

Role of Active Deresuscitation After Resuscitation (RADAR)

A survey of critical care physicians

Dear colleague,

As you know, fluid management in critical illness remains a controversial topic. Although the importance of adequate fluid resuscitation in the management of hypovolaemic or septic shock is well-recognised, it is less clear what fluid management strategy should be pursued following the acute resuscitation stage. We are undertaking a research programme, RADAR (Role of Active Deresuscitation After Resuscitation), in which we aim to test the hypothesis that active deresuscitation (minimisation of fluid administration, together with diuretics and perhaps ultrafiltration) of critically ill patients who have fluid accumulation may lessen the morbidity of critical illness.

We would be grateful for a few minutes of your time to complete the following online survey. The purpose of this survey is to understand the perspectives of intensivists regarding fluid management in ICU patients; your views will help to inform the design of future trials. This survey is supported by the UK Intensive Care Foundation and the Canadian Critical Care Trials Group, and is endorsed by the European Society of Intensive Care Medicine.

We appreciate you taking the time to complete the survey; it should require no more than 5 to 10 minutes of your time. It is administered anonymously, however if you would like to receive a copy of the results, please leave us your email address at the end, and we will forward them to you. As with all such surveys involving multiple choice questions, there may not be an answer which perfectly fits with your preferred answer - in that case we would ask that you select the closest match.

Many thanks,

The RADAR investigators:

Dr Jon Silversides

Dr Eddy Fan

Prof Danny McAuley

Dr Bronagh Blackwood

Dr Andrew Ferguson

Prof John Marshall

* 1. Are you a consultant / specialist working in the field of adult intensive care / critical care?

Yes (N=524. Only responses who answered 'yes' were able to complete subsequent questions)

No (N=34)

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Demographics

Please provide us some basic information about yourself.

* 2. For how many years have you been working in ICU following completion of training in intensive care medicine? (N=524)

- < 5 years
- 5-10 years
- 11-20 years
- > 20 years

* 3. In which type of ICU do you mainly practice? (N=504)

- Mixed ICU
- Surgical ICU
- Medical ICU
- Cardiac surgical ICU
- Cardiology ICU
- Neuro ICU
- Other (please specify)

* 4. In which country do you mainly practice? (N=504)

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Questions about your views

* 5. Broadly speaking, how do you perceive the issue of fluid overload (positive fluid balance with oedema) in ICU patients?

	1 Strongly agree	2 Agree	3 Uncertain/neither agree nor disagree	4 Disagree	5 Strongly disagree	No of respondents
An inevitable consequence of appropriate fluid resuscitation in the presence of capillary leak						363
A modifiable consequence of fluid administration from multiple sources						364
A manifestation of sodium and water retention due to endocrine factors and acute kidney injury						364
An issue which will resolve spontaneously with resolution of the underlying illness						360
A finding without clinical consequence						361
A modifiable source of morbidity						363

* 6. Observational studies consistently demonstrate that a positive fluid balance is associated with poor outcome in critically ill patients. We define deresuscitation as the use of diuretics or dialysis to achieve a negative fluid balance. Regardless of your view as to whether deresuscitation is beneficial or not, please indicate what importance you attach to the following research question: "Does deresuscitation of critically ill patients with fluid overload improve patient outcomes?" (N=457)

- Very important
- Important
- Uncertain
- Unimportant
- Very unimportant

* 7. Would you be willing to enter patients to a clinical trial comparing a protocolised deresuscitation strategy (using diuretics and potentially dialysis to achieve a negative fluid balance) with usual care? (N=457)

Yes

No

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Scenario 1

Scenario 1a. Please consider the following case and answer the questions below.

A 56 year old man was admitted 6 days ago with severe alcohol-induced pancreatitis. He has a history of moderate COPD for which he is using bronchodilators, and hypertension which is controlled with medication.

On morning rounds, he remains sedated, intubated and fully ventilated on an FiO₂ of 0.6, with PEEP 8; SpO₂ is 97%. His heart rate is 105 bpm, blood pressure 100/55 mmHg (MAP 70 mmHg) on 0.1 µg/kg/min norepinephrine (noradrenaline), CVP 12 mmHg and serum lactate 1.6 mmol/l. His creatinine is 110 µmol/l (1.2mg/dL), and urine output 30 to 50 ml/hr. His temperature reached a maximum of 38.3 degrees Centigrade overnight, and his WBC count is 14.8 x10⁹/L. He is diffusely edematous, and his calculated fluid balance suggests that he is 10 liters positive since ICU admission. He is currently receiving 30 mls/hour enteral feed, and 50 mls/hour of a balanced crystalloid as maintenance fluid.

* 8. How likely would you be to take each of the following actions? (N=423)

	1 Highly likely	2 Somewhat likely	3 Uncertain	4 Somewhat unlikely	5 Highly unlikely
Administer a diuretic with the aim of achieving a negative fluid balance.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Administer a fluid bolus with the goal of reducing heart rate, increasing MAP, and/or reducing pressor requirements.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Use renal replacement therapy with the aim of achieving a negative fluid balance	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Discontinue maintenance IV fluid.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Continue without changes to fluid management	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Scenario 1b.

You review his status four hours following administration of 20mg furosemide (Lasix) intravenously. His cardiovascular status is unchanged. His hourly urine output for the last 4 hours is similar to previously, with 90 mls, 60 mls, 40 mls, 30 mls per hour, giving him a positive fluid balance of 620 mls for the ICU day so far.

*

* 9. How likely would you be to take each of the following actions? (N=423)

	1 Highly likely	2 Somewhat likely	3 Uncertain	4 Somewhat unlikely	5 Highly unlikely
Administer a fluid bolus	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Repeat the same dose of diuretic	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Administer a higher dose of diuretic	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Continue without further changes to fluid management	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Scenario 1c.

Suppose that the patient has exactly the same initial clinical profile as described above in [1a](#), but has acute kidney injury with a serum creatinine which increased from 160 $\mu\text{mol/l}$ (1.8 mg/dL) yesterday to 200 $\mu\text{mol/l}$ (2.3mg/dL) today.

* 10. In the presence of acute kidney injury as described here, how likely would you be to administer a diuretic with the aim of achieving a negative fluid balance? (N=423)

1 Highly likely	2 Somewhat likely	3 Uncertain	4 Somewhat unlikely	5 Highly unlikely
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Scenario 2

A 61 year old female was involved in a motor vehicle collision. She was initially admitted to a peripheral hospital where she was given 5 liters of crystalloid and 4 units of packed red cells in the emergency department before being taken to the operating room for a splenectomy. Her other injuries include fractures of left ribs 3 to 9, a stable laceration of the liver, and a mid-shaft fracture of the right femur which has been reduced and internally fixated.

Following transfer to your centre four days following the crash, she is mechanically ventilated with an FiO₂ of 0.7. Cumulative fluid balance is unclear, but she is markedly oedematous. The intra-abdominal pressure is elevated at 21 mmHg. She withdraws to painful stimuli. Her heart rate is 85 bpm and the BP 140/85 mmHg without support; CVP is 15 mmHg and dynamic indices do not suggest fluid responsiveness. Her creatinine is 190 µmol/L (2.1 mg/dL), urea is 17 mmol/L, potassium 4.0 mmol/L and bicarbonate 19 mmol/L. Over the past 24 hours she has been in a positive fluid balance of 1.5 liters and urine output is 25-40 mls/hour despite what you consider to be a high dose of diuretics.

* 11. Based on the information given in the above scenario, would you initiate renal replacement therapy for the purposes of fluid removal? (N=401)

Yes

No

Only if the following additional conditions were met:

* 12. Assume that renal replacement therapy has now been initiated. What will be your target for fluid removal over the next 24 hours? (N=401)

No fluid removal

Maintain even fluid balance over 24 hours

Achieve a negative fluid balance of 500 to 1000 mls over 24 hours

Achieve a negative balance of 1001 – 1500 mls over 24 hours

Achieve a negative fluid balance of more than 1500 mls over 24 hours.

* 13. As fluid removal is underway, her blood pressure drops to 100/50 mmHg with no changes to heart rate, serum lactate, or skin perfusion. Which of the following represents your most likely response? (N=401)

- Continue fluid removal, with the addition of vasopressors if required to maintain an acceptable mean arterial pressure.
- Discontinue fluid removal for this 24 hour period
- Continue fluid removal, with the use of an albumin (or other colloid) bolus if required to maintain an acceptable mean arterial pressure.
- Temporarily reduce or discontinue fluid removal with the intention of restarting when haemodynamic parameters return to baseline
- Continue fluid removal and review after an hour
- Other (please specify)

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Questions about your practice (1)

* 14. Is fluid overload (defined as a positive fluid balance with peripheral oedema) a common occurrence in your ICU? (N=397)

Yes

No

* 15. If applicable, what strategies do you use to avoid or deal with fluid overload (check all that apply)? (N=397)

Minimisation of resuscitation fluid

Avoidance of maintenance fluid and minimisation of drug diluents

Administration of diuretics to patients with evidence of fluid overload

Early use of renal replacement therapy to prevent or treat fluid overload

None of the above / I do not consider fluid overload to be a problem

Other (please specify)

* 16. How often do you use diuretics to treat fluid overload in your ICU patients? (N=397)

Daily (every day I work in ICU)

Frequently (more than 50% of the days in which I work in ICU)

Sometimes (approximately 20 - 50% of the days in which I work in ICU)

Rarely (less than 20% of the days I work in ICU)

Never

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Questions about your practice (2)

* 17. Recognising that the decision to initiate a deresuscitation strategy (using diuretics and/or dialysis to target a negative fluid balance) is complex and patient-dependent, how important do you consider each of the following indications for deresuscitation in clinical practice?

	Very important	Somewhat important	Uncertain	Unimportant	Very unimportant	No of respondents
Positive calculated cumulative fluid balance from ICU admission						392
Increased weight from baseline						390
Pulmonary congestion on chest imaging						393
High inspired oxygen concentration						393
Presence of peripheral oedema						392
Time from ICU admission						390
Resolution of underlying pathology						392
Elevated CVP						391
Serum urea						389
Serum creatinine						393
Serum bicarbonate						391

* 18. What is your preferred **initial** approach to fluid removal? (N=393)

- Intermittent bolus loop diuretic
- Intermittent bolus loop diuretic + regular administration of hyperoncotic albumin solution
- Infusion of loop diuretic infusion
- Infusion of loop diuretic + infusion of hyperoncotic albumin solution
- Removal by dialysis / ultrafiltration
- Initial bolus dose of loop diuretic followed by infusion of loop diuretic

Other (please specify)

* 19. Of the occasions on which you administer loop diuretics to achieve a negative fluid balance, how often do you use the following agents (either as adjuncts or alternatives)?

	Always or nearly all of the time	Frequently (>50% of the time)	Sometimes (20-50% of the time)	Rarely (<20% of the time)	Never
Thiazides (e.g. bendroflumethiazide) (N=383)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Potassium-sparing (eg spironolactone) (N=385)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Carbonic anhydrase inhibitors (eg acetazolamide) (N=381)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

* 20. What is the maximum dose of norepinephrine (noradrenaline) infusion at which you would typically consider it acceptable to administer diuretics for removal of accumulated fluid? (N=393)

- None (I would not administer diuretics to a patient on norepinephrine / noradrenaline)
- 0.05 mcg / kg / min
- 0.1 mcg / kg / min
- 0.15 mcg / kg / min
- 0.2 mcg / kg / min
- 0.25 mcg / kg / min
- 0.5 mcg / kg / min
- Patient-dependent, no absolute maximum

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Side effects

In the event of each of the following common side effects of loop diuretics, which options best describe your likely response(s)?

* 21. Mild hypotension (MAP 55 - 65 mmHg) (N=389)

- Discontinue deresuscitation
- Administer an albumin or other colloid bolus, continue diuretics and monitor closely
- Commence low-dose vasopressors, continue diuretics and monitor closely
- Temporarily withhold diuretics and monitor closely

* 22. Mild hyponatraemia (Sodium 132-135) (N=389)

- Discontinue deresuscitation
- Continue diuretics and monitor closely for further fall in serum sodium
- Administer saline (iso- or hypertonic), continue diuretics, and monitor serum sodium closely
- Add additional diuretics and monitor serum sodium closely
- Commence renal replacement therapy

* 23. Mild hypernatraemia (Sodium 145-150 mmol/l) (N=389)

- Discontinue deresuscitation
- Administer water (e.g. enteral water or 5% dextrose IV), continue diuretics and monitor closely
- Administer water (e.g. enteral water or 5% dextrose IV), temporarily withhold diuretics, and monitor closely
- Add additional diuretics and monitor closely
- Commence renal replacement therapy

* 24. Mild Hypokalaemia (K+ 3.0 – 3.5 mmol/l) (N=389)

- Discontinue deresuscitation
- Replace potassium, continue diuretics, and monitor closely
- Initiate corrective action, temporarily withhold diuretics, and monitor closely

* 25. Metabolic alkalosis (Bicarbonate >30 mmol/l) (N=389)

- Discontinue deresuscitation
- Continue loop diuretics and monitor closely
- Temporarily withhold diuretics, and monitor closely
- Add (or switch to) acetazolamide, and monitor closely

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Feedback

Many thanks for your interest and participation in this survey. We appreciate your willingness to give up your time to help improve our understanding of this issue.

26. Do you have any other comments, questions, or concerns?

Kind regards,

The RADAR team