The purpose of this booklet is to help clinical staff to reduce preventable deaths in their patients. If we give 4 patients with septic shock antibiotics on arrival in hospital rather than 4 hours later, we will save at least one life. Read on...
Sepsis: A Primer for Clinical Staff

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Particular thanks go to Ron Daniels of the UK Sepsis Trust, Dilip Nathwani of the Scottish Antimicrobial Management Group, Alison Hunter and Kevin Rooney from the SPSP Sepsis Collaborative.
Introduction / Revision of Sepsis

This diagram illustrates the continuum of sepsis. A patient can rapidly progress through the stages, potentially dying within hours of onset.

**Infection** can be described in lay terms with the phrase “bugs multiplying where they shouldn’t be”. In other words, bacteria, viruses etc can multiply in our gut, on our skin etc. without doing harm. Likewise, Chicken pox, TB etc, can be in our body for many years but if they are not multiplying, then they do no harm. It is only when they gain access to an internal site AND multiply that clinical infection occurs.

**Sepsis** can be described in lay terms as “the whole body response to infection”. In medical terms it is defined as SIRS* (Systemic Inflammatory Response Syndrome) due to infection. This is a complex process involving lots of chemical signals resulting in inflammation throughout the body. This can be easily characterised by the presence of two or more of the criteria for SIRS (see page 8).

**Severe Sepsis** is sepsis with signs of organ dysfunction. This can include any organ from brain to kidneys. Many of the signs of organ dysfunction are subtle, and in the past the severity of illness has been underestimated in many patients with infection. Severe Sepsis carries a mortality of 20-40%.

**Septic Shock** is the most severe presentation of infection. It carries a very high mortality (about 40%). Septic shock is defined as hypotension despite adequate initial fluid resuscitation, OR a lactate level more than twice normal (>4). Lactate is produced by anaerobic metabolism. When tissues don’t have an adequate blood

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* SIRS and SSI (Signs of Systemic Inflammation) are now synonymous and get used interchangeably. Strictly speaking, SSI has 6 components, and traditional SIRS had only 4. However, SIRS6 is now commonly used, with the components being identical to those of SSI.
supply, they produce lactate. Lactate has become one of the most useful prognostic indicators in sepsis, and is useful for charting progress.

It can be difficult to separate severe sepsis from septic shock in the initial assessment. **This does not matter**, as the initial treatment is identical.

**A U.K. Perspective**

This diagram illustrates just how common sepsis is as a cause of death. This is particularly concerning when you consider that sepsis affects all ages, whereas cancer deaths tend to be in the older population. Importantly, most sepsis deaths are preventable, as rapid treatment saves lives.

Taking the statistic from the graph above of 33,000 deaths in the UK per year, this suggests that we would expect approximately 180 deaths in the Highlands each year. This is likely to be a significant under-estimate as these figures are taken from ITU data and many patients die without reaching ITU.
The Surviving Sepsis Campaign and the Sepsis Six


**Objective:** To provide an update to the “Surviving Sepsis Campaign Guidelines for Management of Severe Sepsis and Septic Shock,” last published in 2008.

**Design:** A consensus committee of 68 international experts representing 30 international organizations was convened. Nominal groups were assembled at key international meetings for those committee members attending the conference. A formal conflict of interest policy was developed at the outset of the process and entered throughout. The entire guidelines process was conducted independent of any industry funding. A stand-alone meeting was held for all subgroup heads, co- and vice-chairs, and selected individuals. Teleconferences and electronic-based discussion among subgroups and among the entire committee served as an integral part of the development.

**Methods:** The authors were advised to follow the principles of the Grading of Recommendations Assessment, Development and Evaluation (GRADE) system to guide assessment of quality of evidence from high (A) to very low (D) and to determine the strength of recommendations as strong (1) or weak (2). The potential drawbacks of making strong recommendations in the presence of low-quality evidence were emphasized. Some recommendations were ungraded (U). Recommendations were classified into three groups: 1) those directly targeting severe sepsis; 2) those targeting general care of the critically ill patient and considered high priority in severe sepsis; and 3) pediatric considerations.

**Results:** Key recommendations and suggestions, listed by category, include: early quantitative resuscitation of the septic patient during the first 6 hours after recognition (1C); blood cultures

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The Surviving Sepsis Campaign was set up in 2003 to promote international guidelines on management of sepsis. The guidelines are rapidly becoming standards of care. The guidelines promote the idea of “care bundles”. These are groups of management goals which aim to reduce mortality. While much of the content of these bundles were originally based on expert opinion rather than good trial evidence, trials are now showing the beneficial effect of applying the bundles in clinical practice.

The full guideline is worth reading and can easily be found on the internet:


In the UK, we have adopted the Sepsis Six as the first and most important bundle of care. The Scottish Patient Safety Programme adopted the Sepsis Six as the model of best practice, and the SPSP Sepsis Collaborative was set up early in 2012 to support local teams to effectively deliver the Sepsis Six to patients with sepsis.

Improvements in the recognition and management of sepsis have contributed to the recent reduction in mortality in Scottish hospitals. Improvements have been driven by the SPSP and other initiatives including that led by the Royal College of Emergency Medicine. In NHSH Highland, Sepsis improvement work has been ongoing since 2010, and very good results are evident in several areas. More teams and areas are joining the Collaborative and it is hoped that the improvement work will spread to improve outcome for every septic and potentially septic patient in the Highlands.
The diagram above shows the reduction in mortality for patients admitted to the AMU in Raigmore Hospital for approximately 3 weeks in 2011 compared with approximately 3 weeks in 2010. While the reduction in deaths in the severe sepsis/septic shock group appears dramatic, it is a relatively small group and does not achieve statistical significance. However, there was a significant reduction in mortality in the group with sepsis without organ dysfunction. This represents a larger number of lives saved due to being a larger group, and the reduction in mortality overall is statistically significant.

It is for this reason that we aim to deliver the Sepsis Six within one hour to all patients presenting with sepsis rather than just those who present with severe sepsis or shock.

The initial work centred around education of staff in AMU and the ED. However a system change was also required to ensure that doctors, nurses and others responded to sepsis as a team. This breaks down barriers to completing the process within the hour.

A Sepsis Record is used to support the early recognition and rapid management of all patients with sepsis. The next section will cover the rationale behind the different sections of the Record.
START: Look for Signs of Systemic Inflammation in every patient with an elevated SEWS OR where infection is likely

**Signs of Systemic Inflammation Criteria:**
1. Respiratory rate >20
2. Temperature <36 or >38°C
3. Heart Rate >90
4. White cell count <4 or >12
5. Acutely altered mental state
6. Bedside glucose >7.7mmol/L
7. Without diabetes

If SSI 2 or more AND infection suspected: THIS IS SEPSIS

Commence the Sepsis Six immediately and make a rapid assessment for the presence of ANY organ dysfunction.

SECONDS COUNT!

**Sepsis Six: Aim to complete within 1 hour of arrival in hospital (OR for inpatients: within 1 hour since SSI criteria reached)**

<table>
<thead>
<tr>
<th>Time</th>
<th>Initials</th>
<th>Notes/Result</th>
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1. Oxygen to achieve Saturations >94%, ≤ 98%
2. IV fluids (≥500ml/hr OR 20ml/kg stat if organ dysfunction)
3. Blood Cultures
4. Intravenous antibiotics as per local guidelines
5. Measure Lactate and FBC
6. Catheterise if organ dysfunction apparent

Look for sign of organ dysfunction (laboratory tests should be requested as emergencies, and results must be available and acted upon within 1 hour)

**Signs of organ dysfunction:**

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<tbody>
<tr>
<td></td>
<td>Systolic BP &lt;90 OR MAP &lt;65 OR</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Systolic &gt; 40 below patient’s normal</td>
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<tr>
<td></td>
<td>New need for O₂ to achieve sats &gt;90%</td>
<td></td>
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<tr>
<td></td>
<td>Lactate &gt;2 mmol/L</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Urine &lt;0.5ml/kg/hr for 2 hours</td>
<td></td>
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<tr>
<td></td>
<td>Creatinine &gt;177mmol/L</td>
<td></td>
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<tr>
<td></td>
<td>Bilirubin &gt; 34 micromol/L</td>
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<td></td>
<td>INR&gt;1.5 or aPTT&gt;60s</td>
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<tr>
<td></td>
<td>Platelets &lt;100 x 10⁹/L</td>
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</table>

ANY organ dysfunction: THIS IS SEVERE SEPSIS

Get senior input as soon as possible (Experienced Registrar or Consultant)

Reassess frequently in first hour. Consider other investigations and management. Look for septic shock:

- Lactate >4
- Hypotensive after after 20ml/kg fluid
- (Systolic BP <90 or MAP < 70 or systolic >40 below baseline)

If either present: THIS IS SEPTIC SHOCK.

Immediately contact consultant if not already present.

If possible, move to high dependency area.

Immediately commence 6-hour resuscitation bundle

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EXIT/MODIFICATION OF GUIDELINE:
Not all patients with a high SSI/SIRS score have sepsis, OR there may be additional problems requiring different management (Current CCF, DKA, MI, GI bleed, etc), OR patients may be palliated. At any stage, if the guideline is exited or modified, record the reason here:

- Not Sepsis
- Palliative care
- Other problem in addition to sepsis

Notes
The NHS Highland Sepsis Record

The sheet on the previous page was developed to support clinical teams to make rapid decisions about possible sepsis and to speed up the time from presentation or deterioration of a patient to delivery of appropriate care. At least 2 other similar records have been developed by teams in the Raigmore Emergency Department, and Lorne & the Isles Hospital. While the format is different, the aim is identical and the content very similar. For the purposes of this discussion, we are using the form most widely used.

The following section breaks up the Record into its different parts and gives some explanation of the important features

The initial recognition of possible sepsis is THE most important step in reducing deaths in hospital.

It is important to emphasise the above point. No-one can deliver effective, timely sepsis care if the first link in the chain fails. It is for this reason that the Sepsis Record can be initiated by anyone.

The Sepsis Record should be used as a screening tool. To do this most effectively, it is worth assuming everyone who is unwell has sepsis until proven otherwise.

Time zero is the time the patient arrives in our care (effectively the time they arrive in the building) for new patients. It is NOT the time at which sepsis is recognised. Unrecognised sepsis is the fault of the system, and results in the septic patient missing out on vital care. It is system change (such as use of a Sepsis Record) which will improve the care we deliver.

Inpatients deteriorating with infections need to be recognised too. Time zero is more difficult because they may develop an infection at any time, or because the infection which was mild on admission worsens to the point where they start to score on SIRS/SSI criteria. For inpatients time zero is when a significant deterioration is first recorded. Usually, this is an arbitrary cut-off of a SEWS of 4 or more. The deteriorating inpatient is much more difficult to recognise routinely and manage quickly. This is a challenge faced by all wards. In Raigmore, the situation has in part been addressed by the Medical Emergency Team who have become very skilled at recognition and management of sepsis. However, the ward team still has to recognise the need to call the MET, or to deal with deterioration themselves.
The Systemic Inflammatory Response Syndrome is most commonly triggered by infection, but can be triggered by other insults including trauma, burns and pancreatitis. SIRS previously had only the first 4 points above, but SIRS6 is synonymous with SSI, and is a more widely recognised term.

These parameters make a sensitive screening tool when applied to patients who are unwell. 1, 2, 3 and 5 can be taken directly from the observations chart. A bedside blood glucose should be done in everyone when screening for sepsis, as it is commonly elevated as part of the SIRS response. The white cell count should be measured as early as possible in an admission or in dealing with a deteriorating patient, but often two out of six SIRS/SSI criteria will be met before the WCC is available. Where the score is 1/5 without the WCC it is important that this result is seen and acted on as quickly as possible.

**Don't be fooled by a normal or low temperature.** Temperature is only one of six indicators of possible sepsis. Remember, sepsis can occur in the absence of fever. The sickest septic patients often have a low temperature, but a normal temperature does NOT preclude the patient having sepsis.

Recording the likely source of infection is useful, but only as a guide to what empiric antibiotics to choose. If the source is unclear, don’t delay treatment pending investigations. **The investigations do not kill the bugs!** Where pneumonia is likely, the CXR is simply a confirmatory test, and justifies continuation of therapy, but should not be used to decide whether to treat initially. The presence of sepsis with a likely respiratory source is enough to justify the initial IV antibiotics, whatever the CURB65 score.
The Sepsis Six

These six simple tasks save lives. They do this by reversing the ongoing cascade of sepsis which can result in multi-organ failure if left untreated. The greatest impact of the Sepsis Six on mortality is probably in the less unwell patients, as these have the most to gain by switching off the sepsis cascade at the time they are assessed.

1 **Oxygen** is of paramount importance in helping to prevent tissue hypoxia which leads to lactic acidosis. Thus, all hypoxic patients should receive oxygen (In chronically hypoxic patients such as COPD, the aim is to give oxygen to achieve normal levels for the individual, usually 88-92%). If a patient is not hypoxic, there is no good evidence for giving supplemental oxygen. **Too much oxygen may be harmful.** The reason for this is that oxygen in high concentration in the blood causes vasoconstriction and may paradoxically reduce oxygen delivery to compromised tissues. This is almost certainly why hyperoxia is associated with increased mortality in MI and worse outcome in stroke.

2 **IV fluids.** The septic patient may have many reasons for being relatively hypovolaemic. These include increased losses through sweating, vomiting, diarrhoea, decreased intake while unwell, vasodilation and leak of fluid through inflamed capillary walls. All these mechanisms can occur in the same patient, so a septic patient may need several litre of fluid in the first few hours. When a patient is not obviously very unwell, they may still be compensating for quite a large relative fluid lack. Early IV fluid can prevent deterioration into a decompensated state (shock). The use of IV fluids early in resuscitation appears to be extremely important, although there is an ongoing debate about whether continuing IV fluid resuscitation with several litres of fluid is beneficial. However, the simple rule of giving AT LEAST 500ml/hr initially remains. The more scientific 20ml/kg is important when larger volumes are being used for sicker patients, and this is usually whenever relative hypovolaemia is such that end organs are showing signs of dysfunction. **We should not be afraid to use more fluids than traditionally accepted.**

If a patient has a history of heart failure, they are just as likely to be relatively hypovolaemic as a patient without heart failure. The patient with heart failure has a higher risk of dying, and while “caution” with IV fluids is advisable, what caution actually means is giving the initial fluid bolus swiftly but having a lower threshold for CVP measurement if the patient does not respond.
The current move to use Compound Sodium Lactate in acutely unwell patients does not necessarily apply to sepsis. At present, the recommendation is to use saline initially, and until further evidence about the use of Compound Sodium Lactate in sepsis resuscitation is available, the local advice remains unchanged. However, it is likely that the choice of fluid is less important than how early and fast it is given.

3 Blood Cultures. These are mandatory in any patient who scores for sepsis on SIRS/SSI criteria, regardless of what the temperature is. Trying to do blood cultures retrospectively after the commencement of antibiotics has a very low yield.

4 IV antibiotics. The time to antibiotics is the best measure we have of the quality of care we are delivering to septic patients. Kumar et al showed the importance of early antibiotic administration in the study below.

What this shows is that in severe sepsis/shock, for every hour delay in administering antibiotics, mortality increases (unnecessarily) by 7.8%. Patients commonly wait 4 or more hours even in prospective trials. If this delay occurs, 28% of patients will die who would have survived if antibiotics were given immediately hypotension occurred. Putting it the other way around, if we give the antibiotics 4 hours earlier, the number of patients we would have to do this to, to save one life is 3.6 (Compared with MI thrombolysis where NNT is at least 42)

It is therefore of paramount importance for the whole team to minimise delays in antibiotics actually reaching the vein. Any individual can use the tool to recognise sepsis, but as soon as the clock starts ticking, delivery of the Sepsis Six and
particularly the antibiotics requires a team approach: **Get the antibiotics into the vein NOW!**

5 Measure Lactate. Lactate has become a very useful measure in sepsis management. Any elevation above normal indicates a compromised system in need of immediate support. Thus, knowing that the lactate is greater than 2 should immediately alert the team and lead to a team approach to resuscitation of a patient with severe sepsis. *(Remember mortality in severe sepsis is up to 40%).* A lactate twice normal (>4) indicates Septic Shock. This should be dealt with as a medical emergency on a par with cardiac arrest. Your patient has a very high risk of dying, but this can be greatly reduced by continuing the simple resuscitation measures swiftly.

6 Commence fluid balance and consider a catheter where organ dysfunction is apparent. When someone is significantly unwell, acute kidney injury is common. In sepsis, kidney hypoperfusion can cause low urine output as one of the first signs of multi-organ failure. Also, improving urine output is one of the best markers of improvement overall in a critically ill patient.

Early measurement of urine output is part of the Sepsis Six because it is so important. However, as there are risks associated with catheterisation (urethral trauma and hospital-acquired UTI), it is not recommended to catheterise everyone with sepsis. To complete the Sepsis Six appropriately, it is necessary to commence a fluid balance chart and consider catheterisation. **A catheter should usually be inserted in everyone with any sign of organ dysfunction** (see below).
Severe Sepsis and Septic Shock

Early recognition of Severe Sepsis saves lives. Everyone involved in the care of acutely unwell patients should be able to recognise when organ dysfunction is present. The list above is not exhaustive, and the cut-offs used are fairly arbitrary. However, it is extremely useful as a simple guide to whether a patient with sepsis is at increased risk of death.

**Hypotension** The most important evidence of organ dysfunction and increased risk of death is hypotension. However, blood pressure is very different between individuals. Young women can have normal systolic blood pressures of just over 90, hence they may not be unwell when their systolic is 85. Conversely, a 65-year-old who is usually on 3 antihypertensives and has asymptomatic hypertension at 160/100 could be deeply shocked with a BP of 110/70. For this reason, the measure of >40 below the patient’s normal systolic is very useful (check old charts and GP records for normal BP).

**Hypoxia** One of the commonest, (and commonly missed) signs of severe sepsis, is hypoxia. It is very common for patients to be given oxygen when the first set of observations show hypoxia. If the delivery of oxygen resolves the hypoxia, its original presence is often overlooked by subsequent reviewers. Hypoxia can occur with any site of infection, due to the systemic inflammation affecting the lungs (gas exchange is impaired by the interstitial fluid which occurs as part of the inflammatory response). It is a grave sign of a whole system which is under severe stress and should never be ignored.

**Lactate** is produced when tissues are not receiving enough oxygen for normal aerobic metabolism. It is an excellent measure of whether there is significant tissue hypoxia. A lactate which is elevated (>2) is enough to diagnose severe sepsis, if the elevation is due to infection (any cause of tissue hypoxia will result in elevated lactate levels, so it should not be used as a diagnostic test for sepsis). An elevated lactate should be acted on immediately, and if the Sepsis Six has not already been completed, it should be done as quickly as humanly possible. The patient with a lactate in the range 2-4 will often respond to good early management including appropriate fluid (20ml/kg initially, up to a maximum of 30 ml/kg in the first 3 hours). A lactate of >4 indicates severe tissue hypoxia and is diagnostic of septic shock (when due to infection), whatever the blood pressure.
Low urine output  The importance of measuring urine output has been discussed under the Sepsis Six above. Anyone with a urine output of < 0.5ml/kg/hr is at severe risk of going into multi-organ failure. Anyone in this situation needs immediate senior input into managing their fluid status, and a central line may be required for measurement of CVP early in the resuscitation if there is any doubt about how much fluid to give, or whether vasopressors / inotropes may be required.

Creatinine >177  This odd cut-off is simply due to conversion from the American non-SI units where the arbitrary level chosen was 1.5mg/dL. In practice, any rise in creatinine above normal, or significantly above the baseline for the patient is a poor prognostic indicator, and needs aggressive early management, usually with IV fluids, and stopping all nephrotoxic drugs, plus keeping a very close eye on urine output.

Bilirubin >34  Liver hypoperfusion can result in reduced metabolism, and this will be evidenced by a rise in bilirubin. It is another marker of poor prognosis when due to sepsis.

Abnormal Clotting  indicates that the liver cannot synthesise sufficient clotting factors to keep up with demand. Severe Sepsis is associated with intravascular inflammation which activates the clotting cascade and ultimately can result in DIC (disseminated intravascular coagulation). Any elevation in clotting times may be highly significant.

Low platelets  are an indication that bone marrow supply cannot keep pace with consumption, as happens in DIC, but may also be seen in severe sepsis without DIC, in part due to marrow suppression as a result of SIRS.
Septic Shock requires very co-ordinated team activity to give the patient any realistic chance of survival. A senior doctor experienced in managing septic shock should assess the patient immediately septic shock is diagnosed. This may require calling an on-call consultant in from home out of hours. It may require transfer to an HDU or ITU, potentially in another hospital. However, the need for transfer should not delay management. Every minute the patient has hypoperfusion of tissues is another minute producing lactic acid and increasing the likelihood that irreversible multi-organ failure will set in. It often takes a whole team of several doctors and nurses to resuscitate someone with septic shock adequately and quickly. At some times of day, and in some locations, this may necessitate getting help by calling 2222, or 999 in community settings. In Raigmore, additional help is available by phoning the Medical Emergency Team on 1999.

If a patient requires multiple interventions (central line, inotrope infusion, arterial line, urinary catheter etc.), different people should do different procedures concurrently or in quick succession. This emergency should NEVER wait until more routine things such as ward-rounds are complete.

When early septic shock (before established multi-organ failure) is recognised and treated aggressively, many patients make a rapid recovery, increasing the chance of overall survival, reducing length of stay and reducing costs.

Reminder: The initial recognition of possible sepsis is THE most important step in reducing deaths in hospital. Everything else in the treatment of sepsis follows on from this.
A guideline should not be followed slavishly. There are many situations where common sense dictates modification of the management of sepsis.

**Not Sepsis**

Sometimes a more experienced clinician than the first assessor will recognise that the presentation with a raised SIRS is due to something other than significant sepsis, and at this stage it is appropriate to modify or exit the guideline. It is extremely unlikely that a patient initially treated for sepsis will come to harm if they are later found to have a non-septic cause for their presentation. The dangers of C.diff and other HAIs exist, but if review happens within a few hours of treatment commencing, this risk is minimal.

**Palliative Care**

Sometimes it is clear that a patient is dying. Although the aggressive early management of sepsis saves lives, we need to recognise that sometimes aggressive treatment is inappropriate. This decision is usually best made by a senior clinician, and therefore may only happen at later review. It is always reasonable to consider palliative care if the chances of survival are slim or not in the best interests of the individual.

**Other problem in addition to sepsis**

There are many medical conditions which require us to modify the management of patients with sepsis. However, most do not change the immediate management significantly, and junior staff should have confidence in following the initial steps. An example of one situation where the immediate management is different is where sepsis occurs with current LVF. This can happen when LVF is precipitated by sepsis, or when someone ill with LVF develops infection as a complication. Fluid administration is not appropriate in the setting of florid pulmonary oedema, but aggressive management of the sepsis and the LVF together can have dramatic results. (Early senior help and inotropes are often required.)

It is important to realise that the initial fluid bolus is still indicated in someone with sepsis and a previous history of LVF, but their fluid status may require assessment with a fluid challenge.

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**The Fluid challenge**

This is a diagnostic tool, not a therapy. It is for use in a hypotensive or tachycardic patient where there is doubt about whether they are hypovolaemic or not. The volume involved is very unlikely to do harm, even in someone in cardiogenic shock. The reason for this is that in an adult, 250ml of saline will not stay in the circulation very long.

**Steps:**

- Take pulse and BP (plus CVP if available)
- Administer 250ml 0.9% Sodium Chloride via the largest available IV access in the shortest possible time (<2 minutes ideal). This is best achieved with manual pressure or a pressure bag. Most ward pumps take 15 minutes at their fastest rate, and should not be used.
- Take pulse, BP +/- CVP again.

A rise in systolic BP or a fall in pulse is a positive test, and more fluid can confidently be given. No response is less useful as it may mean that the patient has a cardiogenic element to their shock OR that 250mls was insufficient to improve their hypovolaemia clinically. A further fluid challenge may be needed where doubt remains.
SPSP and Sepsis: Improvement Methodology in Practice

The SPSP started in 2008 with the aim of reducing mortality in Scottish hospitals by 15%. Many different improvement programmes were started based on the Model for Improvement developed by the Institute for Health Improvement in the USA. During the period of the programme, there has been a reduction in mortality in Scottish hospitals of 12.4%.

In January 2012, the Sepsis Collaborative started, and since then a huge amount of work has been undertaken by clinical teams aiming to deliver the Sepsis Six for the reasons discussed earlier. The continuing reduction in mortality is almost certainly partly due to this hard work.

However, clinical teams have many different priorities and despite its obvious importance, sepsis work takes time. It is important therefore that any time clinical teams spend on the Sepsis Collaborative is time well spent. This is where improvement methodology comes in. This section is not written by an expert in improvement methodology, but by a sceptical convert. Experience in AMU in Raigmore with all of the SPSP workstreams has taught the team that improvement methodology really does work. The programme was originally launched with a lot of American jargon and hyperbole which Scots found difficult to swallow. However the techniques produce results.

The following “driver diagram” is for sepsis, but could easily be adapted for any clinical project undertaken.

Keeping the central aim in mind is useful, but it can seem like an impossible goal. Breaking it down into more manageable chunks is done by looking at the primary

AIM

To improve the recognition and timely management of Sepsis in acute hospitals

Outcome:
5% reduction in mortality from Sepsis by December 2012 increasing to 10% reduction by December 2014

**PRIMARY DRIVERS**

- Improve Recognition & Assessment of Sepsis
- Improve Treatment of Sepsis
- Education & Awareness
- Culture of QI and Safety
- Infrastructure to support the management of data

**SECONDARY DRIVERS**

- Reliable Sepsis screening (MEWS + SIRS)
- Ensure reliable communication across clinical teams of at risk patients
- Ensure timely rescue of deteriorating patient - Outreach
- Ensure reliable delivery of Sepsis Six within 1 hour
  - Include consideration of Source Control
  - Ensure reliable escalation of septic patients to higher level of care
  - Improve Antimicrobial stewardship - 3 day review
  - Implement Surviving Sepsis Maintenance Bundle
- Involve patients & families to raise awareness
- Local & National education on burden of illness & current performance
- Provide training to staff on clinical knowledge and improvement skills
- Clinical Leadership
- Multidisciplinary team working
- Executive Sponsorship
- Develop local & national measurement frameworks to guide improvement

Joint Collaborative - Sepsis Driver Diagram
things which will drive the change (primary drivers) and then breaking these down into smaller chunks which can be worked on individually (secondary drivers).

Within our own teams, leaders need to ensure that people understand the need for improvement, and the advantages improvement can bring. With sepsis this is easy, as most experienced healthcare workers will have had someone die from sepsis in their care. It happens frequently enough that a small change in mortality is measureable at a local level, even in small units.

When the key people believe that improvement in sepsis care should be a priority and that reliable delivery of the Sepsis Six is a key part of this, then the next step is to design small tests of change. **This is the vital part of improvement methodology that inexperienced people often underestimate.** A large change can be effective, but can also fail in a large way. Developing, testing, analysing and redeveloping small changes may seem labour-intensive but is key to producing results. The cycle is referred to as PDSA (Plan, Do, Study, Act)

![The PDSA Cycle for Learning and Improvement](image)

An excellent introduction to this vital tool can be watched at:

**http://www.youtube.com/watch?v=xzAp6ZV5ml4**

As an example, early recognition of sepsis is key, so one aim is to reliably recognise patients with an elevated SIRS score. The Plan could be to test a new admission document which has SIRS within it. Rather than assuming it will work and printing 1000 copies, the team does a small test on one patient, and studies the process. They find that the form was filled in well, but the doctor didn’t see the score as it was on an inside page. They act to change the form and then plan another small test. Vitally, this engages the team in the improvement, and allows everyone to feed into the development of a better system. It does require someone to keep an overview of
the larger goals, but it is very effective at supporting the ongoing process of improvement.

It is well worth recording the PDSA cycles, and the paperwork can be invaluable later on. The template reproduced below and as appendix 1 is also freely available from the IHI at:

http://www.ihi.org/knowledge/Pages/Tools/PlanDoStudyActWorksheet.aspx

When introducing change it is vital to start small. PDSA tests are often done on just “one patient, one nurse, one doctor, one time” initially. If it doesn’t work for one, it won’t work for many. Expanding can be done 1, 3, 5, many, although this does not need to be slavishly followed. The main point is to start small initially.
Run charts and the Hawthorne effect.

The Hawthorne Works was a factory where changes to working conditions resulted in increased productivity during any period when workers were studied. The act of performing the study produced results rather than the changes made to the working conditions.

This is relevant to healthcare improvement because it provides a powerful tool. If you display real-time data on a team’s performance, the feedback from this automatically improves performance.

Run charts like the one above are designed to chart improvement, and to allow statistics to be done to show when changes are real and not just normal variation. However, if they are updated and displayed in real time, where the team can easily see them the effect can be dramatic. Care needs to be taken to ensure that the effect is positive (a sudden dip in displayed performance can lead to disengagement, as can continued failure to reach a target). If there is a danger of this occurring, the leaders of the team need to examine whether changes need to be made, either to break the improvement up into smaller interim goals, or to take a new approach to achieving the set goals. Annotating charts can help avoid people becoming disheartened by giving explanations for poor performance (Eg “Time to first antibiotic 6 hours but patient had multiple allergies and required Levofloxacin delivered by taxi”)

Locally, Sepsis run charts have been created by John Mackintosh john.mackintosh@nhs.net. They can be accessed from any NHS Highland computer on the W network drive. To set up W drive access, email John giving your details and your NHS Highland login ID (As used for SCIstore etc). He will arrange with eHealth for access.

Remember that software helps, but sometimes a piece of paper and a pen can be better for a real-time graph of performance. Also, run charts are not the only tool for
feedback. One useful tool used in AMU is a “leader board” for which members of staff have delivered antibiotics most quickly. Other hospitals have initiated Sepsis Champions and give awards (chocolate medals) to the weekly/monthly champions.

The use of electronic aids such as the NHS Highland iPad Sepsis Timer or the iPhone app developed by NES may help teams to deliver better care. They solve some of the data collection and entry problems, and may help in enthusing the team about the Collaborative. However, access to these hi-tech solutions is not of paramount importance. Engaging the local team and ensuring everyone understands the importance of the improvement work is vital.

It is hoped that this primer can be used to give team members the facts behind what we are trying to do and help ensure that we do reach every person every time
Next steps in NHS Highland

The Sepsis Collaborative aims to reduce deaths from sepsis and reduce morbidity associated with sepsis. As a fortunate side-effect of this improved patient care, length of stay in hospital, use of ITU beds and other costs are likely to fall. Improving sepsis care is a win-win for patients and those providing the finances.

Following the training day on 06/06/13 or subsequent local training sessions, we challenge teams to look at how their own care delivery can be improved, whether they are just starting sepsis work or have already had experience. The Collaborative will continue to meet by video-link and aims to support local teams in developing and delivering their own improvements.

This booklet is on the intranet under Organisation→Raigmore Hospital→Acute Medicine and will be downloadable as a .pdf for use by anyone with an interest in sepsis. It is also on the W drive under Sepsis.

The Sepsis Record app for iPads is in the last stages of development and will be available for all teams in the near future.

The teams currently active in the Sepsis Collaborative are:

- Raigmore ED
- Raigmore AMU
- Raigmore Surgical Admissions (4A)
- Raigmore MET
- Belford Hospital
- Caithness General Hospital
- Lorne and the Isles Hospital

New teams are welcome to join the Collaborative.

There are plans to trial a Community sepsis response from GPs and the Scottish Ambulance Service is also looking nationally at how to improve sepsis care.

The future improvement of Sepsis care is down to every individual who reads this primer. We need to act in our own clinical jobs, and we need to ensure that our actions are effective. We need to do it now. To quote Don Berwick from the Institute for Health Improvement: “Some is not a number. Soon is not a time.”

The patients we help will not be aware that this collaborative has made the difference between them living and dying, but we will know as an organisation that a continued reduction in mortality rates across our hospitals is due in part to the work we do now.
PDSA Worksheet for Testing Change

Aim: (overall goal you wish to achieve)

_Every goal will require multiple smaller tests of change_

<table>
<thead>
<tr>
<th>Describe your first (or next) test of change:</th>
<th>Person responsible</th>
<th>When to be done</th>
<th>Where to be done</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Plan (2 parts: Listing tasks predicting possible outcomes of testing)

<table>
<thead>
<tr>
<th>List the tasks needed to set up this test of change</th>
<th>Person responsible</th>
<th>When to be done</th>
<th>Where to be done</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Predict what will happen when the test is carried out</th>
<th>Measures to determine if prediction succeeds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Do

Describe what actually happened when you ran the test

Study

Describe the measured results and how they compared to the predictions

Act

Describe what modifications to the plan will be made for the next cycle from what you learned

Institute for Healthcare Improvement
In-Hospital Antimicrobial Management of Common Community-Acquired Infections in MEDICAL Patients

**Signs of Systemic Inflammation (SSI, previously known as SIRS):**
Temp < 36 / > 38°C, Pulse > 90, Resp. rate > 20, WCC < 4/12, acutely altered mental state, ↑Glucose without diabetes

If SSI 2 or more AND infection suspected THIS IS SEPSIS - commence SEPSIS SIX immediately
Review regularly, de-escalate/switch from IV to oral with culture & sensitivity information and clinical response

**DOCUMENT THE INDICATION FOR THERAPY & REVIEW DATE IN PATIENT NOTES.**
Once culture and sensitivity results are available choose narrow spectrum agent where possible to reduce risk of disease due to *C. difficile.*
Avoid ceftiraxone, ceftazidime, clindamycin, ciprofloxacin or co-amoxiclav unless as protocol or on specialist advice.
If known or recent *C. difficile* positive and requiring broad spectrum treatment, contact Microbiology for advice.

<table>
<thead>
<tr>
<th>Severe/Complicated (IV)</th>
<th>Mild/Moderate (Oral)</th>
<th>Duration</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Severe Sepsis, Neutropenic OR site unknown</strong></td>
<td></td>
<td>Seek advice</td>
<td>Seek immediate senior help Manage in HDU environment Measure Lactate</td>
</tr>
<tr>
<td><strong>CNS Infection</strong></td>
<td>Ceftriaxone 2g TWICE daily If &gt; 55 or immunocompromised ADD amoxicillin 2g 4 hourly (6 x day) If viral encephalitis suspected ADD aciclovir 10mg/kg 3 x daily</td>
<td>N/A</td>
<td>Seek advice Consider Dexamethasone 10mg 4 x daily at time of first antibiotic Discuss with Microbiology Inform Public Health if Meningococcal disease suspected</td>
</tr>
<tr>
<td><strong>Community Acquired Pneumonia (X-ray consolidation)</strong></td>
<td>CURB65 = 3 to 5 OR CAP with SEPSIS Co-amoxiclav 1.2g 3 x daily PLUS Clarithromycin 500mg 2 x daily</td>
<td>CURB65 = 2 Amoxicillin 500mg 3 x daily PLUS Clarithromycin 500mg 2 x daily CURB65 = 1 See infective exc. COPD(below)</td>
<td>7-10 days</td>
</tr>
</tbody>
</table>

**Check BNF for Clarithromycin drug interactions e.g. warfarin, theophylline, statins**

| Infective Exc. COPD/Non-pneumonic LRTI | Co-amoxiclav 1.2g 3 x daily Amoxicillin 500mg 3 x daily OR Doxycycline 100mg 1 x daily | 5 - 10 days | Treat Severe Sepsis if concurrent Early IV/oral switch often possible ➔ First Stat dose 200mg |
| **Aspiration Pneumonia** | Pipercillin / tazobactam 4.5g 3 x daily | N/A initially | Up to 7-14 days | Stop if aspiration unlikely at review |
| **Urinary Tract Infection** | **Urosepsis/Upper UTI/ Catheterised Amoxicillin 1g 3 x daily PLUS gentamicin** Must review early with culture and sensitivity information If significant renal impairment use co-amoxiclav 1.2g 3 x daily | **Lower UTI/Cystitis** Nitrofurantoin 100mg M.R 2 x daily if no renal dysfunction OR Cefalexin 500mg x 3 daily | 3 days initially | Check previous recent sensitivities on SCI store. Upper UTI/Urosepsis may need 10-14 days. Early IV/oral switch often possible. Consider prostatic involvement. Catheter related UTI: remove/replace catheter and culture urine. |
| **Skin & Soft Tissue Infection** | Fluoxacillin 1 – 2g 4 x daily If dirty or penetrating wound ADD gentamicin* and Metronidazole 500mg 3 x daily | Fluoxacillin 500mg to 1g 4 x daily If dirty or penetrating wound ADD Metronidazole 400mg 3 x daily | Depends on response 7-14 days | Care with facial cellulitis: senior advice. Bites require Co-amoxiclav. Penetrating wounds need surgical advice. |

**Necrotising fasciitis is a surgical emergency.**

| Upper Limb | Clindamycin 1.2g 4 x daily PLUS Vancomycin* | SEEK URGENT SURGICAL OPINION AND CONSULT MICROBIOLOGIST |
| Lower Limb/Abdomen/Perineum | Clindamycin 1.2g 4 x daily PLUS Meropenem 2g 3 x daily |
| Intra-abdominal (inc.Hepatobiliary) | Pipercillin/tazobactam 4-5g 4 x daily PLUS Gentamicin* | Co-amoxiclav 1.2g IV 3 x daily | 7-10 days | Seek surgical advice early. Oral route rarely appropriate initially |

*For gentamicin & vancomycin dosing and adjustment of dose in renal impairment refer to Highland Formulary.

**Diarrhoea**
Diarrhoea may be a symptom associated with any systemic infection. Antibiotics are not usually indicated for community-acquired gastroenteritis.

Consider and test for *C. diff.* If *C. diff.* + ve: See treatment algorithm. Assess severity and review current antibiotics, PPIs, laxatives.

**Additional Notes:** This guideline is ONLY for use for community-acquired infections being treated in hospital, and requiring empiric therapy. For hospital-acquired infections, and infections not covered here, refer to the Highland Formulary, or contact microbiology for advice. Assess need for antibiotics at each ward-round. "Full course" does not need completing if situation has changed. Always check on SCI store for previous results and sensitivities, which may alter empiric therapy from the above. If MRSA +ve, seek advice on need to cover MRSA in the current treatment.

**Antibiotic allergy:** Document allergy history carefully, including checking with GP. True Penicillin allergy is rare, and cross-reactions with cephalosporins are exceptionally rare. If anaphylaxis documented to any antibiotic, all antibiotics should be used with caution. In life-threatening infection, use the most appropriate antibiotic, unless it has been documented as causing severe reaction.

**True Penicillin allergy:** Use meropenem in neutropenia and severe sepsis/CNS infection, vancomycin* in severe SSTI and doxycycline for mild/moderate SSTI, ertapenem IV or oral ciprofloxacin in severe complicated UTI, levofloxacin in severe CAP and vancomycin*, ciprofloxacin + metronidazole in severe intra-abdominal sepsis.

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Link Consultants: Dr Grant Franklin, Dr Emma Watson.

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