE | pRIFLE | nRIFLE |
| Risk | Increased creatinine x1.5 or GFR decreases >25% | Increased creatinine x1.5 or GFR decreases >25% | UO ≤0.5 mL/kg/h × 6 h | UO ≤0.5 mL/kg/h × 8 h | UO <1.5 mL/kg/h for 24 h |
| Injury | Increased creatinine x2 or GFR decreases >50% | Increased creatinine x2 or GFR decreases >50% | UO ≤0.5 mL/kg/h × 12 h | UO ≤0.5 mL/kg/h × 16 h | UO <1.0 mL/kg/h for 24 h |
| Failure | Increased creatinine x3 or GFR decreases >75% or creatinine >4 mg/dL (acute rise of >4 mg/dL) | Increased creatinine x3 or GFR decreases >75% or GFR <35 mL/min/1.73 $m^2$ | UO ≤0.3 mL/kg/h × 24 h or anuria × 12 h | UO ≤0.3 mL/kg/h × 24 h or anuria × 12 h | UO <0.7 mL/kg/h for 24 h or anuria for 12 h |

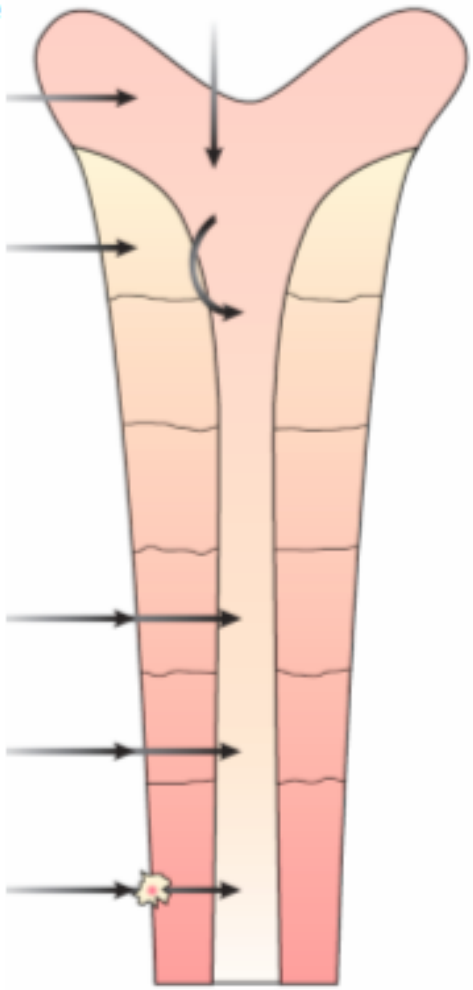
Bezerra, Nephrol Dial Transplant 2013, Ricci , Nephrol Dial Transplant 2013

Filtration des déchets azotés
créatinine

Filtration des protéines plasmatiques par altération de la barrière glomérulaire
albumine

Altération de la réabsorption tubulaire
cystatine C

Protéines tubulaires
- inductibles par l'ischémie
KIM-1
- libérées par la destruction endothéliale
L-FABP
- sécrétées par les cellules inflammatoires en réponse à l'ischémie
NGAL, IL-18



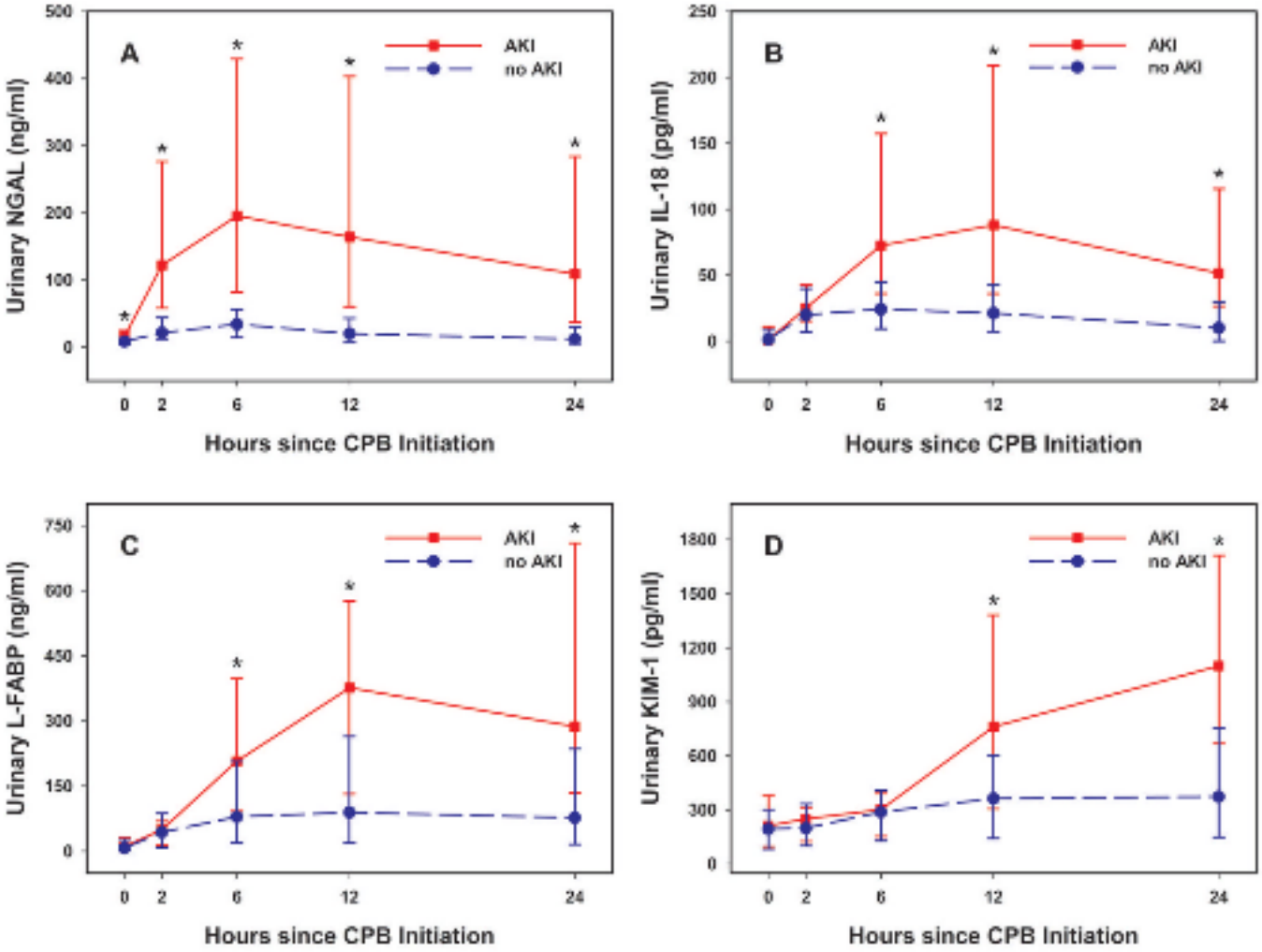
*Briggs JP. Kidney Int. 2008*

## Biomarqueurs rénaux

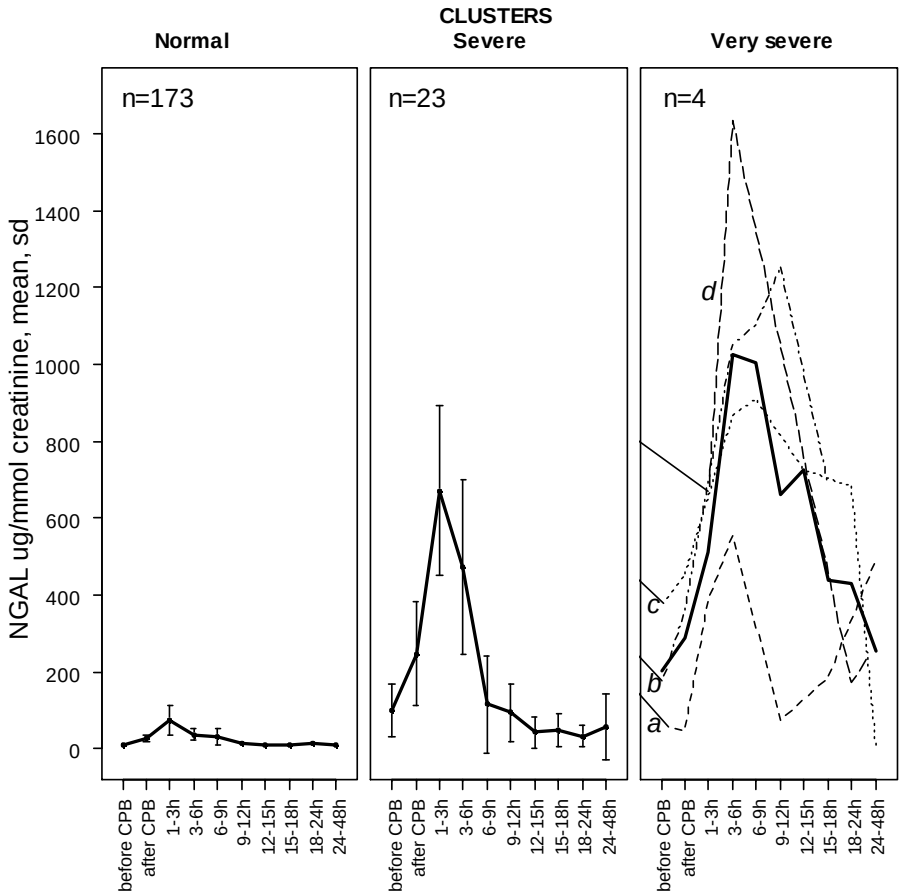
1. Marqueurs de l'atteinte tubulaire = marqueurs lésionnels (NGAL, KIM-1, LFAB, IL-18)

2. Marqueurs de la filtration glomérulaire = marqueurs fonctionnels (inuline, créatinine, cystatine C, albuminurie)

# Temporal Relationship and Predictive Value of Urinary Acute Kidney Injury Biomarkers After Pediatric Cardiopulmonary Bypass




*Krawczeski JACC 2011*




*Bojan, Clin J Am Soc Nephrol 2014*

**Urine creatinine normalized NGAL concentration (µg/mmol creatinine)**

| Time interval | Before CPB | Within 1 h of CPB | 1 to 3 h of CPB | 3 to 6 h of CPB | 6 to 12 h of CPB | 12 to 18h of CPB | 18 to 24 h of CPB | 24 to 48 h of CPB |
|---|---|---|---|---|---|---|---|---|
| Cutoff | 12.5 | 21.2 | 186.5 | 126.0 | 9.5 | 7.6 | 7.1 | 7.2 |
| Sensitivity and 95%CI* | 0.64 [0.53 – 1.00] | 0.81 [0.58 – 1.00] | 0.55 [0.47 – 1.00] | 0.61 [0.43 – 0.93] | 0.81 [0.56 – 1.00] | 0.87 [0.62 – 1.00] | 0.92 [0.83 – 1.00] | 0.57 [0.32 – 1.00] |
| Specificity and 95%CI* | 0.76 [0.32 – 0.84] | 0.68 [0.40 – 0.94] | 0.85 [0.31 – 0.96] | 0.85 [0.56 – 0.99] | 0.68 [0.53 – 0.92] | 0.61 [0.47 – 0.94] | 0.58 [0.38 – 0.82] | 0.51 [0.21 – 0.99] |
| Positive likelihood ratio and 95% CI* | 2.73 [1.33 – 4.52] | 2.56 [1.45 – 8.52] | 3.61 [1.39 – 14.17] | 4.26 [1.72 – 44.62] | 2.54 [1.90 – 8.24] | 2.25 [1.76 – 11.59] | 2.18 [1.63 – 5.28] | 1.16 [1.17 – 23.67] |
| Negative likelihood ratio and 95% CI* | 0.47 [0.00 -0.68] | 0.27 [0.00 – 0.59] | 0.52 [0.00 – 0.66] | 0.45 [0.00 – 0.68] | 0.27 [0.00 – 0.55] | 0.20 [0.00 – 0.53] | 0.14 [0.00 – 0.33] | 0.84 [0.00 – 0.85] |
| Diagnostic Odds-ratio and 95% CI* | 5.85 [2.17 – ∞] | 9.57 [3.32 - ∞] | 6.87 [2.04 - ∞] | 9.48 [4.01 - ∞] | 9.24 [4.19 - ∞] | 11.03 [4.93 - ∞] | 15.17 [7.94 - ∞] | 1.37 [0.47 - ∞] |
| Net Reclassification Index and 95% CI P-value | 0.81 [0.26 – 1.36] 0.004 | 0.99 [0.38 – 1.61] 0.001 | 0.80 [0.13 – 1.47] 0.02 | 0.94 [0.36 – 1.52] 0.001 | 0.97 [0.27 – 1.29] <0.001 | 0.97 [0.46 – 1.49] 0.003 | 0.99 [0.38 – 1.61] 0.001 | 0.53 [-0.05 – 1.10] 0.07 |
| Integrated Discrimination Improvement and 95% CI P-value | 0.07 [0.02 – 0.13] 0.01 | 0.07 [0.03 – 0.10] <0.001 | 0.03 [-0.006 – 0.07] 0.10 | 0.08 [0.02 – 1.51] 0.006 | 0.06 [0.03 – 0.08] <0.001 | 0.06 [0.02 – 0.09] <0.001 | 0.08 [0.03 – 0.12] <0.001 | 0.04 [-0.001 – 0.08] 0.05 |
| Number needed to screen and 95% CI* | 1.97 [1.55 – 2.75] | 2.63 [1.95 – 4.13] | 1.51 [1.30 – 1.83] | 1.53 [1.28 – 1.96] | 2.60 [1.95 – 4.02] | 3.65 [2.41 – 8.14] | 3.86 [2.11 – 20.00] | -27.00 [-77 - ∞] |

# Cell-cycle arrest and acute kidney injury: the light and the dark sides

John A. Kellum[1] and Lakhmir S. Chawla[2]

Tissue inhibitor of metalloproteinases-2 (TIMP-2)
Insulin-like growth factor-binding protein 7 (IGFBP-7)

| | population | [TIMP-2 * IGFBP-7] threshold |
|---|---|---|
| Gist<br>Pediatr Nephrol 2016 | 94, average 154 days old | > 0.78<br>ROC area = 0.71 |
| Meersch<br>Plos ONE 2014 | 51 patients 1.5 – 3 years old | > 0.70<br>ROC area = 0.85 |

Kellum, Nephrol Dial Transplant 2016

# Cell-cycle arrest and acute kidney injury: the light and the dark sides

John A. Kellum[1] and Lakhmir S. Chawla[2]

Tissue inhibitor of metalloproteinases-2 (TIMP-2)
Insulin-like growth factor-binding protein 7 (IGFBP-7)

| | population | [TIMP-2 * IGFBP-7] threshold |
|---|---|---|
| Gist<br>Pediatr Nephrol 2016 | 94, average 154 days old | > 0.78<br>ROC area = 0.71 |
| Meersch<br>Plos ONE 2014 | 51 patients 1.5 – 3 years old | > 0.70<br>ROC area = 0.85 |

Kellum, Nephrol Dial Transplant 2016

Insuffisance rénale aiguë

Epidemiologie

Physiopathologie

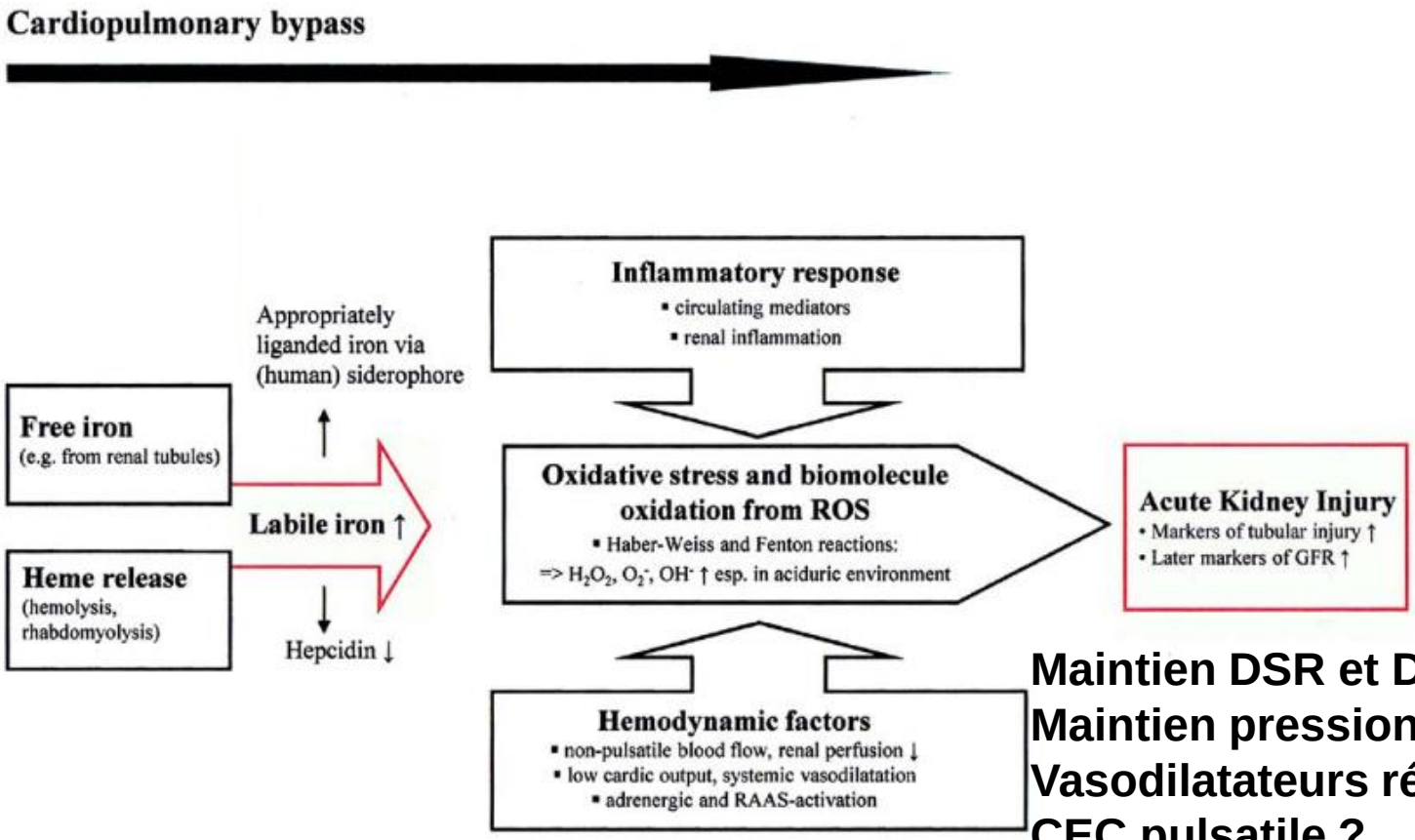
Diagnostic

Biomarqueurs

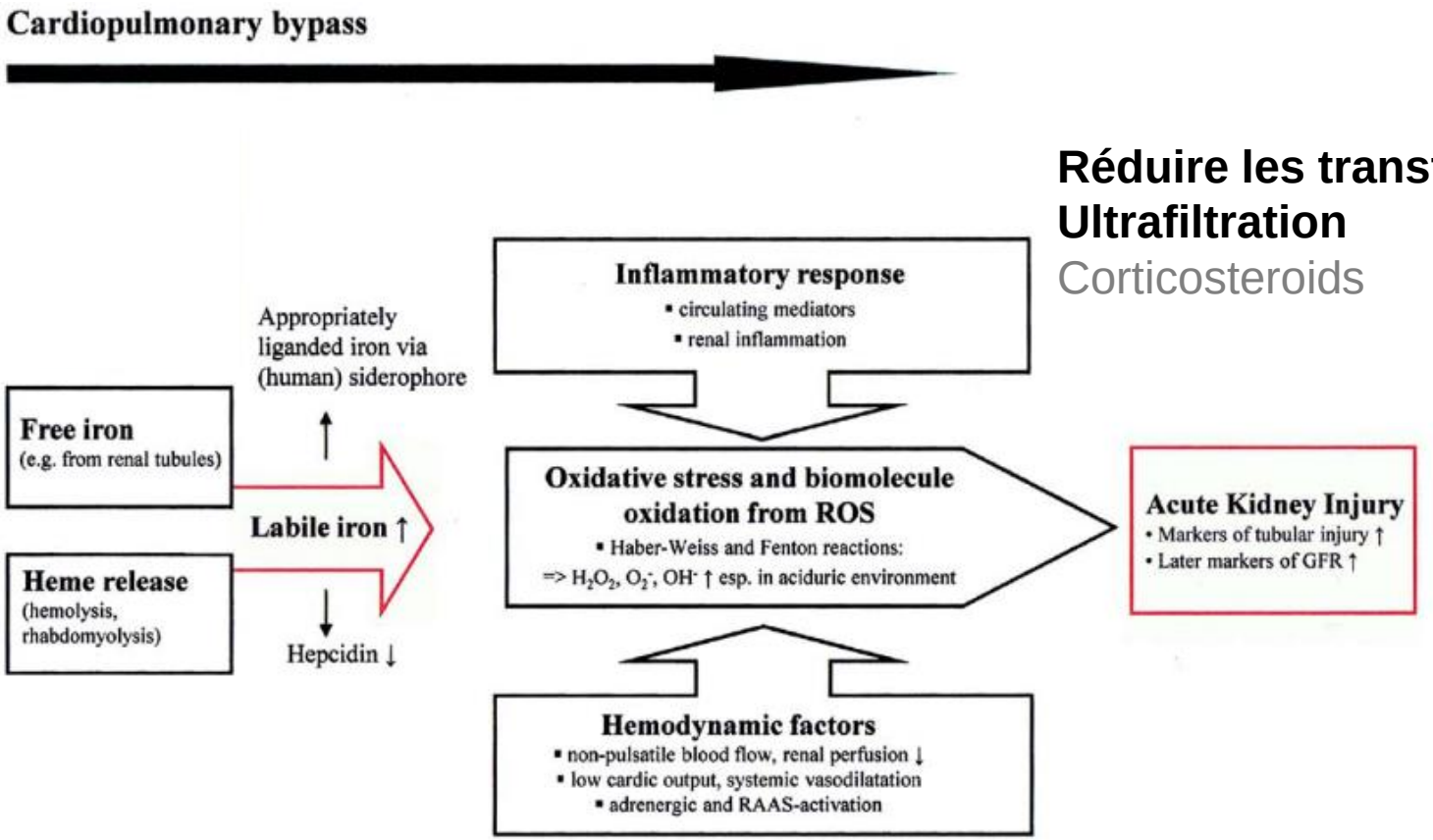
**Prévention**

Traitement

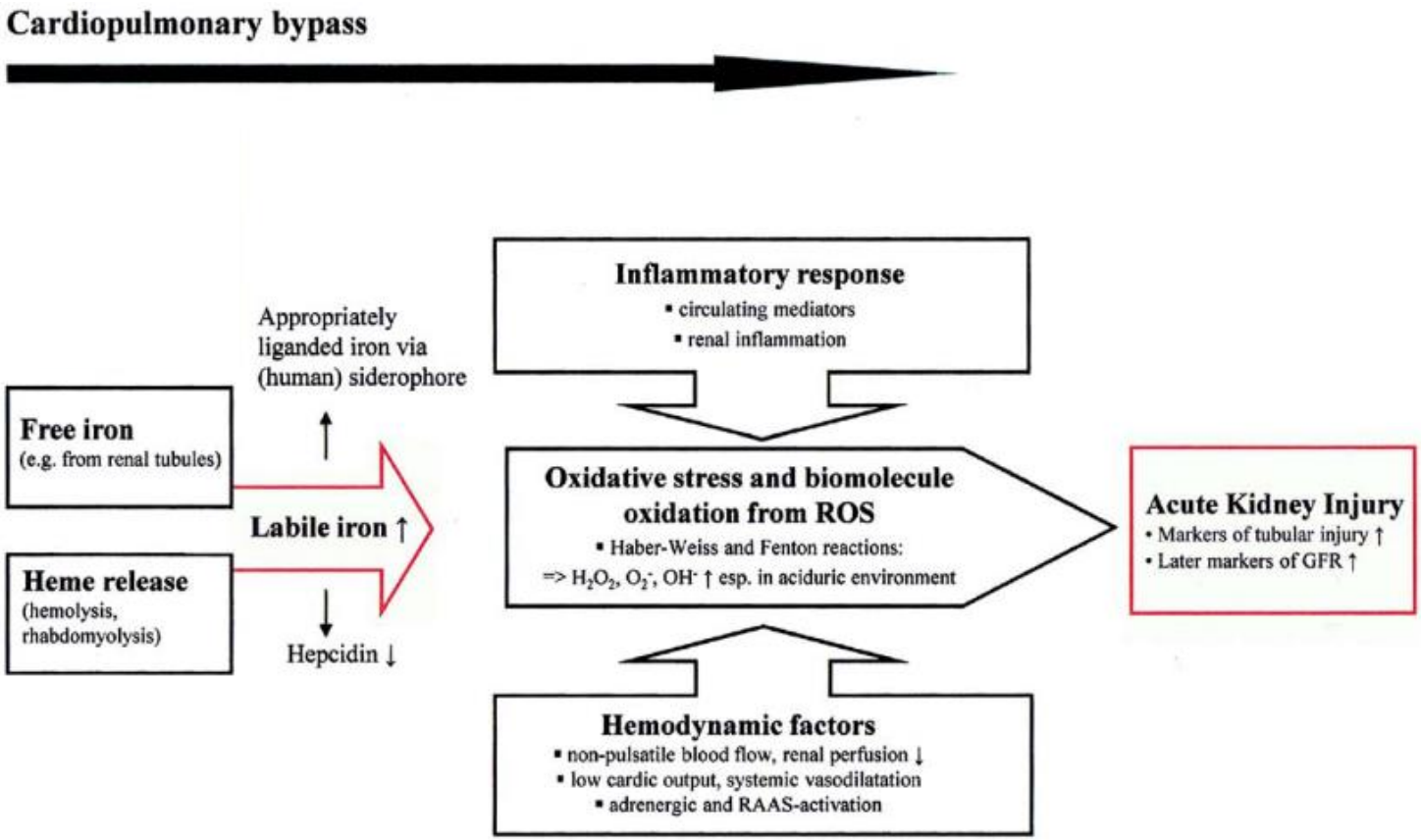
Insuffisance rénale chronique




**Maintien DSR et DO2**
**Maintien pressions de perfusion**
**Vasodilatateurs rénaux**
**CEC pulsatile ?**
**Monitorage NIRS ?**




**Réduire les transfusions**
**Ultrafiltration**
Corticosteroids

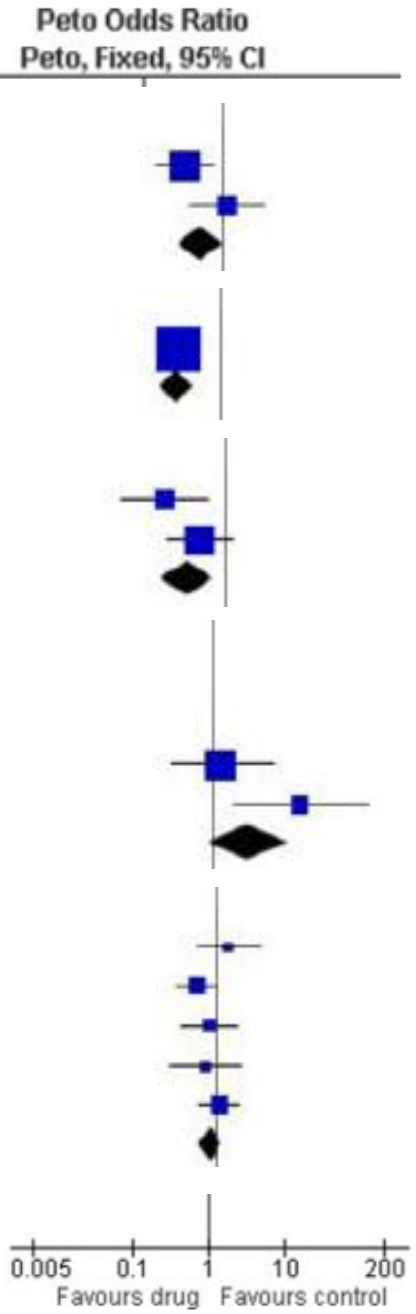



**Moins de transfusions CGR frais**
**NaHCO3**
N-acetyl cysteine
Haptoglobine
Deferoxamine

# Effet estimé / risque d'IRA lors d'une utilisation à titre préventif

*Patel, Heart Fail Rev 2011*

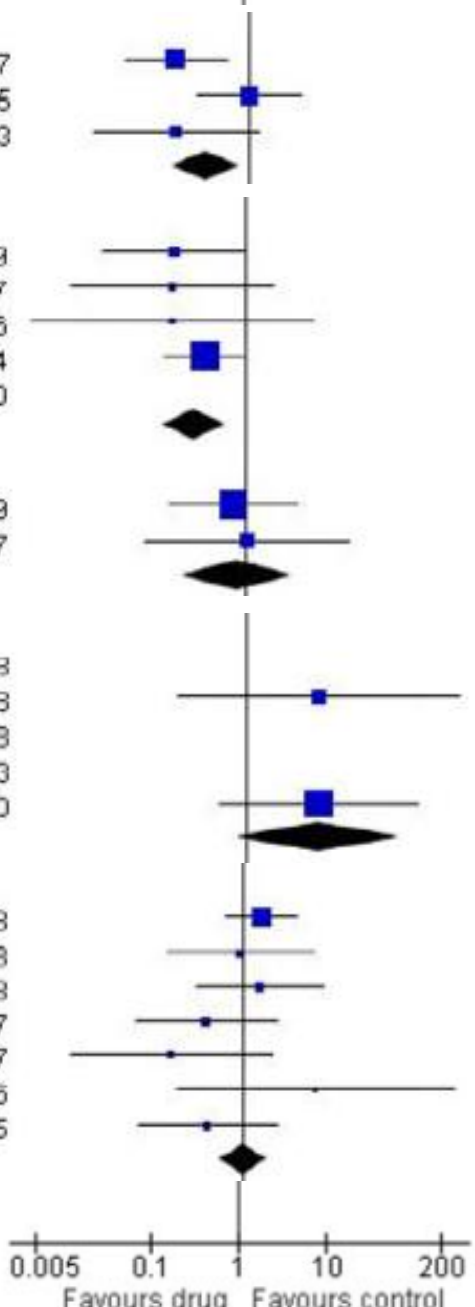
| Study or Subgroup | Drug Events | Drug Total | Control Events | Control Total | Weight | Peto Odds Ratio Peto, Fixed, 95% CI | Year |
|---|---|---|---|---|---|---|---|
| **1.3.2 Fenoldopam** | | | | | | | |
| Cogliati 2007 | 12 | 95 | 27 | 98 | 61.4% | 0.40 [0.20, 0.80] | 2007 |
| Bove 2005 | 17 | 40 | 16 | 40 | 38.6% | 1.11 [0.46, 2.68] | 2005 |
| **Subtotal (95% CI)** | | **135** | | **138** | **100.0%** | **0.59 [0.34, 1.02]** | |
| **1.3.4 Atrial Natriuretic Peptide** | | | | | | | |
| Sezai 2009 | 40 | 251 | 92 | 253 | 100.0% | 0.35 [0.23, 0.52] | 2009 |
| **Subtotal (95% CI)** | | **251** | | **253** | **100.0%** | **0.35 [0.23, 0.52]** | |
| **1.3.5 Brain Natriuretic Peptide** | | | | | | | |
| Ejaz 2009 | 3 | 45 | 14 | 49 | 36.5% | 0.23 [0.08, 0.66] | 2009 |
| Mentzer 2007 | 10 | 141 | 17 | 138 | 63.5% | 0.55 [0.25, 1.22] | 2007 |
| **Subtotal (95% CI)** | | **186** | | **187** | **100.0%** | **0.40 [0.21, 0.76]** | |
| **1.3.7 Diuretics** | | | | | | | |
| Smith 2008 | 0 | 23 | 0 | 24 | | Not estimable | 2008 |
| Yallop 2008 | 0 | 20 | 0 | 20 | | Not estimable | 2008 |
| Mahesh 2008 | 9 | 21 | 8 | 21 | 64.8% | 1.21 [0.36, 4.10] | 2008 |
| Lassnigg 2000 | 6 | 41 | 0 | 40 | 35.2% | 8.23 [1.58, 42.96] | 2000 |
| **Subtotal (95% CI)** | | **105** | | **105** | **100.0%** | **2.38 [0.89, 6.34]** | |
| **1.3.8 N-acetylcysteine** | | | | | | | |
| Adabag 2008 | 22 | 50 | 19 | 52 | 12.0% | 1.36 [0.62, 2.99] | 2008 |
| Sisillo 2008 | 52 | 129 | 65 | 125 | 30.8% | 0.63 [0.38, 1.02] | 2008 |
| Wijeysundera 2007 | 25 | 88 | 28 | 87 | 18.1% | 0.84 [0.44, 1.59] | 2007 |
| Ristikankare 2006 | 16 | 38 | 19 | 39 | 9.4% | 0.77 [0.32, 1.87] | 2006 |
| Burns 2005 | 44 | 148 | 42 | 147 | 29.7% | 1.06 [0.64, 1.75] | 2005 |
| **Subtotal (95% CI)** | | **453** | | **450** | **100.0%** | **0.86 [0.66, 1.13]** | |



# Effet estimé / recours à la dialyse lors d'une utilisation à titre préventif

*Patel, Heart Fail Rev 2011*

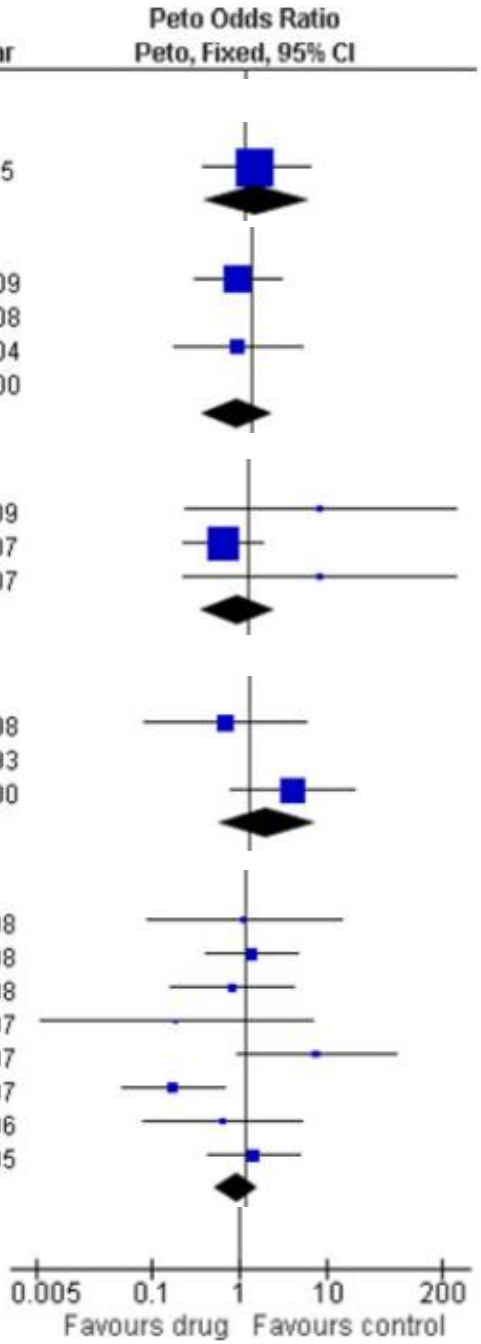
| Study or Subgroup | Drug Events | Drug Total | Control Events | Control Total | Weight | Peto Odds Ratio Peto, Fixed, 95% CI | Year |
|---|---|---|---|---|---|---|---|
| **1.2.2 Fenoldopam** | | | | | | | |
| Cogliati 2007 | 0 | 95 | 8 | 98 | 42.9% | 0.13 [0.03, 0.53] | 2007 |
| Bove 2005 | 4 | 40 | 4 | 40 | 40.6% | 1.00 [0.23, 4.27] | 2005 |
| Caimmi 2003 | 0 | 80 | 3 | 80 | 16.5% | 0.13 [0.01, 1.29] | 2003 |
| **Subtotal (95% CI)** | | **215** | | **218** | **100.0%** | **0.30 [0.12, 0.75]** | |
| **1.2.4 Atrial Natriuretic Peptide** | | | | | | | |
| Sezai 2009 | 0 | 251 | 4 | 253 | 19.5% | 0.13 [0.02, 0.96] | 2009 |
| Sezai 2007 | 0 | 63 | 2 | 61 | 9.7% | 0.13 [0.01, 2.08] | 2007 |
| Sezai 2006 | 0 | 75 | 1 | 73 | 4.9% | 0.13 [0.00, 6.64] | 2006 |
| Sward 2004 | 6 | 29 | 14 | 30 | 65.9% | 0.32 [0.11, 0.93] | 2004 |
| Hayashida 2000 | 0 | 9 | 0 | 9 | | Not estimable | 2000 |
| **Subtotal (95% CI)** | | **427** | | **426** | **100.0%** | **0.24 [0.10, 0.56]** | |
| **1.2.5 Brain Natriuretic Peptide** | | | | | | | |
| Ejaz 2009 | 2 | 45 | 3 | 49 | 71.1% | 0.72 [0.12, 4.32] | 2009 |
| Chen 2007 | 1 | 19 | 1 | 20 | 28.9% | 1.05 [0.06, 17.51] | 2007 |
| **Subtotal (95% CI)** | | **64** | | **69** | **100.0%** | **0.80 [0.18, 3.64]** | |
| **1.2.7 Diuretics** | | | | | | | |
| Yallop 2008 | 0 | 20 | 0 | 20 | | Not estimable | 2008 |
| Mahesh 2008 | 1 | 21 | 0 | 21 | 33.6% | 7.39 [0.15, 372.38] | 2008 |
| Smith 2008 | 0 | 23 | 0 | 24 | | Not estimable | 2008 |
| Carcoana 2003 | 0 | 26 | 0 | 24 | | Not estimable | 2003 |
| Lassnigg 2000 | 2 | 41 | 0 | 40 | 66.4% | 7.39 [0.45, 120.32] | 2000 |
| **Subtotal (95% CI)** | | **131** | | **129** | **100.0%** | **7.39 [0.76, 71.75]** | |
| **1.2.8 N-acetylcysteine** | | | | | | | |
| Sisillo 2008 | 10 | 129 | 6 | 125 | 43.8% | 1.65 [0.60, 4.52] | 2008 |
| Barr 2008 | 2 | 20 | 2 | 19 | 10.7% | 0.95 [0.12, 7.30] | 2008 |
| Adabag 2008 | 3 | 50 | 2 | 52 | 14.0% | 1.58 [0.26, 9.46] | 2008 |
| Wijeysundera 2007 | 1 | 88 | 3 | 87 | 11.4% | 0.36 [0.05, 2.58] | 2007 |
| Haase 2007 | 0 | 30 | 2 | 30 | 5.7% | 0.13 [0.01, 2.14] | 2007 |
| Ristikankare 2006 | 1 | 38 | 0 | 39 | 2.9% | 7.59 [0.15, 382.44] | 2006 |
| Burns 2005 | 1 | 148 | 3 | 147 | 11.5% | 0.36 [0.05, 2.59] | 2005 |
| **Subtotal (95% CI)** | | **503** | | **499** | **100.0%** | **0.98 [0.50, 1.92]** | |



# Effet estimé / mortalité lors d'une utilisation à titre préventif

*Patel, Heart Fail Rev 2011*

| Study or Subgroup | Drug Events | Drug Total | Control Events | Control Total | Weight | Peto Odds Ratio Peto, Fixed, 95% CI | Year |
|---|---|---|---|---|---|---|---|
| **1.1.2 Fenoldopam** | | | | | | | |
| Bove 2005 | 4 | 40 | 3 | 40 | 100.0% | 1.36 [0.29, 6.36] | 2005 |
| **Subtotal (95% CI)** | | **40** | | **40** | **100.0%** | **1.36 [0.29, 6.36]** | |
| **1.1.4 Atrial Natriuretic Peptide** | | | | | | | |
| Sezai 2009 | 4 | 251 | 6 | 253 | 67.8% | 0.67 [0.19, 2.34] | 2009 |
| Izumi 2008 | 0 | 10 | 0 | 8 | | Not estimable | 2008 |
| Sward 2004 | 2 | 29 | 3 | 30 | 32.2% | 0.67 [0.11, 4.15] | 2004 |
| Hayashida 2000 | 0 | 9 | 0 | 9 | | Not estimable | 2000 |
| **Subtotal (95% CI)** | | **299** | | **300** | **100.0%** | **0.67 [0.24, 1.88]** | |
| **1.1.5 Brain Natriuretic Peptide** | | | | | | | |
| Ejaz 2009 | 1 | 45 | 0 | 49 | 7.4% | 8.08 [0.16, 408.45] | 2009 |
| Mentzer 2007 | 4 | 141 | 8 | 138 | 85.2% | 0.49 [0.15, 1.55] | 2007 |
| Chen 2007 | 1 | 19 | 0 | 20 | 7.4% | 7.79 [0.15, 393.02] | 2007 |
| **Subtotal (95% CI)** | | **205** | | **207** | **100.0%** | **0.74 [0.25, 2.14]** | |
| **1.1.7 Diuretics** | | | | | | | |
| Mahesh 2008 | 1 | 21 | 2 | 21 | 37.5% | 0.50 [0.05, 5.05] | 2008 |
| Carcoana 2003 | 0 | 26 | 0 | 24 | | Not estimable | 2003 |
| Lassnigg 2000 | 4 | 41 | 1 | 40 | 62.5% | 3.45 [0.57, 20.82] | 2000 |
| **Subtotal (95% CI)** | | **88** | | **85** | **100.0%** | **1.67 [0.40, 6.90]** | |
| **1.1.8 N-acetylcysteine** | | | | | | | |
| Barr 2008 | 1 | 20 | 1 | 19 | 5.1% | 0.95 [0.06, 15.76] | 2008 |
| Sisillo 2008 | 5 | 129 | 4 | 125 | 23.0% | 1.22 [0.32, 4.60] | 2008 |
| Adabag 2008 | 2 | 50 | 3 | 52 | 12.7% | 0.69 [0.11, 4.11] | 2008 |
| Haase 2007 | 0 | 30 | 1 | 30 | 2.6% | 0.14 [0.00, 6.82] | 2007 |
| El-Hamamsy 2007 | 3 | 50 | 0 | 50 | 7.8% | 7.70 [0.78, 75.76] | 2007 |
| Wijeysundera 2007 | 0 | 88 | 7 | 87 | 17.9% | 0.12 [0.03, 0.56] | 2007 |
| Ristikankare 2006 | 1 | 38 | 2 | 39 | 7.7% | 0.52 [0.05, 5.13] | 2006 |
| Burns 2005 | 5 | 148 | 4 | 147 | 23.1% | 1.25 [0.33, 4.69] | 2005 |
| **Subtotal (95% CI)** | | **553** | | **549** | **100.0%** | **0.76 [0.40, 1.44]** | |



# High-dose fenoldopam reduces postoperative neutrophil gelatinase-associated lipocaline and cystatin C levels in pediatric cardiac surgery

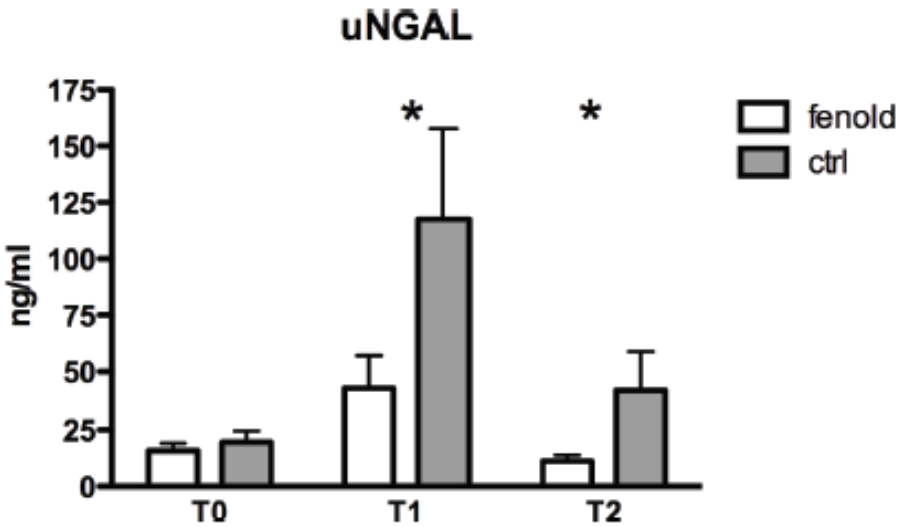



**Figure 2 Urinary neutrophil gelatinase-associated lipocaline (uNGAL) levels**. A significant increase of uNGAL levels from baseline (t0) to ICU admission (t1) and a consequent decrease after 12 hours (t2) was observed in both groups ($P = 0.025$). However, uNGAL values were significantly reduced in group F at t1 ($P = 0.02$) and t2 ($P = 0.04$) compared with group C (*).

*Ricci, Crit Care 2011*

**Insuffisance rénale aiguë**

**Epidemiologie**

**Physiopathologie**

**Diagnostic**

**Biomarqueurs**

**Prévention**

**Traitement**

**Insuffisance rénale chronique**

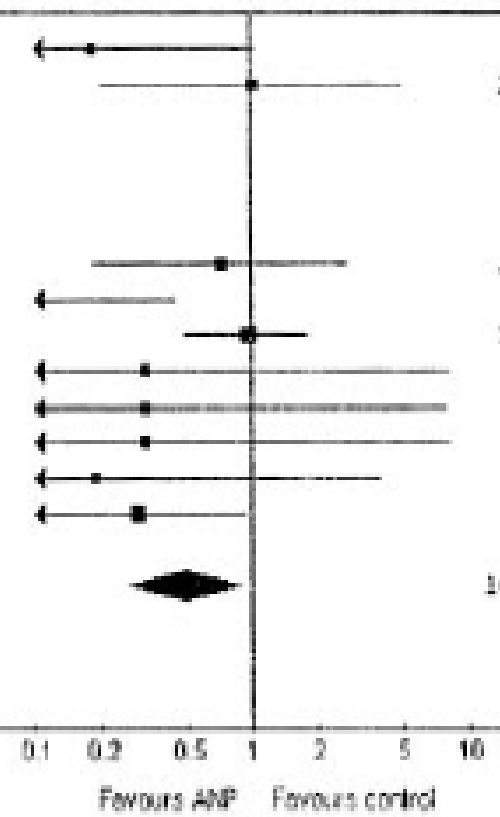
# ANP
# Effet estimé sur le recours à la dialyse lors d'une utilisation à titre curatif après une chirurgie lourde

*Nigwekar,*
*Clin J Am Soc Nephrol*
*2009*

Review: ANP in acute kidney injury (Version 08)
Comparison: 07 ANP in major surgery
Outcome: 03 Need for RRT

| Study or sub-category | ANP n/N | Control n/N | OR (random) 95% CI | Weight % | OR (random) 95% CI |
|---|---|---|---|---|---|
| Akematsu 2005 | 2/19 | 7/18 | | 9.38 | 0.18 [0.03, 1.06] |
| Brenner 1995 | 6/12 | 6/12 | | 10.81 | 1.00 [0.20, 4.95] |
| Hayashi 2003 | 0/26 | 0/24 | | | Not estimable |
| Hayashida 2000 | 0/9 | 0/9 | | | Not estimable |
| Herbert 1998 | 6/6 | 6/6 | | | Not estimable |
| Kuse 1996 | 5/5 | 4/4 | | | Not estimable |
| Langrehr 1997 | 4/33 | 6/37 | | 13.88 | 0.71 [0.18, 2.78] |
| Meyer 1997 | 0/7 | 6/7 | | 2.87 | 0.02 [0.00, 0.45] |
| Meyer 1999 | 40/114 | 21/58 | | 32.65 | 0.95 [0.49, 1.84] |
| Sezai 2000 | 0/20 | 1/20 | | 3.05 | 0.32 [0.01, 8.26] |
| Sezai 2006 | 0/71 | 1/71 | | 3.19 | 0.32 [0.01, 7.99] |
| Sezai 2006 a | 0/20 | 1/20 | | 3.05 | 0.32 [0.01, 8.26] |
| Sezai 2007 | 0/63 | 2/61 | | 3.45 | 0.19 [0.01, 3.98] |
| Sward 2004 | 6/29 | 14/30 | | 17.72 | 0.30 [0.09, 0.94] |
| Total (95% CI) | 438 | 379 | | 100.00 | 0.49 [0.27, 0.88] |

Total events: 69 (ANP), 75 (Control)
Test for heterogeneity: ChF = 11.13, df = 9 (P = 0.27), F = 19.1%
Test for overall effect: Z = 2.40 (P = 0.02)



## Les moyens de l'épuration extra-rénale (EER)

- DP (peritoneal dialysis) : gradient osmotique et de concentration

- Méthodes d'épuration continues CRRT :
  - CVVH (continuous veno-venous hemofiltration) : gradient de pression hydrostatique
  - CVVHD (continuous veno-venous hemodialysis) : gradient de concentration
  - CVVHDF (continuous veno-venous hemodiafiltration) : les deux

- HDI (intermittent hemodialysis) : gradient de pression hydrostatique et de concentration

Liquide de dialysat en pédiatrie : iso-osmotique, tampon bicarbonate

# Choix d'un mode d'EER en pédiatrie

| Mode d'EER | DP | CRRT | HDI |
|---|---|---|---|
| Avantages, indications | Correction rapide d'une hyperkaliémie<br>Surcharge hydrique modérée<br>Facilité de la voie d'accès | Correction rapide d'une hyperkaliémie<br>Surcharge hydrique majeure (OAP, sepsis) : hémofiltration<br>Clearance des grosses molécules : dialyse | Correction rapide d'une hyperkaliémie<br>Surcharge hydrique majeure (OAP, sepsis)<br>Clearance des grosses molécules |
| Contre-indications | Défaut de paroi, hernie diaphragmatique<br>Infection, tumeur, chirurgie abdominale récente<br>ECUN<br>Dérivation ventriculo-péritonéale<br>Mauvaise tolérance dans les cardiopathies précharge-dépendantes | Coagulopathie | Coagulopathie<br>Instabilité hémodynamique |

# La dialyse péritonéale chez le nourrisson < 1an

- Assure une ultrafiltration d'environ 4ml/kg/h chez le nouveau-né et 2,5-3,5 ml/kg/h chez le nourrisson
- Assure une clearance de la créatinine de 2 à 20ml/min/1,73m$^2$ chez le nouveau-né
- *Necker Enfants –Malades, 2000-2008* : une complication grave de la DP à été enregistrée pour 25.4jours de DP

## Indications de L’EER à Necker

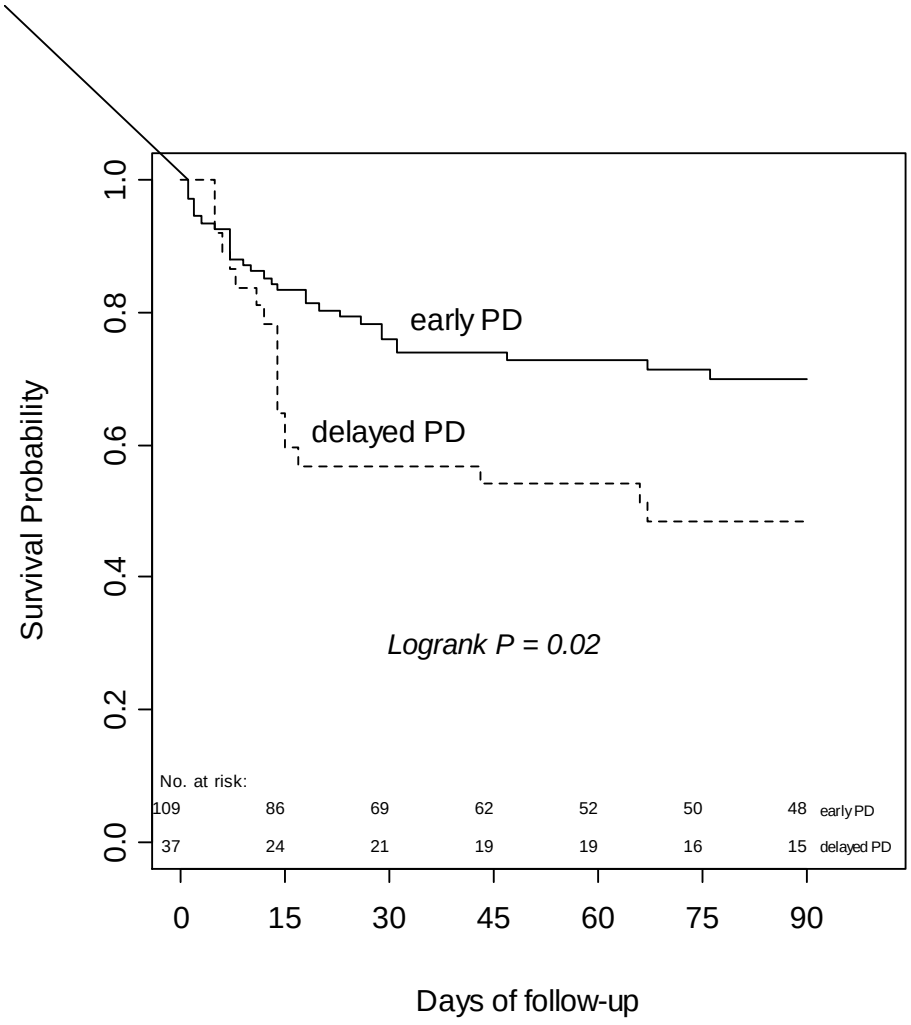
- **L'oligurie** : diurèse < 2ml/kg/h (1ml/kg/h) qui persiste au-delà de **4heures** malgré l'optimisation de la précharge, des constantes hémodynamiques
- La surcharge hydrique
- Le contexte de bas débit
- Les complications métaboliques

# Time to initiation of peritoneal dialysis and short-term outcome in neonates and infants with acute kidney injury following congenital cardiac surgery

3550 patients <1 an opérés entre 2000-2009, parmi lesquels 146 ont été dialysés

Délai avant début de la dialyse: 0 – 21 jours, médiane 1 jour

Mortalité à 30 jours: 28.1%
Mortalité globale: 36.6%




HR ajusté sur l'année: 0.52 [0.29 – 0.85]

Insuffisance rénale aiguë

Epidemiologie

Physiopathologie

Diagnostic

Biomarqueurs

Prévention

Traitement

## Insuffisance rénale chronique

# L'atteinte rénale chronique dans les cardiopathies congénitales

## Prevalence, Predictors, and Prognostic Value of Renal Dysfunction in Adults With Congenital Heart Disease

Konstantinos Dimopoulos, MSc, MD; Gerhard-Paul Diller, MD; Evdokia Koltsida, MD; Antonia Pijuan-Domenech, MD; Sofia A. Papadopoulou, MD; Sonya V. Babu-Narayan, BSc, MRCP; Tushar V. Salukhe, BSc, MRCP; Massimo F. Piepoli, MD, PhD; Philip A. Poole-Wilson, MD, FRCP; Nicky Best, BSc, MSc, PhD; Darrel P. Francis, MA, MD, MRCP; Michael A. Gatzoulis, MD, PhD

***Background***—Renal insufficiency in patients with ischemic heart disease and acquired heart failure is associated with higher mortality and morbidity. We studied the prevalence of renal dysfunction in adult patients with congenital heart disease (ACHD) and its relation to outcome.

***Methods and Results***—A total of 1102 adult patients with congenital heart disease (age 36.0±14.2 years) attending our institution between 1999 and 2006 had creatinine concentration measured. Glomerular filtration rate (GFR) was calculated with the Modification of Diet in Renal Disease equation. Patients were divided into groups of normal GFR ($\geq$90 mL · min$^{-1}$ · 1.73 m$^{-2}$), mildly impaired GFR (60 to 89 mL · min$^{-1}$ · 1.73 m$^{-2}$), and moderately/severely impaired GFR ($<$60 mL · min$^{-1}$ · 1.73 m$^{-2}$). Survival was compared between GFR groups by Cox regression. Median follow-up was 4.1 years, during which 103 patients died. Renal dysfunction was mild in 41% of patients and moderate or severe in 9%. A decrease in GFR was more common among patients with Eisenmenger physiology, of whom 72% had reduced GFR ($<$90 mL · min$^{-1}$ · 1.73 m$^{-2}$, $P<0.0001$ compared with the remainder), and in 18%, this was moderate or severe ($P=0.007$). Renal dysfunction had a substantial impact on mortality (propensity score–weighted hazard ratio 3.25, 95% CI 1.54 to 6.86, $P=0.002$ for moderately or severely impaired versus normal GFR).

***Conclusions***—Deranged physiology in adult patients with congenital heart disease is not limited to the heart but also affects the kidney. Mortality is 3-fold higher than normal in the 1 in 11 patients who have moderate or severe GFR reduction. (***Circulation*. 2008;117:2320-2328.**)

# Critères KDIGO 2012

1. L'estimation du DFG doit se faire par une équation utilisant la créatinine, et si le DFG estimé est pathologique, il est conseillé de le vériofier en utilisant une équation utilisant la cystatine

bedside CKiD equation : $eGFR_{CKiD} = 0.413 * heigh/sCr$

Zappitelli equation: $eGFR_{ZAP} = (507.76 * e^{0.003 \times height})/sCysC^{0.635} * creat^{0.547}$

2. L'estimation de la fonction rénale comprend, au même titre que la mesure/estimation du DFG, la mesure de l'albuminurie

## Prognosis of CKD by GFR and albuminuria category

**Prognosis of CKD by GFR and Albuminuria Categories: KDIGO 2012**

| GFR categories (ml/min/ 1.73 m$^2$) Description and range | | | | Persistent albuminuria categories Description and range | | |
|---|---|---|---|---|---|---|
| | | | | A1 | A2 | A3 |
| | | | | Normal to mildly increased | Moderately increased | Severely increased |
| | | | | <30 mg/g <3 mg/mmol | 30-300 mg/g 3-30 mg/mmol | >300 mg/g >30 mg/mmol |
| | G1 | Normal or high | ≥90 | | | |
| | G2 | Mildly decreased | 60-89 | | | |
| | G3a | Mildly to moderately decreased | 45-59 | | | |
| | G3b | Moderately to severely decreased | 30-44 | | | |
| | G4 | Severely decreased | 15-29 | | | |
| | G5 | Kidney failure | <15 | | | |

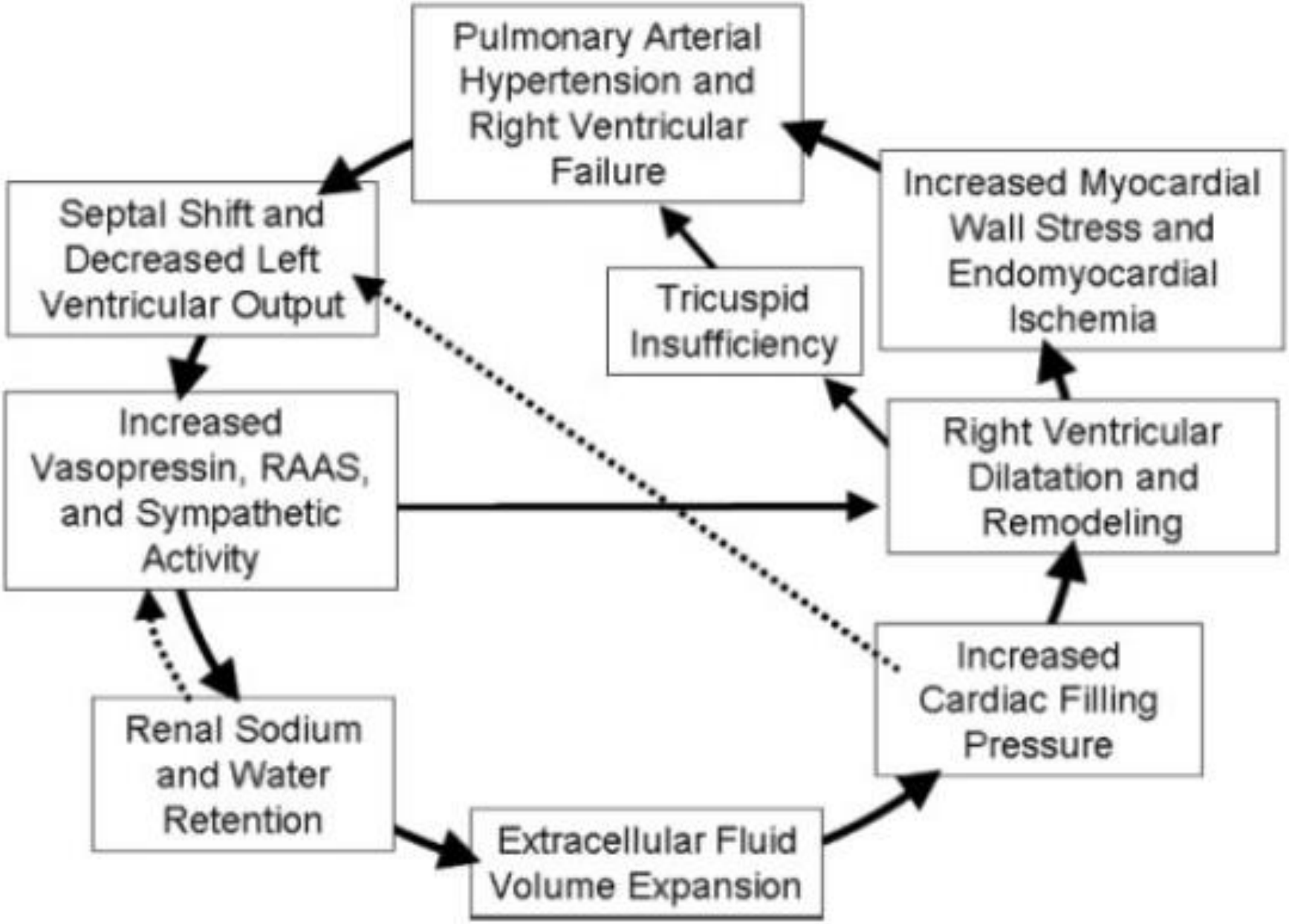
**Green: low risk (if no other markers of kidney disease, no CKD); Yellow: moderately increased risk; Orange: high risk; Red, very high risk.**

## Facteurs de risque IRC dans les cardiopathies congénitales

1. La cyanose / viscosité
    - hyperfiltration glomérulaire -> glomérulomégalie -> protéinurie
    - augmentation des résistances vasculaires postcapillaires -> protéinurie tubulaire

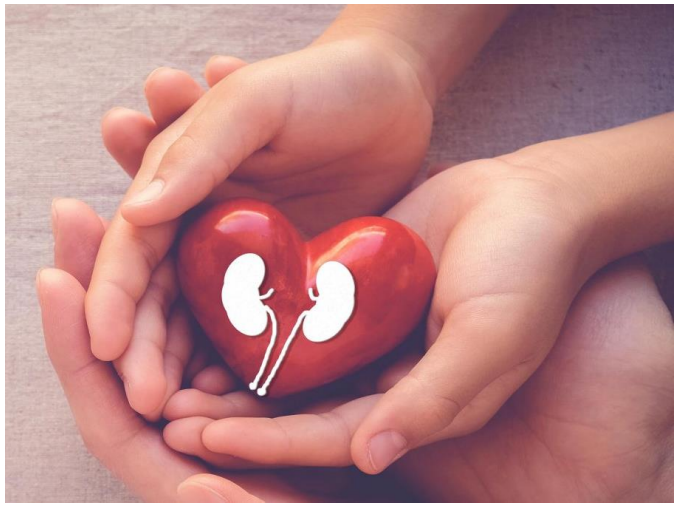
2. La défaillance VG (syndrome cardio-rénal)
    - Bas débit chronique -> stimulation du système rénine – angiotensine-aldostérone -> rétention hydro-sodé

3. Défaillance du VD
    - Clearance créatinine corrélée avec la résistance vasculaire pulmonaire et la PVC (*Anne, Int J Cardiol 2009)*




*Schrier, CJASN 2008*

# Conclusions



L'IRA est une complication sévère après chirurgie cardiaque pédiatrique

La découverte des nouveaux biomarqueurs de l'IRA représente un progrès majeur, permettant un diagnostic précoce

Il n'existe, à présent, aucune thérapie spécifique pour prévenir, atténuer ou accélérer la récupération de la fonction rénale en pédiatrie; la miniaturisation des circuits de CEC diminue son incidence

Le traitement de l'IRA reste conservateur; l'instauration précoce de la dialyse dans l'IRA grave améliore la survie

Le dépistage de l'IRC devrait faire partie du bilan de routine des patients porteurs de cardiopathie congénitale