

# Sepsis Measurement Framework

## Purpose

To provide guidance on developing quality improvement measures to monitor improvement in sepsis care.

## Family of measures

A family of measures is a collection of outcome, process and balancing measures that provide a framework to understand the impact of changes over time. Including one or two measures from each of the following three categories will help determine if improvement has occurred. The Driver Diagram is an effective tool to assist with visualizing and linking outcome, process and balancing measures.

**Outcome measures** are closely aligned with your aim statement or the overall impact you are trying to achieve. They relate to how the overall process or system is performing i.e. the end result. For example, sepsis-related mortality, % patients commenced on the pathway.

**Process measures** are the parts or steps in the process performing as planned. They are logically linked to achieve the intended outcome or aim. For example, percentage of patients started on intravenous antibiotics within 60 minutes, percentage of patients with serum lactate measured, median time to commence intravenous antibiotics, median time to commence fluids.

**Balancing measures** look at the system from different directions or dimensions. They determine whether changes designed to improve one part of the system are causing new problems in another part of the system. For example, change in antibiotic use, number of Rapid Response calls relating to sepsis, number of patients transferred to ICU with sepsis.

Process and balancing measures are key markers to guide close and effective monitoring of reaching your aim. They are collected frequently on a daily or weekly basis. The outcome measures will be collected at longer intervals such as weekly or monthly to monitor progress towards achieving the project aim.

## Numerators and denominators

Quality measures consist of a numerator and denominator. The numerator is the key measure (costs, patients waiting, etc.) and the denominator is the unit of production or volume (total costs, total patients waiting). The following is an example of a numerator and denominator for sepsis improvement:

*Numerator:* Number of patients who had a lactate measured within one hour of sepsis diagnosis for the time period under study.

*Denominator:* Total number of patients diagnosed with sepsis for the time period under study.

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## Sample size

Quality improvement can be bogged down by excessive data collection. This is resource intensive and may not be meaningful.

Collecting small samples of 5-10 consecutive patients every week can demonstrate gaps in care, provide rapid feedback on PDSA cycles and is useful for broader implementation and evaluation monitoring. Sample size will vary according to the size of the healthcare facility i.e. if you are in a busy Emergency Department with 20 patients a week with sepsis, collect data for 5-10 consecutive patients every week. If you are in a small multipurpose service, you may find you need to collect data on every person with suspected or known sepsis to get a large enough sample size.

The key is to ensure your sample size and number of data collection points are large enough to detect patterns that indicate improvement. As a general guide 11 – 50 data points are required to spot patterns that are moderate or large. Further detail is provided in [Appendix A: Examples to illustrate the measurement framework in action](#).

## Methodology

Five simple steps are required to effectively and consistently manage a small sample i.e. to be a valid and reliable data collection. This is particularly important when there is more than one person responsible for data collection.

1. Define the eligible sample e.g. 5 consecutive eligible patients with discharge diagnosis of sepsis
2. Establish exclusion criteria e.g. patients who did not commence IV antibiotics
3. State the study period e.g. date/time start to date/time finish
4. Keep a reject log e.g. collected 8 consecutive patients but 3 excluded as they did not have IV antibiotics
5. Ensure data collection is complete e.g. completed data collection for all 5 eligible patients.

## Operational definitions

Operational definitions provide clarity, so everyone measures the same thing, every time. An operational definition provides a clear and unambiguous description in quantifiable terms of what to measure, and the steps to follow to measure it consistently. The following operational definitions are used in the measurement framework.

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Term	Operational Definition
<b>Adult patient</b>	Aged $\geq$ 16 years
<b>Maternal patient</b>	Woman $\geq$ 20 weeks gestation or $\leq$ 6 weeks post-partum
<b>Paediatric patient</b>	Aged $<$ 16 years (including neonates)
<b>Newborn patient</b>	Newborn (birth episode of care)
<b>Known or suspected sepsis</b>	Patient has: Any signs and/or symptoms of infection PLUS Yellow or Red Zone criteria as per the relevant sepsis pathway WITH or WITHOUT Any sepsis risk factor(s)
<b>Sepsis recognition</b>	Time stamp for triage (emergency) or CERS call (ward)
<b>Sepsis bundle</b>	Blood culture(s), lactate, IV antibiotics, IV fluid bolus within 60 minutes of recognition <small>(NB oxygen not included in bundle)</small>
<b>IV antibiotic commenced</b>	Time stamp first IV antibiotic administration commenced
<b>Appropriate antibiotics</b>	Antibiotics prescribed as per the local sepsis antibiotic guideline or <i>Therapeutic Guidelines: Antibiotic</i>
<b>IV fluid bolus</b>	Adult in Emergency = 20mL/kg crystalloid bolus STAT Adult in inpatient ward = 250-500ml crystalloid bolus STAT Paediatric in Emergency or inpatient ward = 10-20mL/kg 0.9% sodium chloride bolus STAT Newborn = 10mL/kg 0.9% sodium chloride
<b>IV fluid bolus commenced</b>	Time stamp first IV fluid infusion commenced
<b>Appropriate blood cultures</b>	Adult = 2 blood culture sets (4 bottles) Paediatric/neonatal/newborn = 1 blood culture set (2 bottles)
<b>Serum lactate measured</b>	Venous blood gas (VBG), arterial blood gas (ABG) or formal serum blood sample taken for lactate measure
<b>Sepsis management plan documented</b>	Initial sepsis management plan documented in the medical record

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## Measures

The following examples are provided to assist teams in identifying measures to align with the project aim statement and/or develop local measures.

It is recommended that one or two measures from each of the three categories (outcome, process and balancing) are used. Teams can seek support from local QI experts and/or the clinical governance unit to select measures to effectively align with the aim.

Outcome Measures	
<b>Percentage of patients who receive all elements of the sepsis bundle within 60 minutes of sepsis recognition</b>	
<b>Numerator</b>	Number of patients who receive all elements of the sepsis bundle within 60 minutes of sepsis recognition
<b>Denominator</b>	Total number of patients with suspected sepsis
<b>Data source</b>	Medical record review; record as a tally count
<b>Sepsis mortality rate</b>	
<b>Numerator</b>	Number of patients with a final coded sepsis diagnosis
<b>Denominator</b>	Total number of patients in the time period under study
<b>Data source</b>	Health Information Exchange (seek QI support to access this data)

Process Measures	
<b>Percentage of patients who commence first dose of IV antibiotics within 60 minutes of sepsis recognition</b>	
<b>Numerator</b>	Number of patients who have first dose of IV antibiotic commenced within 60 minutes of sepsis recognition
<b>Denominator</b>	Total number of patients with suspected sepsis
<b>Data source</b>	Medical record review; record as a tally count
<b>Median time to commence first dose of IV antibiotic</b>	
<b>Median</b>	Time from sepsis recognition to commencement of first IV antibiotic administered*
	*No numerator and denominator required for median time

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<b>Data source</b>	Medical record review; median calculated from all patients with sepsis in the time period under study
<b>Percentage of patients who have blood cultures prior to commencement of IV antibiotics</b>	
<b>Numerator</b>	Number of adult/maternal/paediatric/newborn* patients with blood cultures taken prior to commencement of IV antibiotics *Adult or maternal patients = 2 sets of blood cultures; paediatric or newborn patients = 1 set of blood cultures
<b>Denominator</b>	Total number of patients with suspected sepsis
<b>Data source</b>	Medical record review; record as a tally count
<b>Percentage of patients who have a serum lactate measured within 60 minutes of sepsis recognition</b>	
<b>Numerator</b>	Number of patients who have a serum lactate measured within 60 minutes of sepsis recognition
<b>Denominator</b>	Total number of patients with suspected sepsis
<b>Data source</b>	Medical record review; record as a tally count
<b>Percentage of patients who have an IV fluid bolus commenced within 60 minutes of sepsis recognition</b>	
<b>Numerator</b>	Number of patients with suspected sepsis who commence an IV fluid bolus within 60 minutes of sepsis recognition
<b>Denominator</b>	Total number of patients with suspected sepsis
<b>Data source</b>	Medical record review; record as a tally count
<b>Median time to commence IV fluid bolus</b>	
<b>Median</b>	Time from sepsis recognition to commencement of first IV fluid bolus* *No numerator and denominator required for median time
<b>Data source</b>	Medical record review; median calculated from all patients with sepsis in the time period under study
<b>Percentage of patients with known or suspected sepsis that have a documented sepsis management plan within two hours of sepsis recognition</b>	
<b>Numerator</b>	Number of patients who have a sepsis management plan documented within two hours of sepsis recognition
<b>Denominator</b>	Total number of patients with suspected sepsis
<b>Data source</b>	Medical record review; record as a tally count

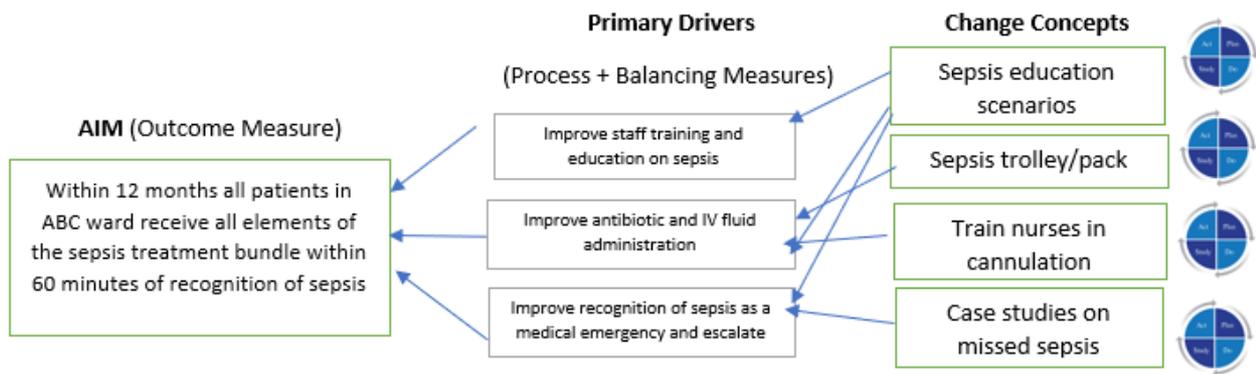
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Balancing Measures	
<b>Percentage of patients who have appropriate IV antibiotics prescribed for the source of sepsis</b>	
<b>Numerator</b>	Number of patients prescribed the appropriate IV antibiotics based on the original assessment of source of sepsis as per approved sepsis antibiotic prescribing guideline
<b>Denominator</b>	Total number of patients with suspected sepsis commenced on IV antibiotics
<b>Data source</b>	Medical record review; record as a tally count
<b>Percentage of patients who have a Rapid Response call within 8 hours of initial sepsis treatment</b>	
<b>Numerator</b>	Number of patients who have a Rapid Response call within 8 hours of sepsis recognition
<b>Denominator</b>	Total number of patients with suspected sepsis
<b>Data source</b>	Rapid Response logs
<b>Percentage of patients with sepsis who are admitted to ICU</b>	
<b>Numerator</b>	Number of patients who are admitted to ICU following initial sepsis treatment in the inpatient ward or Emergency
<b>Denominator</b>	Total number of patients with suspected sepsis
<b>Data source</b>	Medical record review; record as a tally count

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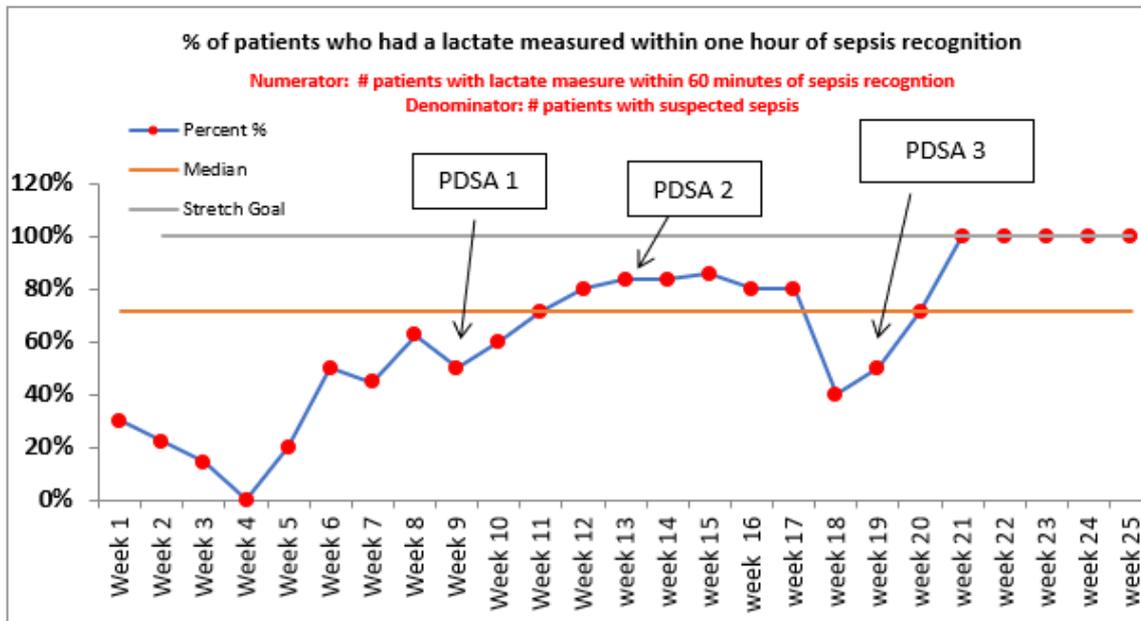
## Appendix A: Examples to illustrate the measurement framework in action

Figure 1. Driver Diagram illustrating the relationship between the outcome, process and balancing measures



Note the Secondary Drivers have been excluded as this is an example only

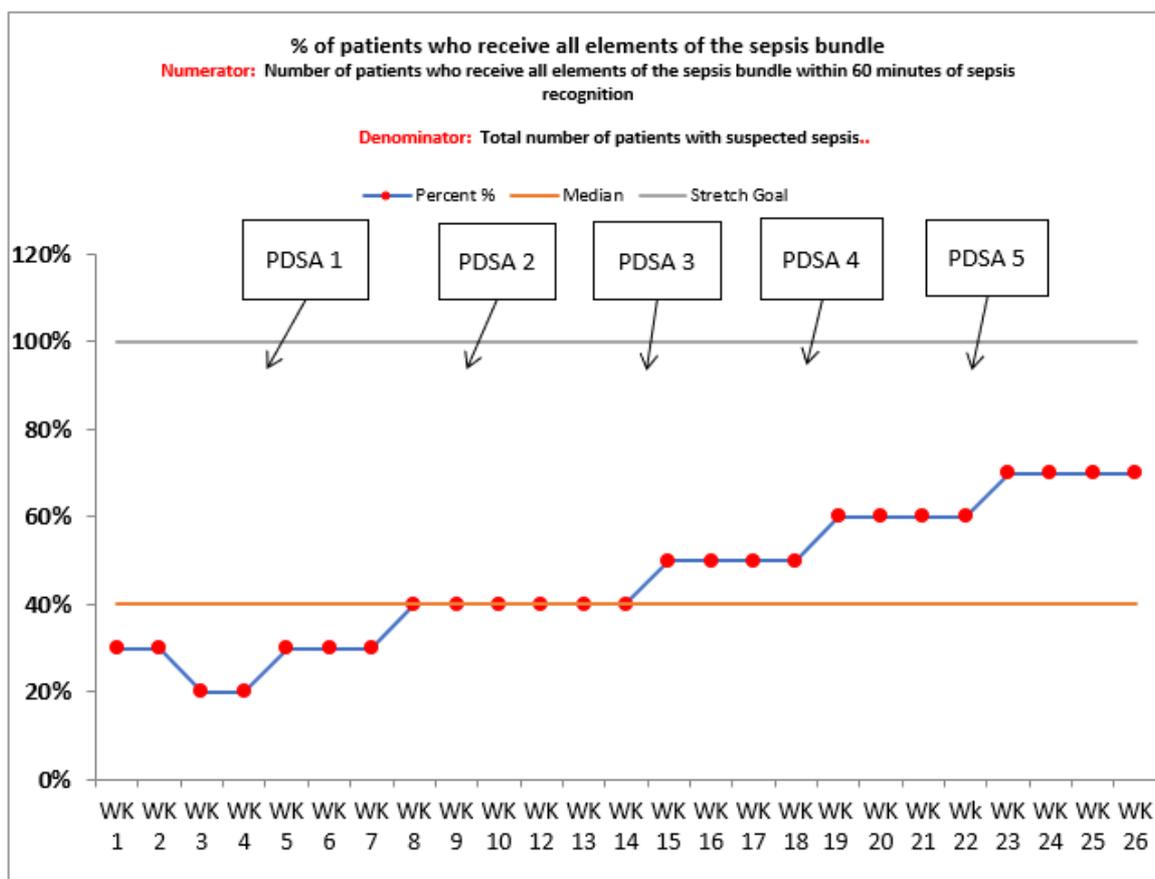
Figure 2. Example of a run chart with 25 data points and annotated PDSAs



A team can look at day-to-day data or plot 25 patients if sepsis case numbers are low or infrequent. The team need enough data points to study the impact of changes, and the median can be added when 10 data points or more are plotted on the chart.

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Figure 3. Example of sepsis data collection over 6 months

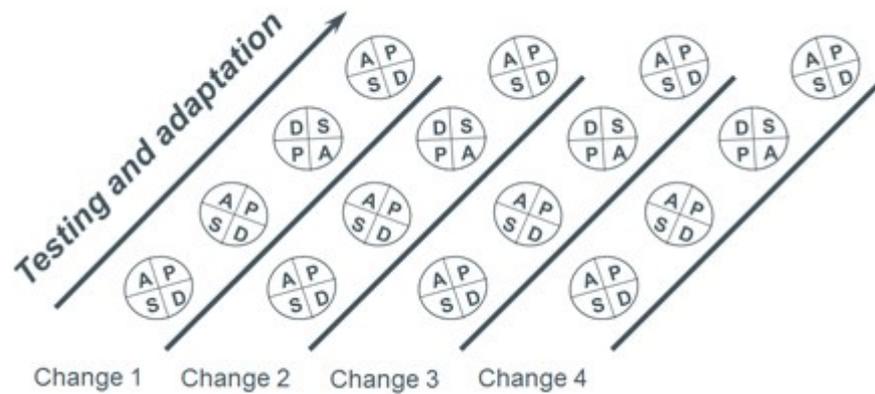


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X-axis Date or Observation in CHRONOLOGICAL ORDER	Numerator (top number in the fraction)	Denominator (bottom number in the fraction)	Percent %	Median	Stretch Goal	Change ideas tested via PDSA
WK 1	3	10	30.0%	40.0%	100.0%	
WK 2	3	10	30.0%	40.0%	100.0%	
WK 3	2	10	20.0%	40.0%	100.0%	
WK 4	2	10	20.0%	40.0%	100.0%	
WK 5	3	10	30.0%	40.0%	100.0%	PDSA 1 (Change 1-4)
WK 6	3	10	30.0%	40.0%	100.0%	
WK 7	3	10	30.0%	40.0%	100.0%	
WK 8	4	10	40.0%	40.0%	100.0%	PDSA 2 (Change 1-4)
WK 9	4	10	40.0%	40.0%	100.0%	
WK 10	4	10	40.0%	40.0%	100.0%	
WK 12	4	10	40.0%	40.0%	100.0%	
WK 13	4	10	40.0%	40.0%	100.0%	
WK 14	4	10	40.0%	40.0%	100.0%	
WK 15	5	10	50.0%	40.0%	100.0%	PDSA 3 (Change 1-4)
WK 16	5	10	50.0%	40.0%	100.0%	
WK 17	5	10	50.0%	40.0%	100.0%	
WK 18	5	10	50.0%	40.0%	100.0%	
WK 19	6	10	60.0%	40.0%	100.0%	PDSA 4 (Change 1-4)
WK 20	6	10	60.0%	40.0%	100.0%	
WK 21	6	10	60.0%	40.0%	100.0%	
WK 22	6	10	60.0%	40.0%	100.0%	
WK 23	7	10	70.0%	40.0%	100.0%	PDSA 5

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						(Change 1-4)
WK 24	7	10	70.0%	40.0%	100.0%	
WK 25	7	10	70.0%	40.0%	100.0%	
WK 26	7	10	70.0%	40.0%	100.0%	



**Note:** changes 1 to 4 form part of a series of PDSA cycles to refine and test the change until the goal is met. Once this is achieved the team can move to implementation. Further information on measurement is available in the Sepsis Toolkit and examples of run charts are available in QIDS.

**Figure 4: Example of data collection to demonstrate reliability of a bundle**

Sepsis bundle reliability is the outcome measure in this example and the snapshot of 10 patients across one week indicates only 3 out of the 10 patients received all elements of the bundle.

Patients Week 1	Known or suspected sepsis	Lactate	IV antibiotics	IV Fluid bolus within 60 min of reg	Blood Culture	#Successful opportunities	All components
1	Yes	Yes	Yes	Yes	Yes	5	Yes
2	Yes	No	Yes	Yes	Yes	4	No
3	Yes	Yes	No	No	No	2	No
4	Yes	Yes	Yes	Yes	No	4	No
5	Yes	Yes	Yes	No	No	3	No
6	Yes	No	Yes	No	Yes	3	No
7	No	Yes	Yes	No	Yes	3	No
8	Yes	Yes	Yes	Yes	Yes	5	Yes
9	Yes	No	No	Yes	No	2	No
10	Yes	Yes	Yes	Yes	Yes	5	Yes
Reliability	9/10	7/10	8/10	6/10	6/10	36/50 (72%)	3/10 (30%)

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The second table shows the results for Week 2 after PDSA cycles focusing on IV fluid administration and taking blood cultures. There is an improvement in the IV fluid and blood culture process measures but no improvement in the outcome measure. In general, it takes some time to see improvement of the outcome measure after improvement in the process measures.

Patients Week 2	Known or suspected sepsis	Lactate	IV antibiotics	IV Fluid bolus within 60 min of reg	Blood Culture	#Successful opportunities	All components
1	Yes	Yes	Yes	Yes	Yes	5	Yes
2	Yes	No	Yes	Yes	Yes	4	No
3	Yes	Yes	No	Yes	Yes	4	No
4	Yes	Yes	Yes	Yes	No	4	No
5	Yes	Yes	Yes	Yes	No	4	No
6	Yes	No	Yes	Yes	Yes	4	No
7	No	Yes	Yes	No	Yes	3	No
8	Yes	Yes	Yes	Yes	Yes	5	Yes
9	Yes	No	No	Yes	No	2	No
10	Yes	Yes	Yes	Yes	Yes	5	Yes
Reliability	9/10	7/10	8/10	9/10	7/10	<b>40/50 (80%)</b>	<b>3/10 (30%)</b>