The Shocking Truth
Case Study 1

The journey of a simple ED presentation
That turned dramatically wrong.........
Presented to Emergency Department 30\textsuperscript{th} July

32 year old woman

Red inflamed painful \textsuperscript{®} lower leg

unwell with nausea/ vomiting for 2 weeks

Fevers, sweats and rigors at home

GP letter stating cellulitis of the \textsuperscript{®} lower leg with ulceration oozing serous fluid
Triage Assessment

**Admission Time**
- Date: 30 Jul 2012
- Time: 17:51

**Observations**
- Presenting Complaint: SYMPTOMS SIGNS - ERYTHEMA / RASH OR OTHER SKIN COMPLAINT
- Triage Assessment: REFERRED FROM LMO WITH CELLULITIS OF R LEG

**Primary Nurse Assessment:**

<table>
<thead>
<tr>
<th>Vital Signs</th>
<th>Procedures</th>
<th>Pre Hospital Care/Treatment in Progress on Arrival</th>
<th>Medication Given</th>
<th>Urine Test</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>D/A HRS</strong></td>
<td><strong>O2</strong> 1Lpm</td>
<td><strong>O2</strong></td>
<td><strong>Other</strong></td>
<td><strong>pH</strong></td>
</tr>
<tr>
<td>Temperature</td>
<td><strong>Respiratory Rate</strong></td>
<td><strong>Cardiac Monitor</strong></td>
<td><strong>Other</strong></td>
<td><strong>Leuc</strong></td>
</tr>
<tr>
<td>Pulse</td>
<td><strong>Systolic BP</strong></td>
<td><strong>ECG</strong></td>
<td><strong>Other</strong></td>
<td><strong>Prot</strong></td>
</tr>
<tr>
<td>Respiratory Rate</td>
<td><strong>Diastolic BP</strong></td>
<td><strong>NBM</strong></td>
<td><strong>Other</strong></td>
<td><strong>Ket</strong></td>
</tr>
<tr>
<td>Systolic BP</td>
<td><strong>SaO2</strong></td>
<td><strong>IVL</strong></td>
<td><strong>Other</strong></td>
<td><strong>Blood Igg</strong></td>
</tr>
<tr>
<td>Diastolic BP</td>
<td><strong>Weight</strong></td>
<td><strong>Blood Studies</strong></td>
<td><strong>Other</strong></td>
<td><strong>HCG</strong></td>
</tr>
<tr>
<td>SaO2</td>
<td><strong>BSL</strong></td>
<td><strong>Ice</strong></td>
<td><strong>Other</strong></td>
<td><strong>MSU Collected</strong></td>
</tr>
</tbody>
</table>
Cellulitis

- Redness
- Pain
- Swelling
- High temps
Acute Deterioration

* Note created 0856hrs, 2\textsuperscript{nd} medical review ED

No Documentation sited in clinical notes
Observations Overnight

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>31/7/12</td>
<td>0830</td>
<td>Nursing entry: Taken over care of 0730</td>
</tr>
<tr>
<td></td>
<td></td>
<td>checked the patient done a set of observations, notified pt. in hypotensive</td>
</tr>
<tr>
<td>2/1/12</td>
<td>0830</td>
<td>cont.: Tachy cardiac noted in the order form, couldn’t find previous obs chart.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Notified treating doctor &amp; shift co-ordinator</td>
</tr>
<tr>
<td></td>
<td></td>
<td>pt. transferred to resus. also ice w not draining.</td>
</tr>
</tbody>
</table>

Documentation lacking from ED 1750 to 0830hrs
Resuscitation

Plan
Moved to resus
IVF challenge total 2L NS, 3rd bag required = Albumin 4%
--> post 2nd challenge; HR 130, BP non invasive 112/66
IV Piptaz and Vanco
Hrly urine measure, bladder scan post 2nd L IVF
Invasive BP/art line if persistent tachy post albumin or deterioration
--> ICU
Dr Bodnar attending
Retrospective note; ongoing issues with haemodynamics and poor
--> now making urine post albumin; 10mL
--> tachy persists 130, BP 80 sys
--> broad spec abs on board

Medical team RV'd aware; for ICU

Imp? Sepsis

Plan
DW Dr Ahmed ICU Reg; will kindly RV for ICU/HDU
Art line inserted sterile technique; R radial; collateral assessed
--> secured
--> MAP 80
Not for central access currently
To ICU; titration IVF/MAP and for inotropic support if required
## Resuscitation

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>HR (bpm)</th>
<th>BP (mmHg)</th>
<th>SpO2</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>09:05</td>
<td>100</td>
<td>60/110</td>
<td>98</td>
<td>RA</td>
</tr>
<tr>
<td>09:20</td>
<td>129</td>
<td>125/85</td>
<td>98%</td>
<td>RA</td>
</tr>
<tr>
<td>09:25</td>
<td>124</td>
<td>122/80</td>
<td>96%</td>
<td>RA</td>
</tr>
<tr>
<td>09:30</td>
<td>124</td>
<td>125/80</td>
<td>96%</td>
<td>RA</td>
</tr>
<tr>
<td>09:35</td>
<td>124</td>
<td>125/80</td>
<td>96%</td>
<td>RA</td>
</tr>
<tr>
<td>09:40</td>
<td>124</td>
<td>125/80</td>
<td>96%</td>
<td>RA</td>
</tr>
<tr>
<td>09:45</td>
<td>123</td>
<td>125/80</td>
<td>97%</td>
<td>RA</td>
</tr>
<tr>
<td>10:00</td>
<td>125</td>
<td>125/80</td>
<td>98%</td>
<td>RA</td>
</tr>
<tr>
<td>10:05</td>
<td>130</td>
<td>125/84</td>
<td>97%</td>
<td>RA</td>
</tr>
</tbody>
</table>

- **tachycardic**
- **hypotensive**
Metabolic Acidosis

**pH**
Acid side of normal acid base balance (7.35 to 7.45)

**Bicarb- HCO_3^-**
Base Excess
Metabolic Component
Indicates acidotic side (22 to 28)
Infection

- Inflammatory response to the presence of microorganisms
- Presence of viable bacteria in the blood

Sepsis

- Systemic inflammatory response to infection
- Manifests in 2 or more of the following:
  - Temperature > 38
  - Heart rate > 90
  - Resp rate > 20
  - WBC raised
Septic Shock

- Urea 11.5  
  *acute kidney injury*
- Creatinine 212  
  *acute kidney injury*
- sGFR 23L
- WCC 8.2N  
  *infection - sepsis*
- C reactive protein >500H
Infection
Release of bacteria

Stimulates inflammatory response
Mediators enter circulation
Induce endocrine response
Alters clotting factors
Loss of ion gradients

Leaking fluid
thrombosis
Mediators enter circulation

• Decreased perfusion
• Ischaemia
• Organ dysfunction
1. Due to vasodilatation, organ perfusion pressure is low and sluggish.
2. Some capillary beds perfuse normally.
3. Others are badly damaged, and there is 4. capillary leak, 5. The tissues become edematous, compressing normal tissues, preventing oxygen exchange.
4. 6. Due to venous stasis and activation of coagulation pathways, small vessels become obstructed, and blood flow stops.
Inflammatory Immune Response

Systemic Immune Response Syndrome (SIRS)

Sepsis

Severe Sepsis

Septic Shock

Multiple Organ Dysfunction (MODS)

Death
Admission to ICU
ICU Admission
Septic Shock

31/7/12
Consultant review

17.45
- Septic shock found last night due to collesus
- ARF not getting better despite fluids
- MAP 65-75
- Dexam not diabetic
- Antibiotic cover changed from flucloxacillin to meropenem, vancomycin

0.5 13.5mm Hg
105/43 lower sugar but still weak
ICU Admission

- Worsening metabolic acidosis
- Nil urine output
- Necrotising Fasciitis
- ARF - acute renal failure
- CVVHDF

- Painful cellulitis
- Necrosis haemorrhagic area
- Worsening cellulitis not spreading
- Tender 0 above cellulitis area
- Very tender groin LN
- Pustular pimplie area in groin
- Pus in 3 x 0 pus from bed

- BUN 7.12
- pH 7.45
- PO2 107
- HCO3 16
- BE -18

- Urine: 0, 0, 0, 0, 0, 0

- Imipenem 1g

- Needing feedback - surgical review
- H/o fed and need consult patient
Shock State - Hypoperfusion

- Inability for the body to meet metabolic demands of the tissues
- Cellular dysfunction - imbalance between nutrient supply and demand
## Summary of Shock States

<table>
<thead>
<tr>
<th></th>
<th>Cardiac Output</th>
<th>Systemic Vascular Resistance</th>
<th>Pulmonary Vascular Resistance</th>
<th>Central Venous Pressure</th>
<th>Pulmonary Artery Wedge Pressure</th>
<th>SvO₂</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hypovolaemic Shock</strong></td>
<td></td>
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<tr>
<td>Decompensated</td>
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<td>↑</td>
<td>↑</td>
<td>↓</td>
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<td>↓</td>
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<tr>
<td><strong>Hyperdynamic</strong></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Septic Shock</td>
<td>↑</td>
<td>↓</td>
<td></td>
<td></td>
<td></td>
<td>↑</td>
</tr>
<tr>
<td><strong>Cardiogenic Shock</strong></td>
<td></td>
<td></td>
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<td>↑</td>
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</tr>
<tr>
<td><strong>Anaphylactic Shock</strong></td>
<td></td>
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<tr>
<td><strong>Neurogenic Shock</strong></td>
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</tr>
</tbody>
</table>
Mismatch: Demand vs Supply

Supply
- Coronary Artery Anatomy
- Diastolic Pressure
- Diastolic Time
- $O_2$ Extraction
- Hgb
- $SaO_2$

Demand
- Heart Rate
- Preload
- Afterload
- Contractility
Stabilisation

STABILISE BP
Adrenaline, Dopamine, Levosimendan, Dobutamine, Digoxin

PRELOAD
Diuretics + Vasodilators Ventilation

PUMP = Contractility

C.O = SV x HR

AFTERLOAD
Dobutamine Vasodilators IABP
Inotropes

* Cardiac output insufficient to provide organ perfusion
* CO is a compensatory mechanism to maintain organ perfusion to hypermetabolic tissue. However, mediator induced vasodilation to areas such as skin or skeletal muscle, can inappropriately redistribute CO, leaving vital organs with inadequate blood flow.

→ Fluid Resuscitation THEN use inotropes:
  → Adrenaline vs Noradrenaline
  → Vasopressors
Cascading Events

Issues:

1. Ongoing septic shock req. double isotrops + multipl.
   ARS.

2. intubated + ventilated with A-a gradient.

3. AKI RRT req. RRT.

4. Feeds? @ goal.
Surgical Debridement

Operation Diagnosis
Re washout + Vaccum Dressing R Leg wound
THigh Wound Still infected-- Debrided
Good Granulation Medial/ LAT and Foot wound

Operation Detail
Wounds Right Leg

Post Op Comments
Keep Vaccum dressing intact
Neuro circ obs
Follow MCS
Care as per ICU
Need to follow with Plastics in RBWH
### Acute Kidney Injury-MOD

<table>
<thead>
<tr>
<th>Date</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>01/9/12</td>
<td>Night Review</td>
</tr>
<tr>
<td>01/30</td>
<td></td>
</tr>
<tr>
<td>Merrie J</td>
<td>32 y. o F   Day 2 ICU</td>
</tr>
<tr>
<td>Tina reg.</td>
<td></td>
</tr>
</tbody>
</table>

Admitted to septic shock due to R leg cellulitis. Went to theatre for debridement and fasciectomy, returned to ICU intubated.

- Issues: Meropenem, Thromoxacin, Lincomycin, Vancomycin

- Septic shock, R leg cellulitis
- AKI - started CVVHDF
- Fasciectomy - drain R leg
- Noradrenaline requirement.

<table>
<thead>
<tr>
<th>00:37</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>HR: 71</td>
<td>180/90 MAP: 70, P: 130</td>
</tr>
<tr>
<td>Pco2: 43</td>
<td>Intubated, S100% RR: 20, TV: 500, Ssat: 94%</td>
</tr>
<tr>
<td>Po2: 152</td>
<td></td>
</tr>
<tr>
<td>O2 sat: 98%</td>
<td></td>
</tr>
</tbody>
</table>

F: Nil by mouth up to now.
lack of consensus in defining and classifying ARF.

The Acute Dialysis Quality Initiative (ADQI) introduced the terms acute kidney injury (AKI) and the RIFLE criteria to define and classify the spectrum of ARF.

AKI encompasses the entire spectrum from minor changes in renal function to renal failure requiring dialysis.

The RIFLE classification defines three graded levels of AKI (risk, injury, and failure) and two outcome criteria (loss and end-stage kidney disease).
CRRT vs IHD

CRRT- Continuous renal replacement therapy
→ catheter draws and returns blood via a large vein-veno-venous access catheter (vascath)
→ Continual removal of fluid & fluid replacement 100 to 150mls/hr

IHD- Intermittent Haemodialysis
→ surgical joining of an artery and vein- AV fistula
→ Removal of large volumes intermittently- 3 to 5L in 3hrs
→ Risk of hypovolaemia in critically ill patients
Continuous Renal Replacement Therapy (CRRT)

Renal Replacement Therapy (RRT) mimics the glomerular filtration performed by the kidneys.

→ Slow Continuous Ultra Filtration (SCUF)
→ Continuous Venovenous haemofiltration (CVVH)
→ Continuous Venovenous Haemodialysis (CVVHD)
→ Continuous Venovenous Haemodiafiltration (CVVHDF)
→ Extended Daily Diafiltration (EDDf) / Slow low-efficiency daily dialysis (SLEDD)
Diffusion

Blood Flow

Membrane / Filter

Concentration Gradient

Compound in HIGH concentration

Dialysate Flow

Compound in LOW concentration

Diffusion

Neligan
Convection

HIGH pressure

Membrane / Filter

Pressure Gradient

SOLVENT DRAG

Convection

LOW pressure

Solute dissolved in Solvent

Neligan
CVVHDF

Continuous Venovenous Haemodiafiltration

CVVHDF combines all the principles of filtration, convection, and diffusion to provide efficient fluid and solute removal. This is possible by the addition of a counter-current dialysate solution, which promotes diffusion.

The mechanical blood pump ensures adequate flow through the filter, and fluid replacement is administered as prescribed.

Clearance broadens from small to larger molecules.
CVVHDF- why

Replace essential renal function

Removal of septic mediators- small proteins (purification)

Correct metabolic acidosis

Treatment of MODs
CVVHDF

Continuous Veno-Venous Hemo-DiaFiltration (CVVHFD)
## Assessment acronyms

- **Feeding**
- **Analgesia**
- **Sedation**
- **Thromboembolic prophylaxis**
- **Head of bed elevated**
- **Ulcer prophylaxis**
- **Glycaemic control**

<table>
<thead>
<tr>
<th>MAP</th>
<th>70</th>
<th>P</th>
<th>130</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Simv</strong>, RR</td>
<td>20</td>
<td><strong>IV</strong></td>
<td>500</td>
</tr>
<tr>
<td><strong>FiO2</strong></td>
<td>10.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>F</strong></td>
<td><strong>NIV</strong></td>
<td>by mask up to now</td>
<td></td>
</tr>
<tr>
<td><strong>A</strong></td>
<td>Fentanyl</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>S</strong></td>
<td>Propofol</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>T</strong></td>
<td>Sed &amp; Teds (β) log</td>
<td>Heparin S.C</td>
<td></td>
</tr>
<tr>
<td><strong>H</strong></td>
<td>up 30°</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>H</strong></td>
<td>Ranitidine</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>O2</strong></td>
<td>3 l</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>F</strong></td>
<td>25 ml/hr last hr, on CVVHDF</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>T</strong></td>
<td>37.8</td>
<td>AB as above</td>
<td></td>
</tr>
<tr>
<td><strong>D</strong></td>
<td>CVVHDF</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Further deterioration

Intra-op findings not consistent with necrotising fasciitis.

Many fluid pus released from medial side

Now skin flaps possible

Anxiously
<table>
<thead>
<tr>
<th>ICU review: Day 2</th>
<th>ICU</th>
<th>SRF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admitted to ICU with septic shock for intravenous + RRT. (Leg cellulitis) NA Vaginosis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2nd OR today for further debridement.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIG: Obese</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depression - Laboratory</td>
<td>Day 3d</td>
<td></td>
</tr>
</tbody>
</table>
| Daughter is currently an inpatient in RCH w/ toxic shock syndrome. (Strep A tonsillitis) Discharged on (n)
Toxic Shock Syndrome

- Acute & life-threatening inflammatory response diagnosed by fever, hypotension, rash and multi-organ involvement (3 or more organs)
  - Kidneys, respiratory and cardiovascular system failure
- Staphylococcus aureus (associated with tampons in menstruating females)
- Streptococcus pyogenes
  - Release toxins called superantigens result in an overwhelming inflammatory response
TSS-facts

- First described in 1978 - menstrual & non-menstrual
- Route of pathogen is unknown in up to 50% cases
- Mortality rate
  - Staph - 3 to 5%
  - Strep - 30 to 70%
<table>
<thead>
<tr>
<th>Date</th>
<th>ICU Night Review</th>
</tr>
</thead>
<tbody>
<tr>
<td>07/08/12</td>
<td></td>
</tr>
<tr>
<td>23:40</td>
<td>S. Ip</td>
</tr>
<tr>
<td></td>
<td>ICU Reg</td>
</tr>
</tbody>
</table>

**Ongoing Treatment**

1. Toxic shock, 2° sepsis + staph + LC cellulitis for return to OT for further surgical debidement.
2. Anuric on CVVHDF

- F: feed Pt good via NGT
- H: 1000ml via NGT
- A: fentanyl
- S: midazolam
- T: heparin SC
- U: ranitidine
- G: BSL-8 insulin infusion

- Linco, Benopen, Flucox
- C/V H/P
- NAD 137 K 4.3
- HCO₃ 26.7
Post Grafting
Post Grafting
# Summary

## Discharge from ICU

### Reason for Admission/Presenting Problems
- Toxic shock syndrome
- Multiple ionotropes
- Multi-organ dysfunction requiring CVVHDF
- Right lower limb necrotising skin infection - fasciotomy, multiple debridement
- Pain management

### Principal Diagnosis
- Necrotising skin infection secondary strep pyogenes

### Other Active Problems
- Sepsis: +ve S. pyogenes, S. aureus, Serratia m.
- AKI 2nd to sepsis
- Obesity
- Depression
Rehabilitation

Pain Management

Nutrition

Treatment of Depression

Mobility