CRRT vs IHD in ICU, nephrologist's point of view

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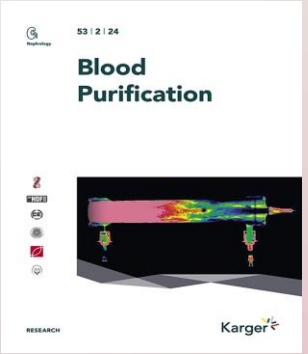
did you know?

Practice patterns for continuous renal replacement therapy (CRRT) are extremely variable. Broadly speaking, CRRT is almost exclusively applied to patients in the intensive care unit (ICU).

Patient-level epidemiologic studies, surveys of self-reported practice patterns and several large case series have documented large variation in clinical practice.

In 1996, Mehta and Letteri surveyed 2,000 nephrologists in the US and found that less than 25% of patients with acute renal failure were treated with CRRT. The use of CRRT is much more common in Europe, although its use is highly variable between centers, while CRRT is the predominant (>90%) choice in Australia .



Patient Selection and Timing of Continuous Renal Replacement Therapy

Marlies Ostermann[a] MichaelJoannidis[b] AntonelloPani[c] MatteoFloris[c] Silvia De Rosa[d] John A. Kellum[e] Claudio Ronco[d] on behalf of the 17th Acute Disease Quality Initiative (ADQI) Consensus Group

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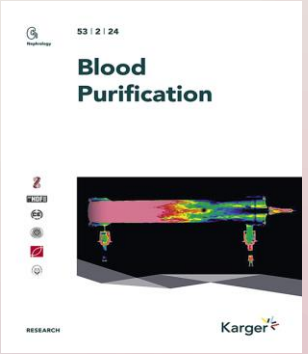
ADQI Consensus 2016;42:224-237

did you know?

In general, it appears that the decision to use CRRT is affected by strongly held physician beliefs as well as a number of patient and organizational characteristics. Patient characteristics may include age, gender, race, illness acuity and comorbidities.

Organizational characteristics vary depending on country, type of institution, type of ICU, type of physician or insurance provider and perceived cost of therapy. However, the strength of association of these characteristics with the decision to use CRRT is not fully understood.

Furthermore, large epidemiological studies are needed to establish the factors that are most important in determining practice patterns, and whether there are important access-to-care issues.



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Acute Kidney Injury

- AKI replaces concept of ‘acute renal failure’ – describes injury to kidney that can occur before function fails
- AKI is a predictor of immediate and long-term adverse outcomes and imposes a heavy burden of illness
- Associated with significant morbidity and mortality
- AKI is amenable to early detection and potential prevention

What is acute kidney injury?

- Involves a number of conditions that affect kidney structure and function, a broad clinical syndrome encompassing many aetiologies such as .....
- Specific kidney diseases e.g. acute interstitial nephritis, acute glomerular and vasculitic renal diseases
- Non-specific kidney conditions e.g. Ischaemia, toxic injury
- External pathology e.g. pre-renal azotaemia, and acute post-renal obstructive nephropathy
- More than one of these conditions can coexist in the same patient.
- Decline in renal excretory function over hours or days resulting in failure to maintain fluid, electrolyte and homeostasis

Causes of AKI

Exposures	Susceptibilities
Sepsis	Dehydration or volume depletion
Critical illness	Advanced age
Circulatory shock	Female gender
Burns	Black race
Trauma	CKD
Cardiac surgery (especially with CPB)	Chronic diseases (heart, lung, liver)
Major non cardiac surgery	Diabetes mellitus
Nephrotoxic drugs	Cancer
Radio contrast agents	Anaemia
Poisonous plants and animals	

(CKD, chronic kidney disease; CPB, cardiopulmonary bypass)

Risk factors

- Age over 65 years
- History of AKI
- Chronic kidney disease (eGFR < 60ml/min/1.73m2)
- Sepsis
- Hypovolaemia
- Oliguria i.e. urine output < 0.5ml/kg/hr
- Nephrotoxic drug use within the last week e.g. NSAIDs, ACE inhibitors, diuretics
- Exposure to iodinated contrast agents within the last week
- Immunosuppression e.g. HIV infection
- Toxins e.g. some herbal remedies, poisonous plants and animals

Complications

- Hyperkalaemia
- Other electrolyte imbalances
- Metabolic acidosis
- Volume overload
- Uraemia
- Chronic kidney disease and end-stage renal disease

Initial management of AKI

- Identifying the aetiology of AKI
- Treating reversible causes e.g. hypotension, volume depletion or urinary tract obstruction
- Removing any active insults to minimise new injury
- Identifying and treating the complications that may eventually require RRT at a later period of time if AKI doesn’t resolve

Goals of renal replacement therapy

- Correction of acid-base balance
- Removal of anti-inflammatory mediators
- Correction of electrolyte imbalance
- Prevention of fluid overload
- Maintenance of cardiovascular stability
- Access for nutritional support

Overdose with a dialysable drug or toxin

Other indications for treatment: overdose with a dialysable drug or toxin.

Some drugs are removed by RRT but some are not. As a general rule, drugs are cleared by RRT if they are water-soluble and not highly protein-bound. Examples of drugs/toxins that are either removed or not removed by RRT are outlined below.

Drugs/toxins removed	Drugs/toxins not removed
• Lithium • Methanol • Ethylene glycol • Salicylates • Barbiturates • Metformin • Aminoglycosides, metronidazole, carbapenems, cephalosporins and most penicillins.	• Digoxin • Tricyclics • Phenytoin • Glicazide • Beta-blockers (except atenolol) • Benzodiazepines • Macrolide and quinilone antibiotics • Warfarin

Table 1. Characteristics of different modalities of renal replacement therapy for acute kidney injury in ICU

Characteristics	Intermittent hemodialysis	Sustained low-efficiency dialysis	Continuous renal replacement therapy
RRT duration	Intermittent, three times a week, 3–5 h each session	Intermittent, daily, 6–8 h each session	Continuous until filters are clotted or no need for RRT
Doses	Based on URR and Kt/V_{urea} for quantification		~25 ml/kg/h
Anticoagulation	Short exposure	Extended exposure	Often continuous exposure

CRRT? **IHD?** **SLED?**

Wang AJ, Bellomo R. Curr Opin Crit Care 2018; 24: 437-42

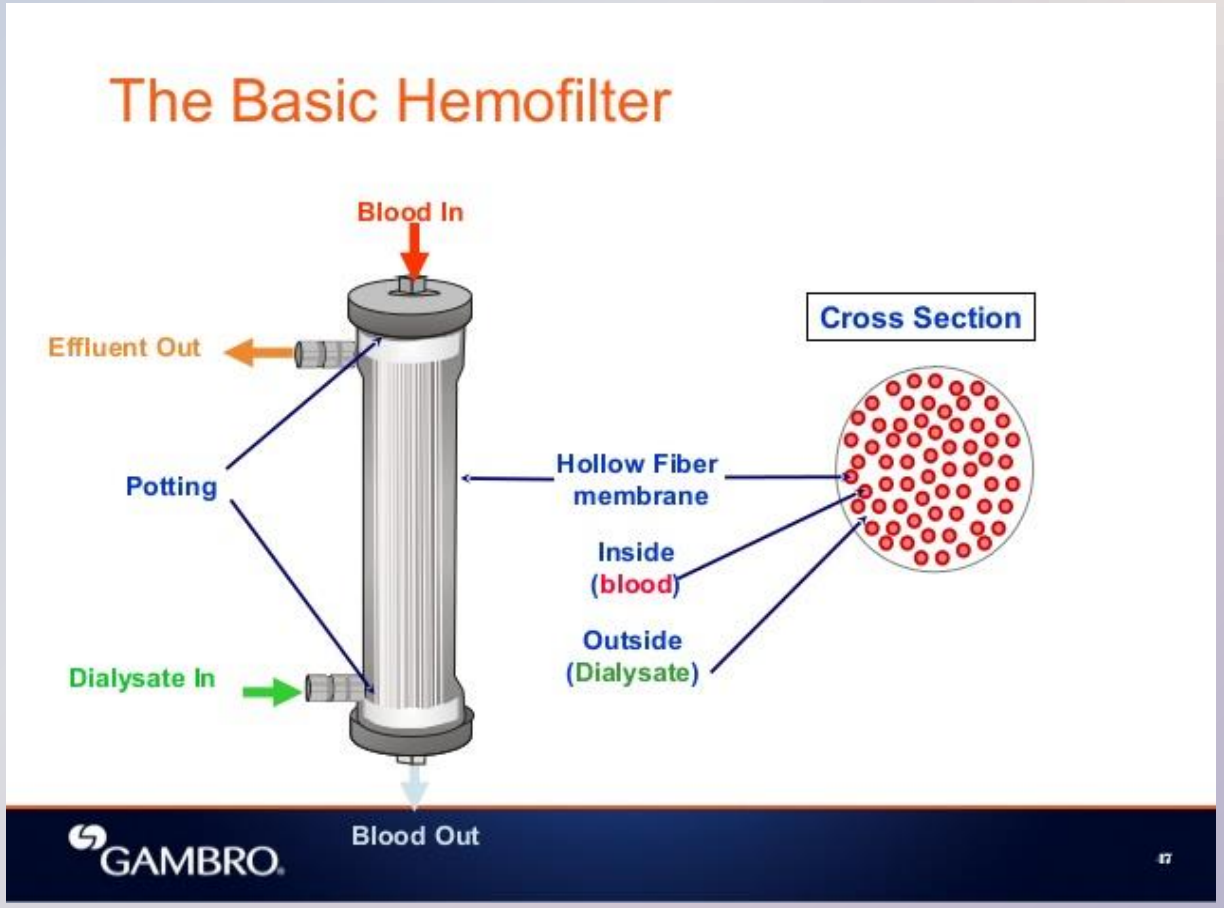
Choice of RRT techniques in the ICU

1. Intermittent haemodialysis (IHD)
2. Continuous renal replacement therapy (CRRT)

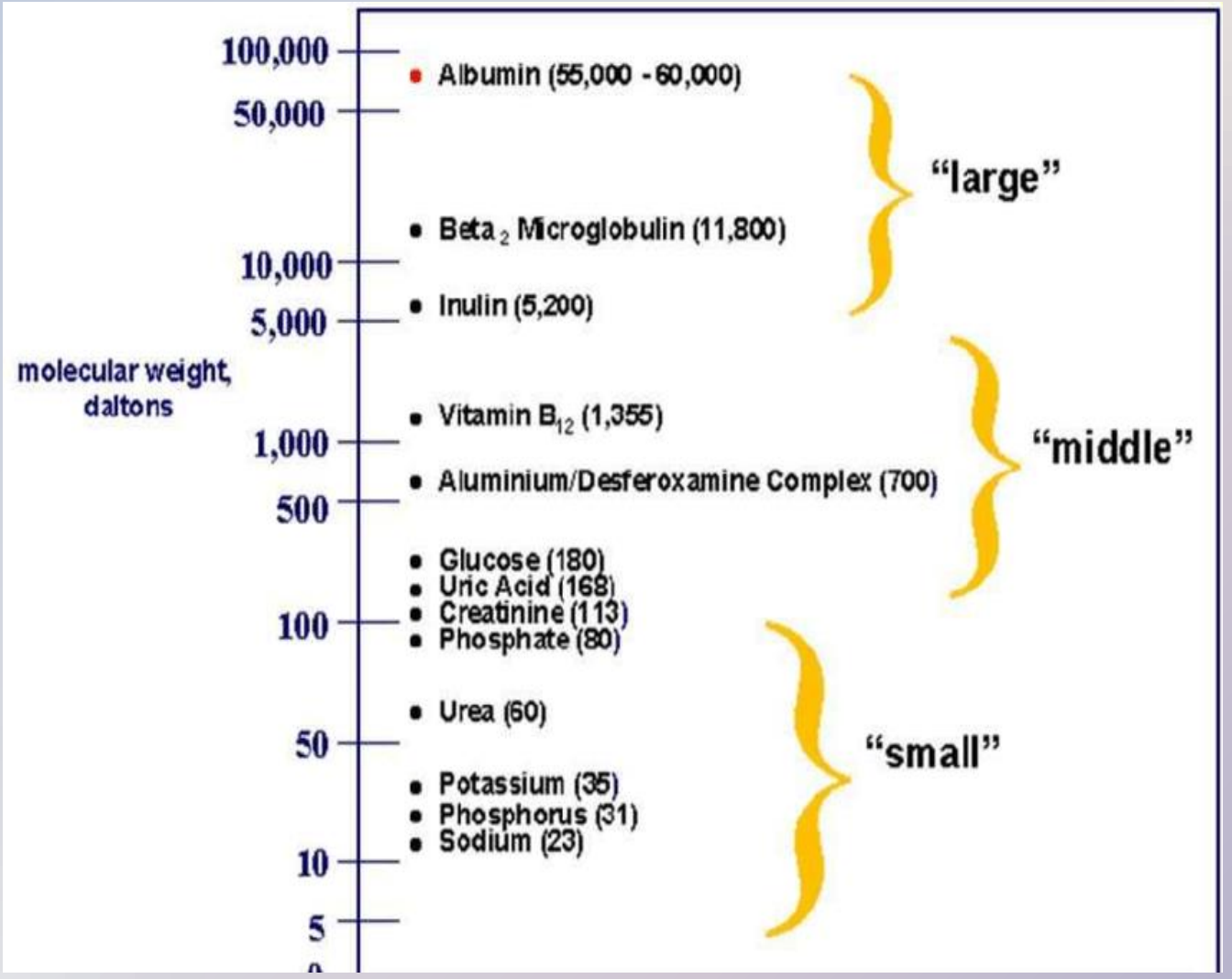
The functional difference between the above techniques above can be classified in terms of

- The mechanism of solute removal i.e. convection versus diffusion
- The duration of treatment i.e. continuous versus intermittent

Basic anatomy of the filter



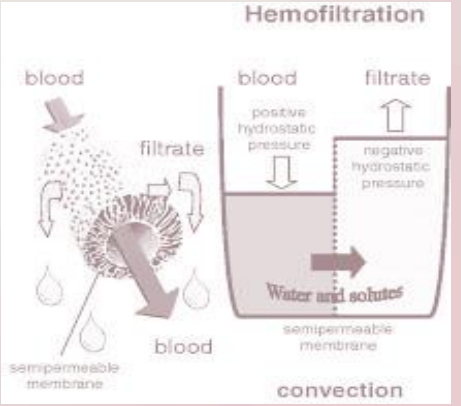
Solute clearance/molecular weight



Factors affecting pharmokinetics whilst on RRT

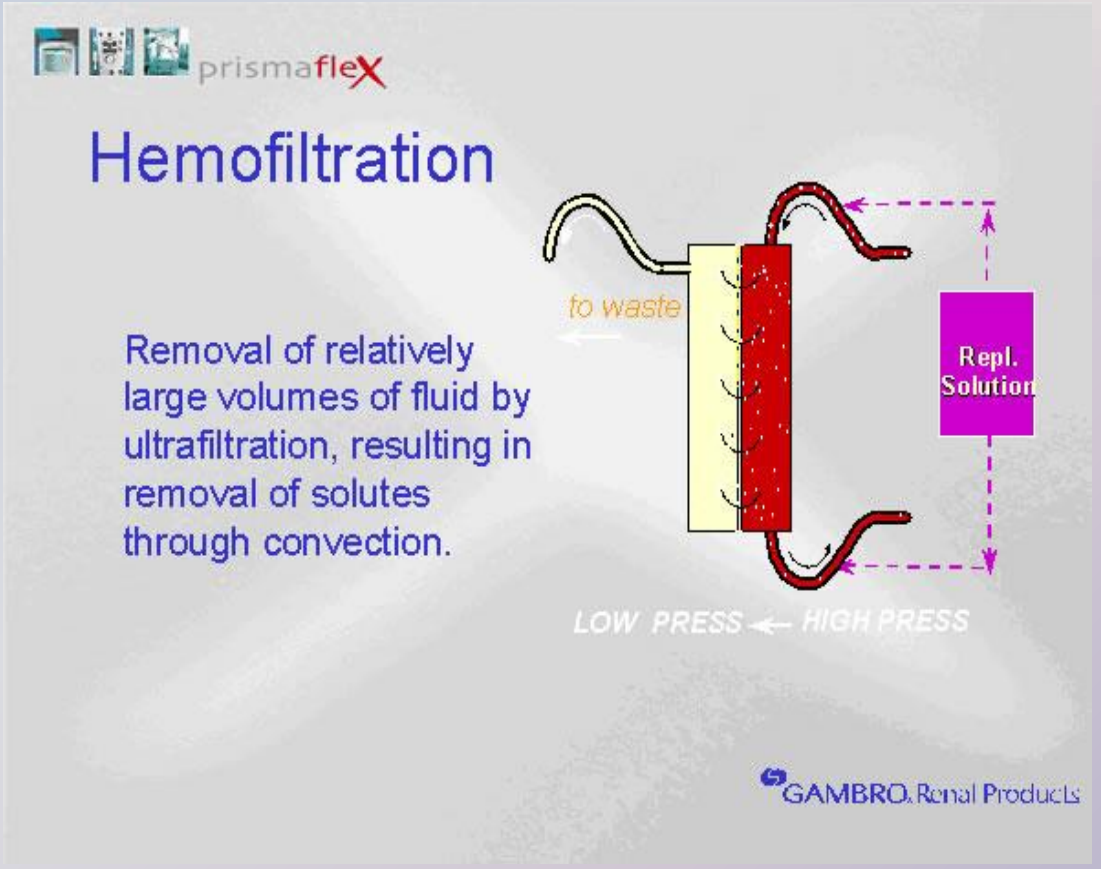
- Protein binding
- Size of drug molecule and mode of RRT
- Timing of RRT: IHD v CRRT
- Dose of RRT
- Membrane permeability

Convection



- Solute removal is by solvent drag across the semi-permeable membrane
- This relies on a pressure gradient (blood)
- Highly kinetic process
- Pre-dilution fluid flows in the ***same direction*** of the blood
- Convection extremely efficient at ***middle*** molecule ***molecule clearance*** i.e. > 500 daltons

Haemofiltration



Advantages of haemofiltration

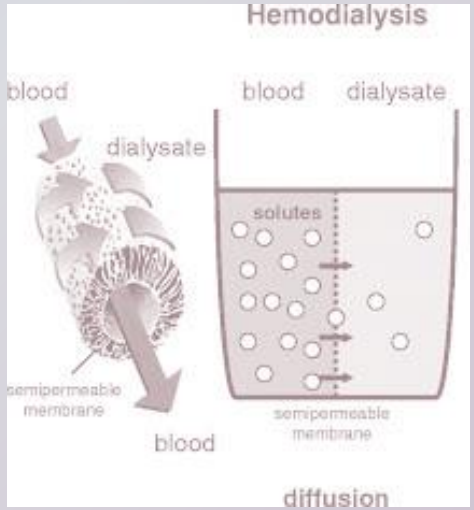
- Best suited for haemodynamically unstable patients
- Creates less haemodynamic disturbance
- Prevents large fluid shifts over time
- Gentler means of clearing urea and electrolytes
- Better control of fluid balance
- More flexibility for drugs and nutrition
- Clearance of middle molecules (> 500 Da)

Haemofiltration “Disadvantages”

- Slower at small molecule clearance (< 500Da)
- Heat loss
- Patient immobility
- More labour intensive and expensive than IHD

Diffusion

- Relies on a ***concentration*** gradient
- Solutes move across the membrane from a high concentration to a low concentration
- Dialysate flows ***countercurrent*** to the flow of blood.
- Passive process – doesn't require energy or work.

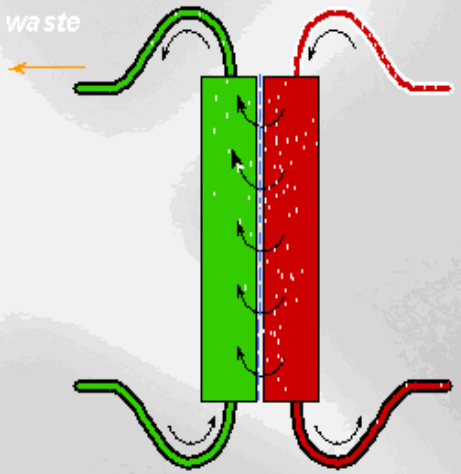


Haemodialysis

prismaflex

Hemodialysis

Movement of small solutes by diffusion through the addition of dialysate to the fluid side of the filter.



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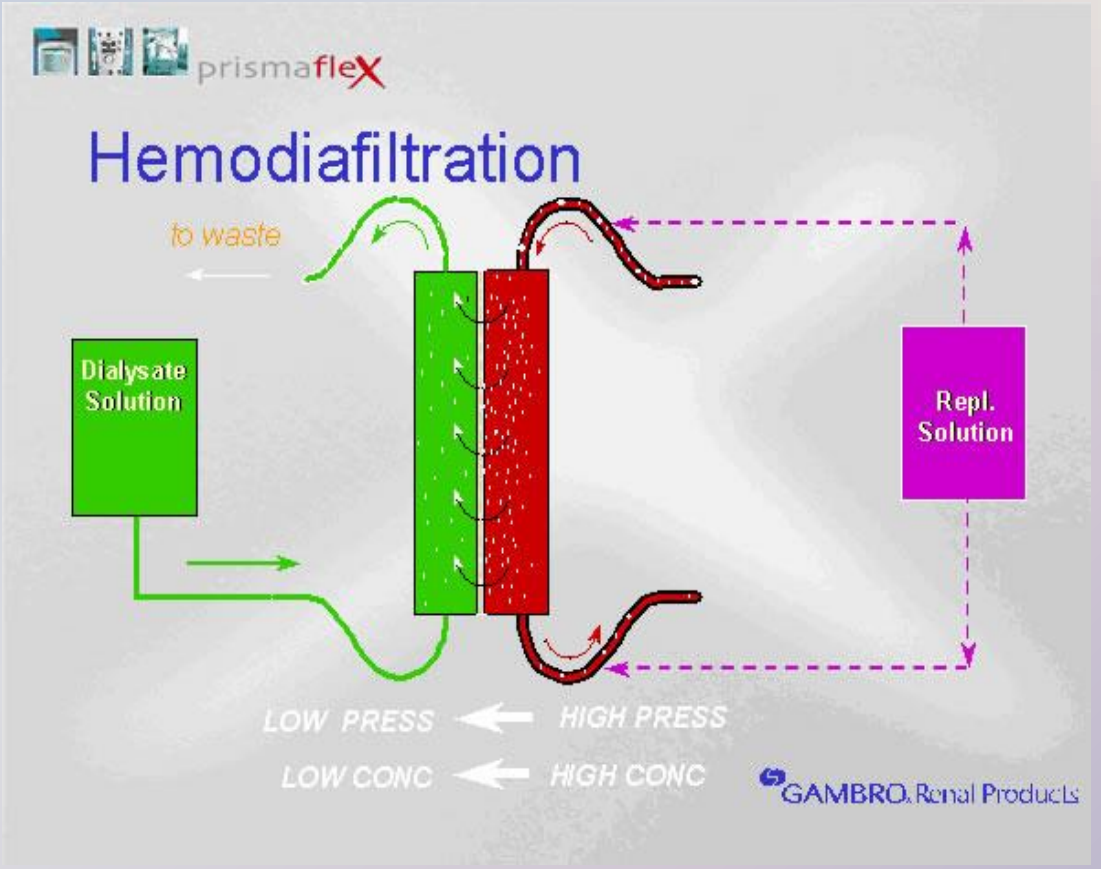
Advantages of haemodialysis

- Intermittent treatment
- Short treatment
- Rapid removal and clearance of toxins
- Efficient at clearing small molecules (<500 Da)

Disadvantages of haemodialysis

- Poorly tolerated by haemodynamically unstable patients
- High flow rates and rapid fall in plasma osmolality
- Hypotension
- Arrythmias
- Muscular complications
- Disequilibrium syndrome

Haemodiafiltration



Clearance using both convection and diffusion

Basic Components in CRRT

Hemofilter

Solutions

CRRT

CRRT System

Anticoagulation

Blood Warmer

Vascular access

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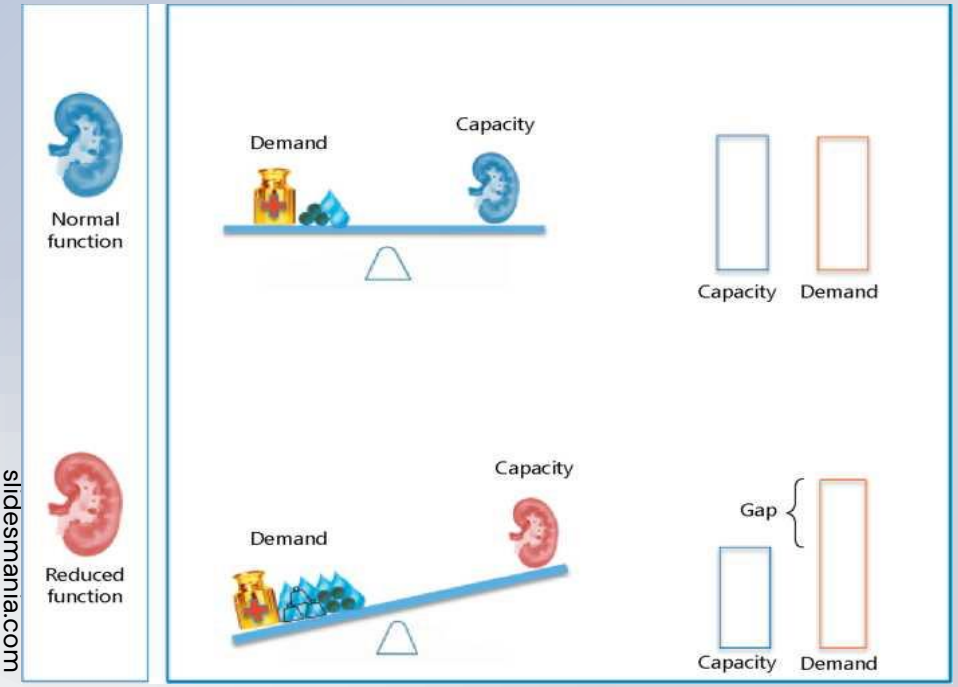
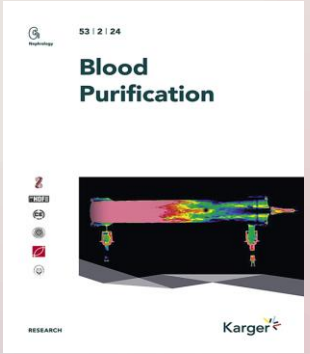
did you know?

When Should Acute Renal Replacement Therapy Be Initiated?

Consensus statement 1.1: Acute RRT should be considered when metabolic and fluid demands exceed total kidney capacity.



Demand	Capacity	Example
High	Normal	High catabolic state in patients with normal renal function
High	Low	High catabolic state in patient with AKI or CKD
Normal	Low	Normal catabolic state in patient with AKI or CKD
Low	Low	Malnutrition in patient with AKI or CKD



Patient Selection and Timing of Continuous Renal Replacement Therapy

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ADQI Consensus 2016;42:224-237

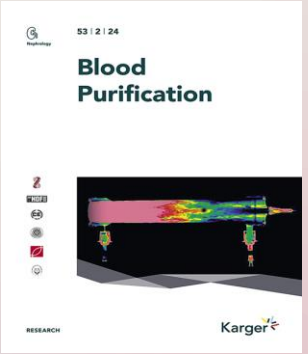
Costanzo MR, Saltzberg MT, Jessup M, et al: Ultrafiltration is associated with fewer rehospitalizations than continuous diuretic infusion in patients with decompensated heart failure: results from UNLOAD. J Card Fail 2010;16:277-284.

Costanzo MR, Negoianu D, Jaski BE, et al: Aquapheresis versus intravenous diuretics and hospitalizations for heart failure. JACC Heart Fail 2016;4:95-105.

Bart BA, Goldsmith SR, Lee KL, et al: Ultrafiltration in decompensated heart failure with cardiorenal syndrome. N Engl J Med 2012; 367: 2296-2304.

Payen D, Mateo J, Cavaillon JM, Fraisse F, Floriot C, Vicaut E; Hemofiltration and Sepsis Group of the College National de Reanimation et de Medecine d'Urgence des Hopitaux extra-Universitaires: Impact of continuous venovenous hemofiltration on organ failure during the early phase of severe sepsis: a randomized controlled trial. Crit Care Med 2009; 37:803-810.

Joannidis M, Forni LG: Clinical review: timing of renal replacement therapy. Crit Care 2011;15:223.



The decision between ultrafiltration (UF) alone versus RRT depends on whether only fluid removal or fluid removal and solute clearance are necessary, Studies investigating the role of UF alone in CCF have shown conflicting results.

RRT is also effective at removing biologically active substances, including cytokines but there is still insufficient evidence to recommend the routine use of CRRT for the treatment of sepsis. In fact, an RCT comparing early continuous veno-venous hemofiltration (CVVH) versus standard medical treatment in severe sepsis showed that outcome was not improved with CVVH .

Finally, in cases of intoxication with a dialyzable/filterable drug or toxin, RRT may also have a role depending on the specific substance to be removed .

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did you know?

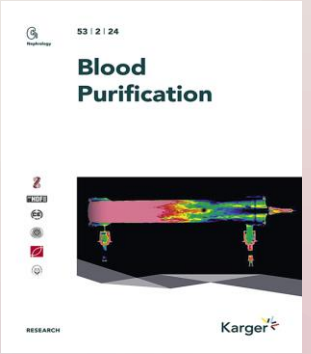
Consensus statement 1.2: Demand for kidney function is determined by non-renal comorbidities, the severity of the acute disease and solute and fluid burden

In critically ill patients, the demands on kidney func-tion depend on 3 main factors:

(i) severity of the acute disease as measured by degree of inflammation, hemody-namic disturbance, alterations in macro- and microcircu-lation and metabolic stress;

(ii) degree of solute load and fluid accumulation; and

(iii) underlying chronic diseases that impact the ability to tolerate volume or solute load



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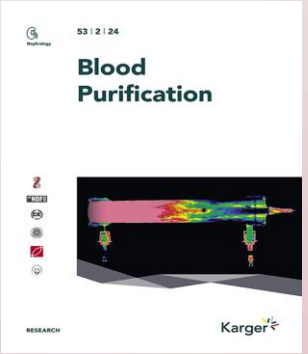
did you know?

Consensus statement 1.4: The demand-capacity imbalance is dynamic and should be evaluated regularly.

Consensus statement 1.5: For patients requiring multiple types of organ support, decisions about initiat¬ing or withholding RRT should be considered together with other therapies

Consensus statement 1.6: Once the decision to initiate RRT has been made, the therapy should be started as soon as possible, typically within less than 3 h.



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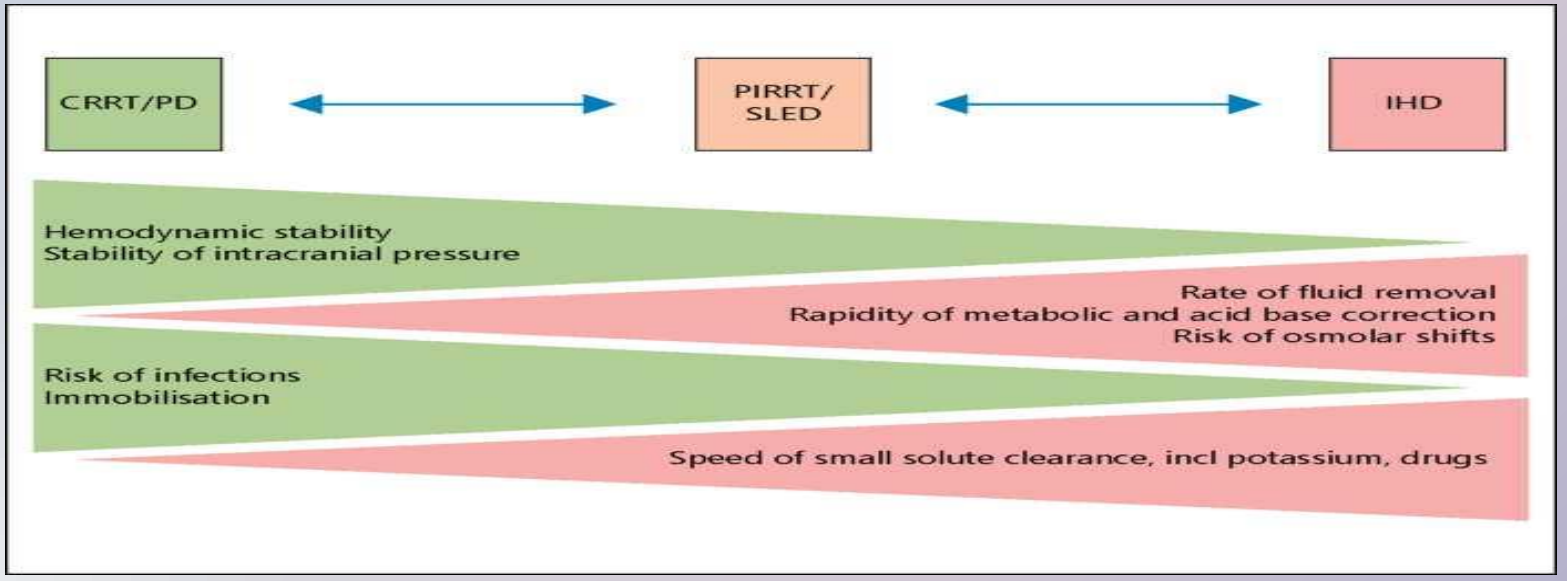
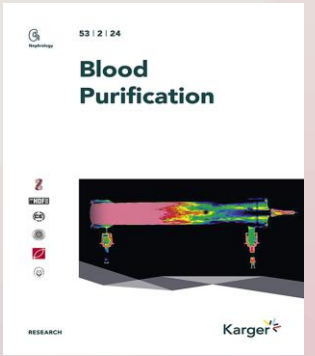
did you know?

What Is the Most Appropriate Therapy to Meet a Demand-Capacity Imbalance for a Specific Patient?

Consensus statement 2.1: Selection of RRT modality depends on the capability/availability of the technology, its inherited risks and the current needs of the patient.





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CRRT

The most appropriate modality in ICU for patients with:

- brain edema
- increased intracranial pressure
- acute brain injury
- fulminant hepatic failure
- head trauma

Wang AJ, Bellomo R. Curr Opin Crit Care 2018; 24: 437-42.
Macedo E, Cerda J. Semin Dial 2021; 34:423-31.
Karkar A, Ronco C. Ann Intensive Care 2020; 10:32.

IHD

- Use of higher flow rates than CRRT to maintain fluid, electrolytes and acid-base balance
- For hemodinamically stable patients
- More suited for patients who require faster removal of uremic toxins and control of electrolyte and acid-base disturbance
- The same IHD machine available for several patients in a same day
- Associated with an increased risk of hypotension, renal ischemia

let’s review some facts.

Both CRRT and IHD achieve adequate metabolic control, and neither modality has been shown to be superior in terms of survival

some studies suggest that the choice of initial RRT modality may affectrenal recovery and dialysis dependence after AKI, which has implications for patients, their families and healthcare systems in terms of survival, quality of life and costs

The question whether IHD compared to CRRT is associated with less renal recovery and a higher risk of dialysis dependence was addressed in a meta-analysis of 7 RCTs and 16 observational studies.

Analysis of the RCTs only concluded that there was no difference in rate of dialysis dependence among survivors (RR 1.15; 95% CI 0.78-1.68; I^2 = 0%).

In a large observational study published following this meta-analysis, Wald et al. reported that CRRT, when compared to IHD as the initial modality of RRT in critically ill adults with AKI, was associated with a lower likelihood of chronic dialysis (hazard ratio 0.75; 95% CI 0.65-0.87). However, this analysis included some centers that only used one modality.

Rabindranath K, Adams J, Macleod AM, Muirhead N: Intermittent versus continuous renal replacement therapy for acute renal fail¬ure in adults. Cochrane Database Syst Rev 2007; 3:CD003773.
Bagshaw SM, Berthiaume LR, Delaney A, et al: Continuous versus intermittent renal re-placement therapy for critically ill patients with acute kidney injury: a meta-analysis. Crit Care Med 2008;36:610-617.
Pannu N, Klarenbach S, Wiebe N, et al: Renal replacement therapy in patients with acute re-nal failure: a systematic review. JAMA 2008; 299: 793-805.
Ethgen O, Schneider AG, Bagshaw SM, Bel- lomo R, Kellum JA: Economics of dialysis de-pendence following renal replacement thera-py for critically ill acute kidney injury patients. Nephrol Dial Transplant 2015;30:54-61.
Schneider AG, Bellomo R, Bagshaw SM, Glassford NJ, Lo S, Jun M, Cass A, Gallagher M: Choice of renal replacement therapy mo-dality and dialysis dependence after acute kid¬ney injury: a systematic review and meta-anal¬ysis. Intensive Care Med 2013;39:987-997.
Wald R, Shariff SZ, Adhikari NK, Bagshaw SM, Burns KE, Friedrich JO, Garg AX, Harel Z, Kitchlu A, Ray JG: The association between renal replacement therapy modality and long¬term outcomes among critically ill adults with acute kidney injury: a retrospective cohort study. Crit Care Med 2014;42:868-877.

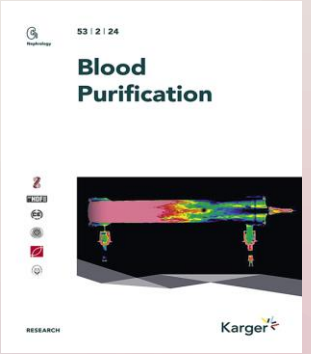
did you know?

Consensus statement 2.3: Availability of technologies is determined by local regulations, local resources, including staff, their training/experience and laboratory support and financial constraints. The choice of the technologies that should be made available must balance these issues.

Cost considerations with RRT vary substantially among centers. A study from 2010 identified the relative impact of 4 cost domains (nurse staffing, fluid, anticoagulation and extracorporeal circuit) on overall cost dif-erences and found that the theoretic range of costs were from $3,629.80/day more with CRRT to $378.60/day more with IRRT.

The median difference in cost between CRRT and IRRT was $289.60 (interquartile range 830.8-116.8) per day (greater with CRRT). Costs also vary greatly by region.

For instance, a RCT conducted in Germany compared slow efficiency dialysis (SLED) ver-sus CVVH and estimated daily costs of €96.8 and €258.9, respectively [53]. Training and experience are both important because centers with very few patients requiring a specific form of support will not be able to maintain competencies with that therapy.



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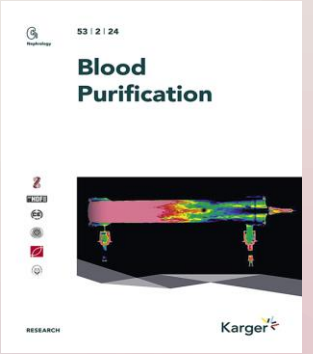
ADQI Consensus 2016;42:224-237

did you know?

Consensus statement 3.1: In situations where other extracorporeal therapies are required, continuous RRT is recommended and integrated systems are preferred over parallel systems.

The evolution of extracorporeal life support (ECLS) technology has expanded the therapeutic options for patients with multi-organ failure and those undergoing car-diothoracic surgery or transplantation. The spectrum of ECLS includes veno-arterial (VA) or veno-venous (VV) extracorporeal membrane oxygenation (ECMO), VA or VV extracorporeal CO2 removal (ECCO2R), ventricular assist devices (VADs), extracorporeal liver assist devices (ELADs), apheresis treatment, including therapeutic plasma exchange (TPE) and renal replacement therapy (RRT).

The practice of combining RRT with other forms of ECLS is rapidly increasing. However, high quality evi-dence-based data are still lacking and clinical practice is variable



Patient Selection and Timing of Continuous Renal Replacement Therapy

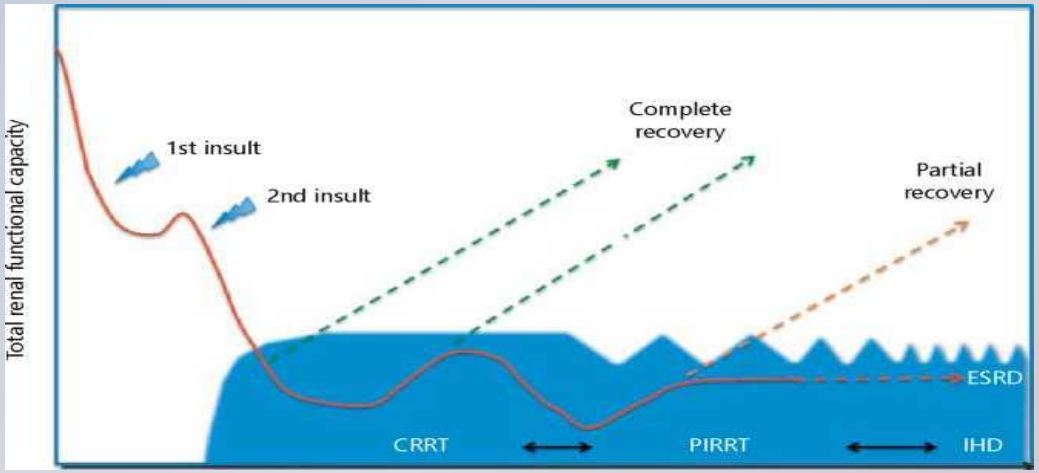
Marlies Ostermann[a] MichaelJoannidis[b] AntonelloPani[c] MatteoFloris[c] Silvia De Rosa[d] John A. Kellum[e] Claudio Ronco[d] on behalf of the 17th Acute Disease Quality Initiative (ADQI) Consensus Group

[a] Department of Nephrologyand Critical Care, Guy's and St. Thomas' Hospital, London, UK; [b]Division of Intensive Care and Emergency Medicine, Department of Internal Medicine, Medical University Innsbruck, Innsbruck, Austria; [c]Renal Unit, Ospedale 'G. Brotzu', Cagliari, and [d] Department of Nephrology, Dialysis and Transplantation, International Renal Research Institute of Vicenza, San Bortolo Hospital, Vicenza, Italy; [e]Center for Critical Care Nephrology, CRISMA, Department of Critical Care Medicine, University of Pittsburgh School of Medicine, Pittsburgh, Pa., USA

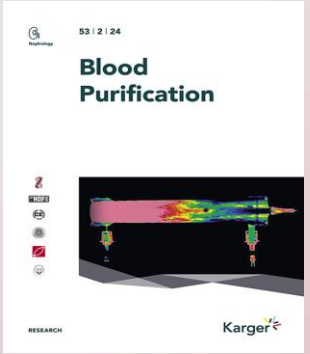
ADQI Consensus 2016;42:224-237

did you know?

Consensus statement 4.1: Transition of modalities should be considered if the demand-capacity imbalance or treatment priorities have changed and can be met better by an alternative technique.



The same principles that apply when considering the most appropriate modality for the first session of RRT should also be applied when evaluating the risks and benefits of switching to another modality



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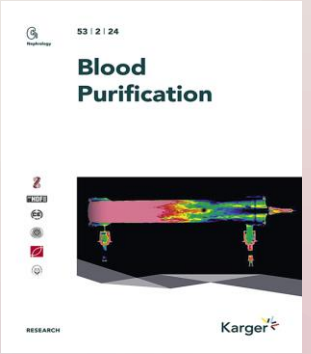
ADQI Consensus 2016;42:224-237

did you know?

In addition to IHD and CRRT, hybrid therapies such as ‘sustained low efficiency (daily) dialysis’, ‘extended daily dialysis’ (EDD) and ‘prolonged IRRT’ (PIRRT) have emerged. They combine the hemodynamic stability of CRRT with the advantages of IRRT (mobilization, rehabilitation, reduced need for anticoagulation, lower financial costs). These modalities utilize either conventional hemodialysis machines adapted to obtain a longer session than traditional IHD , or conventional CRRT machines for planned treatment sessions for 8-12 h at higher doses than usual.

It is not possible to make any firm recommendations regarding superiority of either technique

To date, there is no consensus on important aspects of PIRRT, including frequency, duration and intensity as well as type of RRT machine. Published literature suggests that sessions may range from 6 h every other day to more than 12 h daily. This variation in clinical practice has important implications for drug dosing and may account for some differences in results seen in clinical studies.



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ADQI Consensus 2016;42:224-237

Recommendations for Future Research

we will talk about this first

we will talk about this second

Predictive models (which may include novel diagnostics) thresholds for demand- capacity imbalance (magnitude and duration)

after that we will talk about this

on the risks and benefits of combining treatments and focusing on safety, efficacy and development of new technology

after that we will talk about this

It should be determined if different approaches to RRT weaning (e.g., abrupt or gradual or via transition to alternate modalities) affect patient outcomes.

we will talk about this too

It is necessary to determine whether pharmacologic approaches (e.g., diuretics or growth factors) can modify the success and outcome in the setting of discontinuation of RRT.

CONCLUSIONS

No RRT is ideal for all patients with AKI.

In the presence of hemodynamic instability in patients with AKI, CRRT is preferable to standard IHD.

There is lack of solid evidence showing superiority of any mode of RRT in patients with severe AKI in terms of patient survival.

Decision to start, maintain and discontinue RRT should be individualized based on the demand-capacity concept.

Our recommendations may serve to develop the best clinical practice and standards of care for use of RRT in patients with AKI. Future research is necessary to test and validate our concepts.

thank you!

Do you have any questions?

giannisgriv@hotmail.com
www.athens-nephrology.gr

IHD vs. CRRT: Clinical Outcomes

Table 98 – 3 Major Studies Comparing CRRT to IHD

Study	Year	Design	# of Pts	CRRT	IHD	Survival	Renal Recovery
Mehta et al. *ARF ICU*	2001	RCT	166	CVVHDF or CAVHDF	Qb 200-300	CRRT 34.5% IHD 52.4% (p<0.02)	CRRT 34.9% IHD 33.3% (p=NS)*
Guerin et al.	2002	Prospective observational (unadjusted)	587	variable	variable	CRRT 20.6% IHD 41.2% (p<0.001)	Not mentioned
Gasparovic et al.	2003	RCT	104	CVVH	Qb 200-250	CRRT 28.8% IHD 40.4% (p=NS)	Not mentioned
Augustine et al.	2004	RCT	80	CVVHD	Qb 300	CRRT 32.5% IHD 30.0% (P=NS)	CRRT 12.5% IHD 10.0% (p=NS)*
Vinsonneau et al. *HEMODIAFE*	2006	RCT	259	CVVHDF	Qb 278	CRRT 32.6% IHD 31.5% (p=0.98)	CRRT 93.3% IHD 90.2% (p=NS)**
Lins et al. *SHARF Trial*	2009	RCT	316	CVVH	Qb 100-300	CRRT 41.9% IHD 37.5% (p=0.430)	CRRT 74.5% IHD 83.1% (p=0.474)**
Schefold et al. *CONVINT Trial*	2014	RCT	252	CVVH	Qb 200-250	CRRT 45.4% IHD 39.7% (p=0.72)	CRRT 77.2% IHD 73.6% (p=0.90)**
Truche et al.	2016	Prospective observational (adjusted)	1360	CVVH or CVVHD	variable	CRRT 53.5% IHD 65% (p=ns)	CRRT 64.7% IHD 42.9% (p=0.29)**

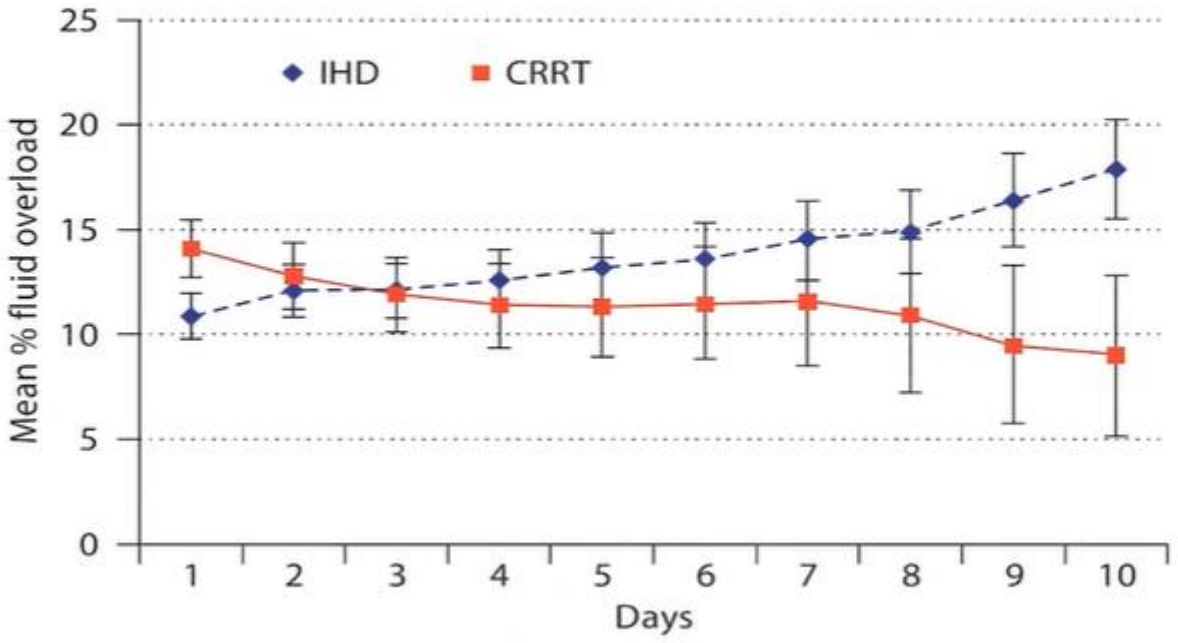
** In all patients randomized*

*** In patients who survived at ICU discharge*

CRRT; Continuous renal replacement therapy, CVVH; Continous venovenous [illegible] CVVHDF; Continuous venovenous hemodiafiltration, CAVHDF; Continuous arteriovenous hemodiafiltration, Qb; Blood flow rate, IHD; Intermittent hemo[illegible] randomized controlled trial, p; p-value, NS; Non-significant

2:37:36

Fluid Balance During CRRT vs. IHD



Bouchard et. al. Kidney International 2009

3:49:53

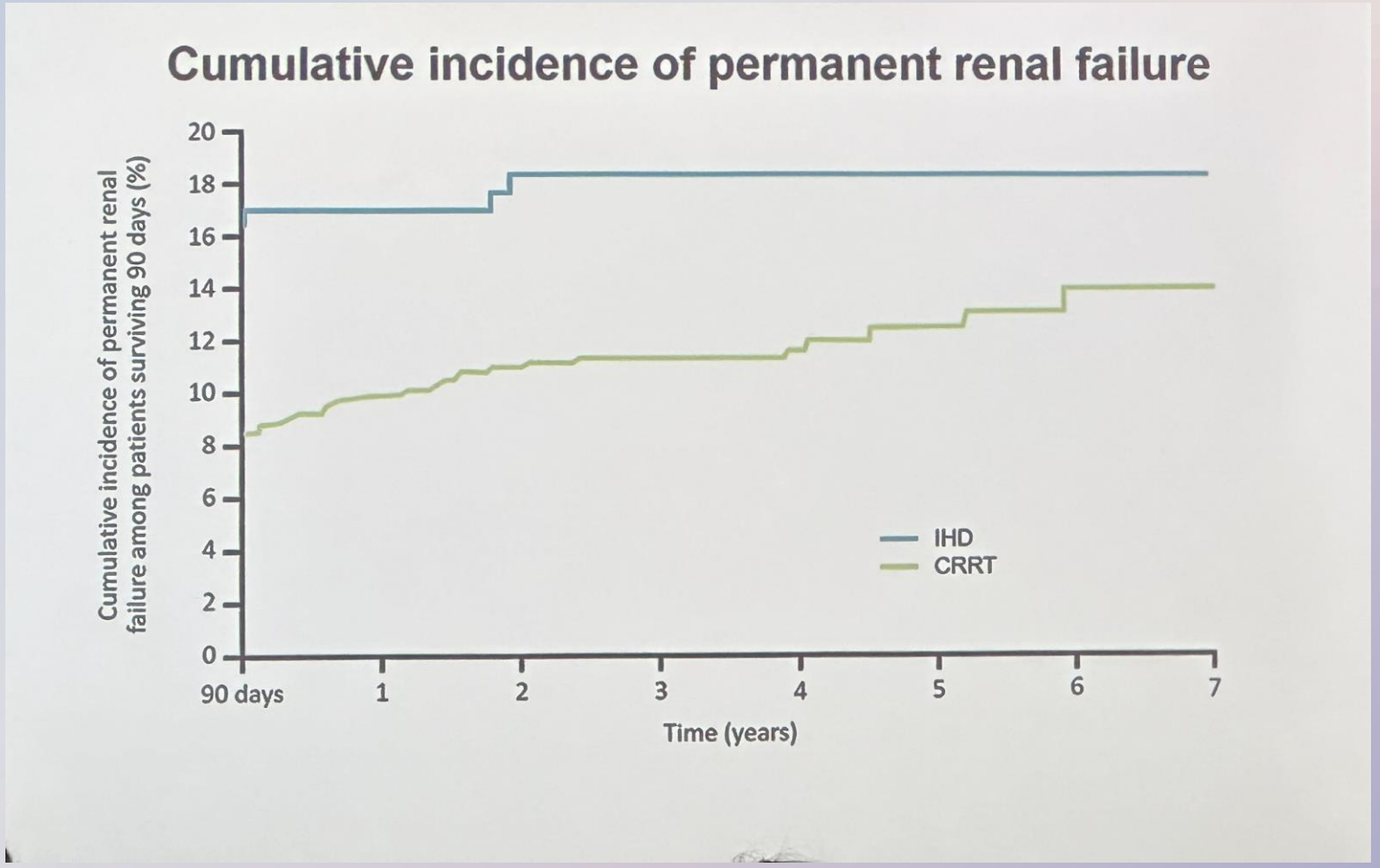
CRRT and IHD: Cohort study of 32 Swedish intensive care units (1995–2004)

Intensive Care Med (2007) 33:773–780
DOI 10.1007/s00134-007-0590-6

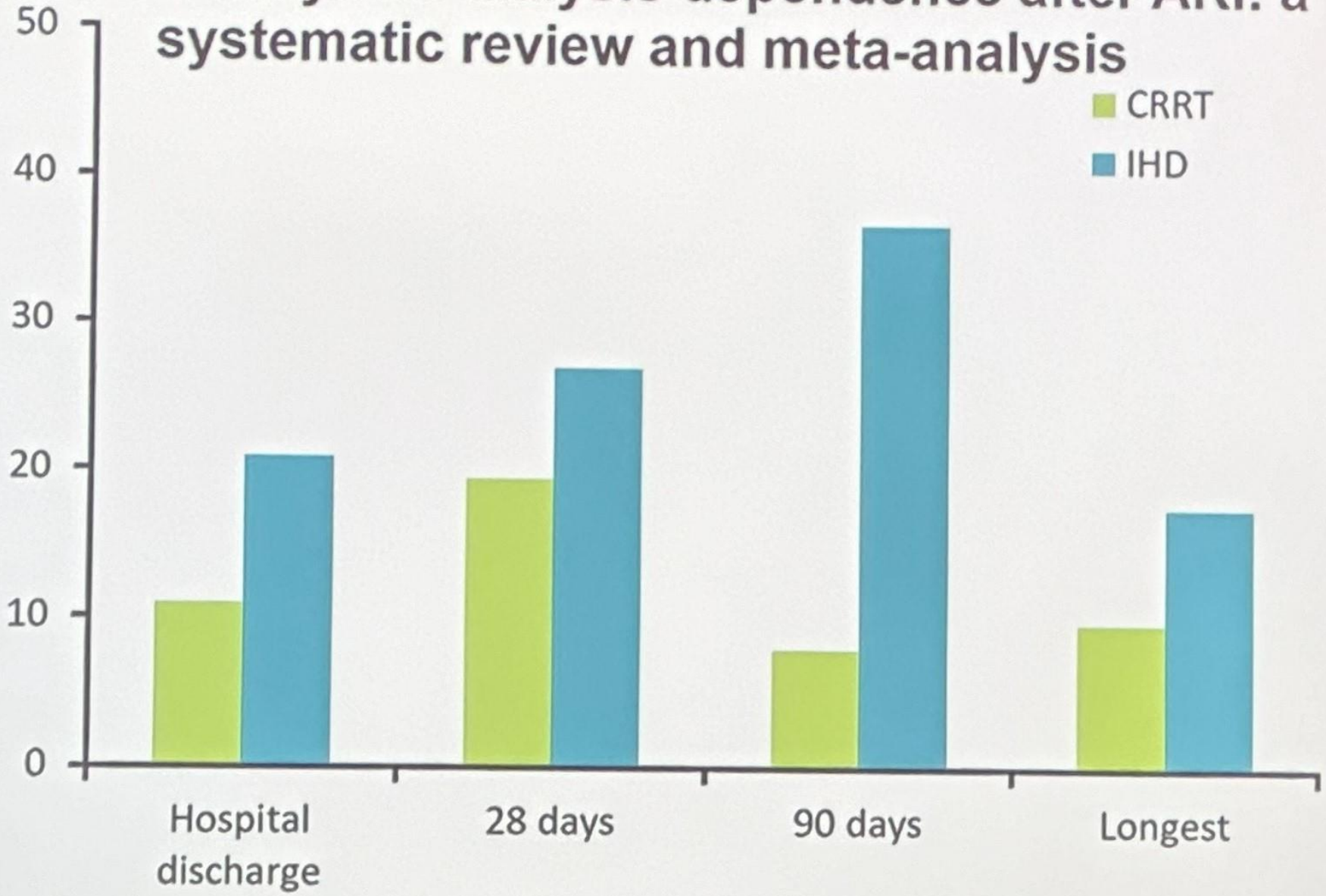
ORIGINAL

Max Bell
SWING
Fredrik Granath
Staffan Schön
Anders Ekbom
Claes-Roland Martling

Continuous renal replacement therapy is associated with less chronic renal failure than intermittent haemodialysis after acute renal failure



RRT modality and dialysis dependence after AKI: a systematic review and meta-analysis



Schneider AG, et al. ISICEM 2012;Poster P368

did you know?

Pandas don’t hibernate.

When winter approaches, they head lower down their mountain homes to warmer temperatures, where they continue to chomp away on bamboo!

There are more kangaroos than humans in Australia.

It is estimated that more than 50 million kangaroos live there. They are Australia’s national symbol and appear on postage stamps, coins, and airplanes.

Koalas are even more lazy than cats.

Koalas don’t have much energy and, when not feasting on leaves, they spend their time dozing in the branches. Believe it or not, they can sleep for up to 18 hours a day!

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hello! I’m...

Here is where you introduce yourself.

You can add your name, title and a little background. Right click the image and replace it with your own.

table of contents

we will talk about this first.

Add a brief introduction of your section here: Let’s dive in and get to know some interesting facts about animals!

did you know?

Elephants and storms.

Did you know that elephants can sense storms?

Elephants may be able to detect a thunderstorm from hundreds of miles away, and will head towards it, looking for water.

did you know?

A man's best friend...

Did you know that dogs can smell your feelings?

Dogs can pick up on subtle changes in your scent, which can help him figure out how you are feeling, such as by smelling your perspiration when you become nervous or fearful.

Mmm, can I fit in?...

Did you know that a cat uses its whiskers as feelers to determine if a space is too small to squeeze through?

Also, cats love to sleep. A fifteen-year-old cat has probably spent ten years of its life sleeping.

did you know?

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Very interesting facts.

This is where you section ends. Duplicate this set of slides as many times you need to go over all your sections.

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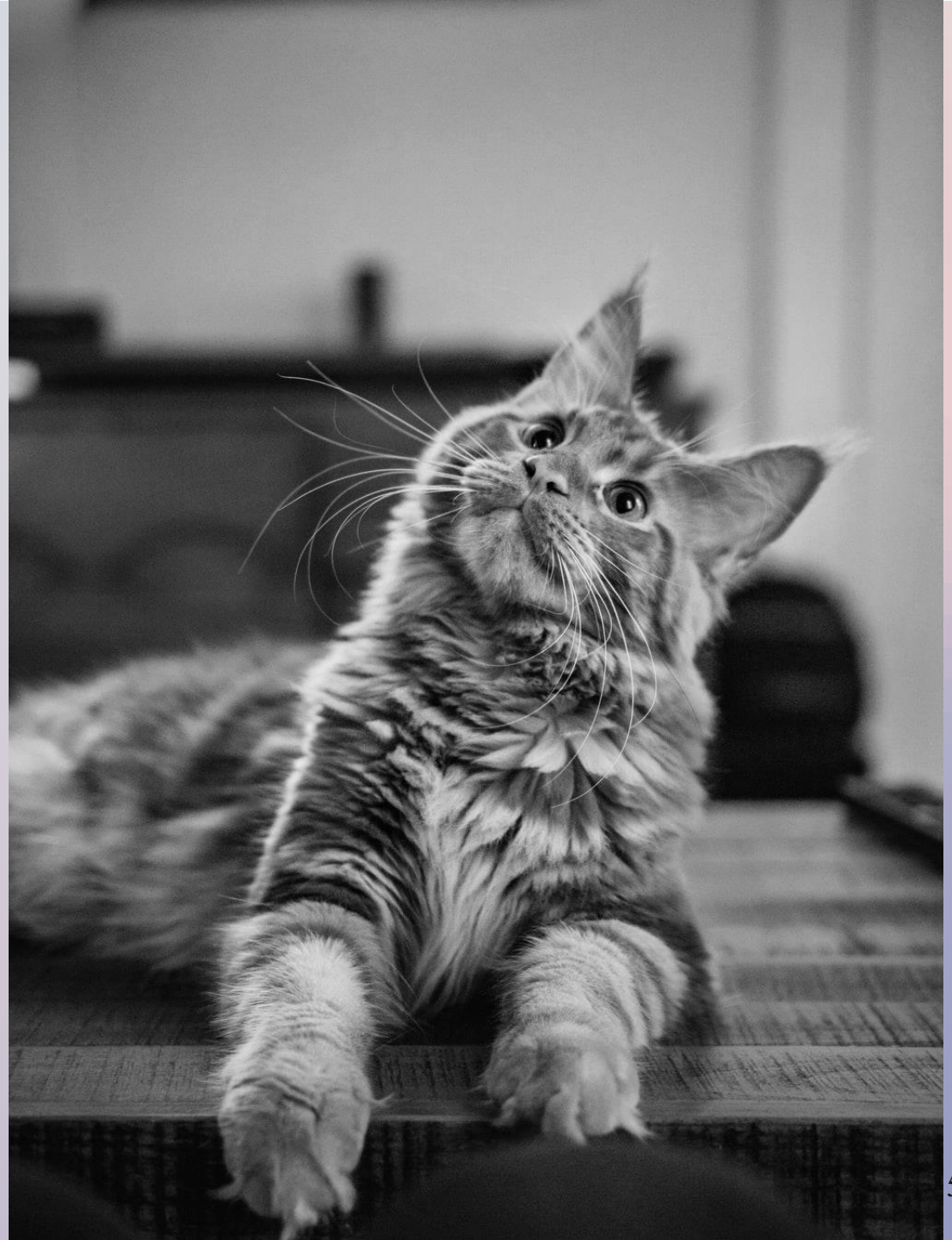

some facts about my cats.

100%

Of my cats are adorable.

25%

Traveled by plane. Twice!

75%

Are females.

let’s review some facts.

Both CRRT and IHD achieve adequate metabolic control, and neither modality has been shown to be superior in terms of survival

some studies suggest that the choice of initial RRT modality may affectrenal recovery and dialysis dependence after AKI, which has implications for patients, their families and healthcare systems in terms of survival, quality of life and costs

The question whether IHD compared to CRRT is associated with less renal recovery and a higher risk of dialysis dependence was addressed in a meta-analysis of 7 RCTs and 16 observational studies.

Analysis of the RCTs only concluded that there was no difference in rate of dialysis dependence among survivors (RR 1.15; 95% CI 0.78-1.68; I^2 = 0%).

In a large observational study published following this meta-analysis, Wald et al. reported that CRRT, when compared to IHD as the initial modality of RRT in critically ill adults with AKI, was associated with a lower likelihood of chronic dialysis (hazard ratio 0.75; 95% CI 0.65-0.87). However, this analysis included some centers that only used one modality.

Rabindranath K, Adams J, Macleod AM, Muirhead N: Intermittent versus continuous renal replacement therapy for acute renal fail¬ure in adults. Cochrane Database Syst Rev 2007; 3:CD003773.
Bagshaw SM, Berthiaume LR, Delaney A, et al: Continuous versus intermittent renal re-placement therapy for critically ill patients with acute kidney injury: a meta-analysis. Crit Care Med 2008;36:610-617.
Pannu N, Klarenbach S, Wiebe N, et al: Renal replacement therapy in patients with acute re-nal failure: a systematic review. JAMA 2008; 299: 793-805.
Ethgen O, Schneider AG, Bagshaw SM, Bel- lomo R, Kellum JA: Economics of dialysis de-pendence following renal replacement thera-py for critically ill acute kidney injury patients. Nephrol Dial Transplant 2015;30:54-61.
Schneider AG, Bellomo R, Bagshaw SM, Glassford NJ, Lo S, Jun M, Cass A, Gallagher M: Choice of renal replacement therapy mo-dality and dialysis dependence after acute kid¬ney injury: a systematic review and meta-anal¬ysis. Intensive Care Med 2013;39:987-997.
Wald R, Shariff SZ, Adhikari NK, Bagshaw SM, Burns KE, Friedrich JO, Garg AX, Harel Z, Kitchlu A, Ray JG: The association between renal replacement therapy modality and long¬term outcomes among critically ill adults with acute kidney injury: a retrospective cohort study. Crit Care Med 2014;42:868-877.

this is our team.

Erika V.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Aenean commodo ligula eget dolor.

John S.

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Aenean commodo ligula eget dolor.

Marie M.

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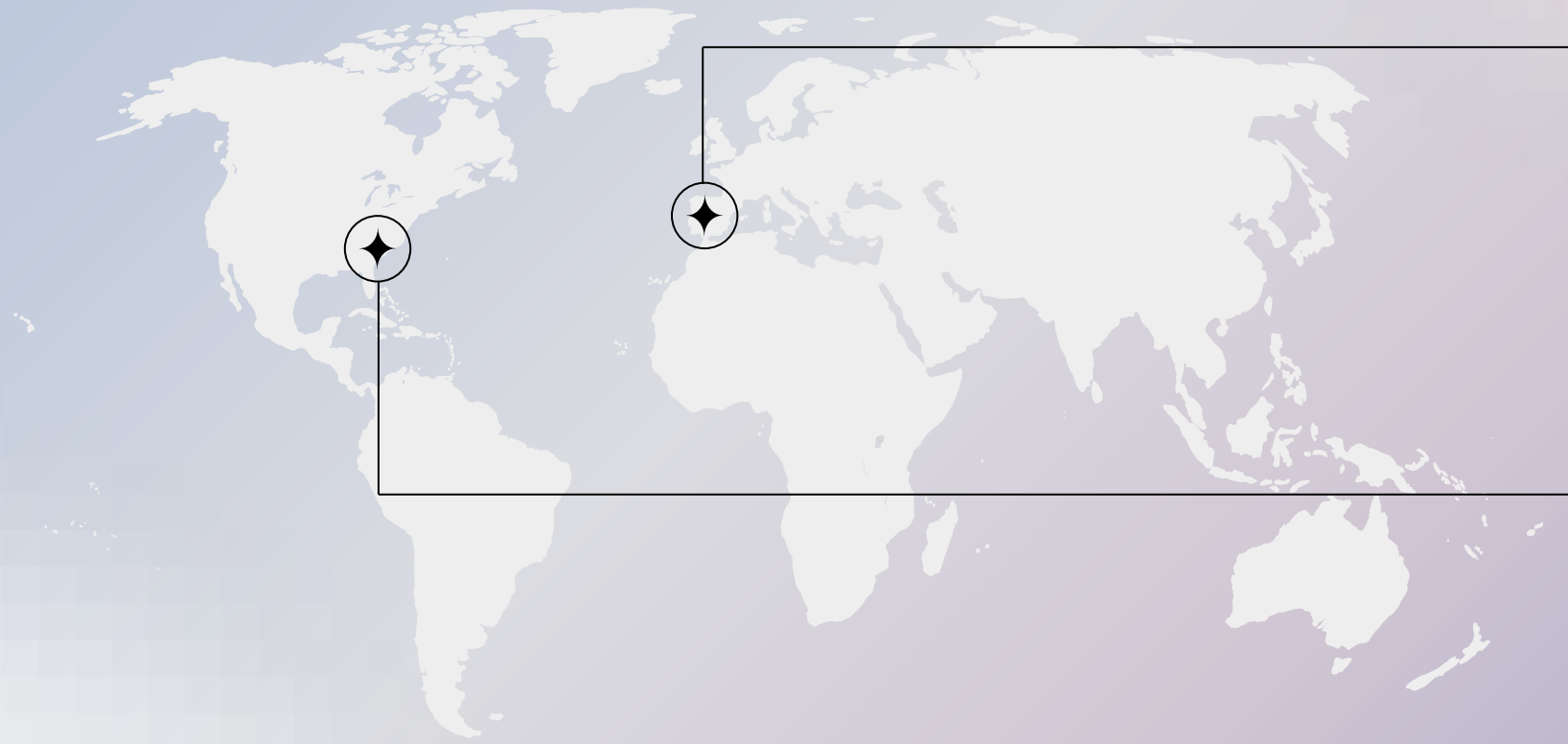
this is an editable world map.



Showcase places

You can use maps to show your offices or markets. Or as charts, highlighting the countries and adding your data.

100% Editable

You can double click on the desired country and change fill color.

and this is a timeline or process.

1992

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2004

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2009

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2013

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2022

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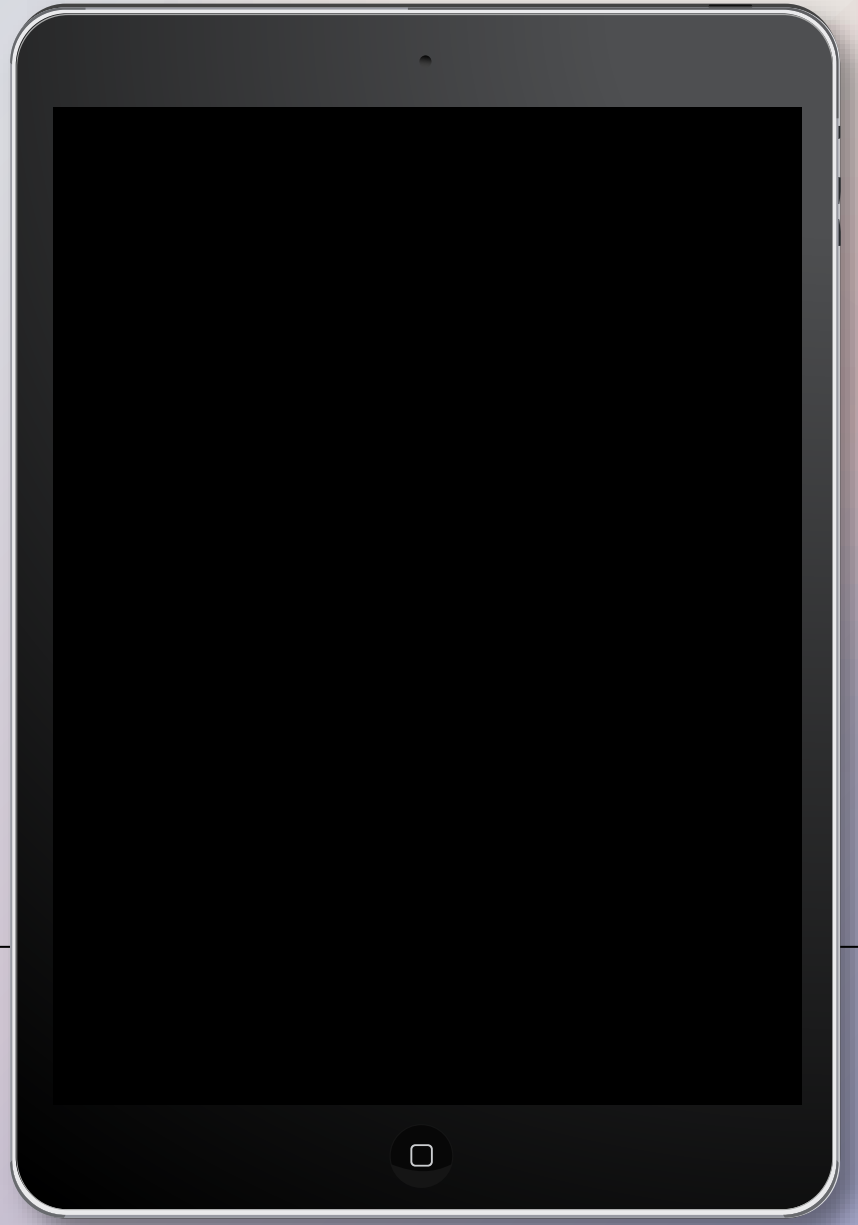

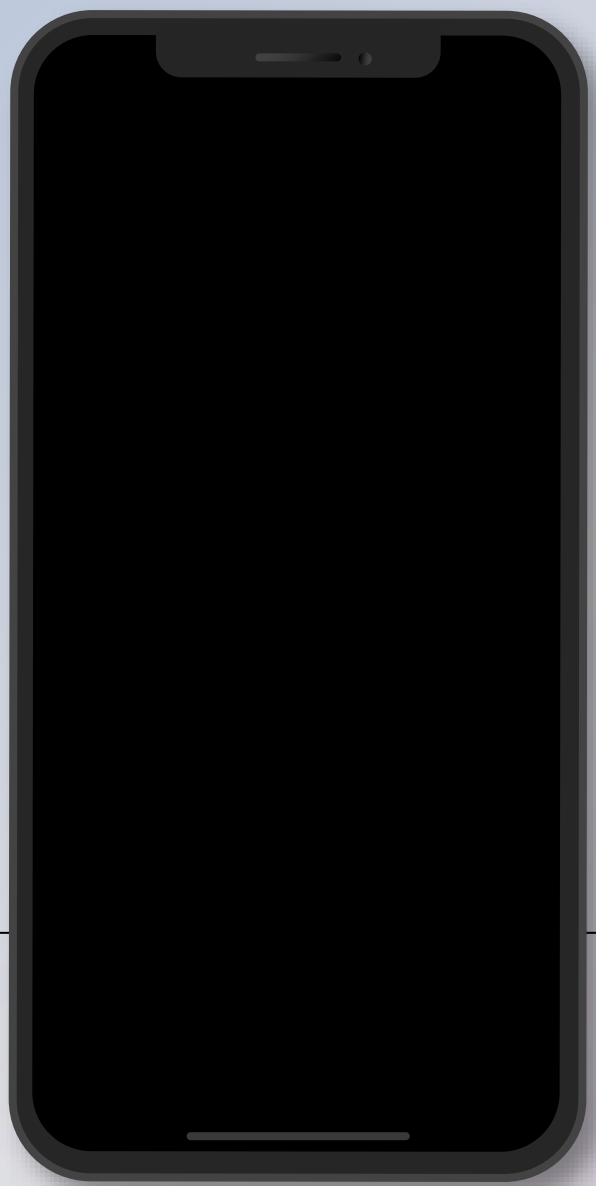

presenting a website or an app?

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