INTRODUCTION TO QUALITY IMPROVEMENT COURSE MATERIALS

The Leeds Teaching Hospitals NHS
NHS Trust

Sean Ninan, Gurjit Chhokar, Anna Winfield, Rebecca Whiting

Introduction to Quality Improvement

What is quality?

The Institute of Medicine defines quality as the "degree to which healthcare services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge."[1] Six dimensions of healthcare quality are identified that *can be used as means for deciding on areas for improvement*.

Dimension	Meaning
Safe	avoiding harm to patients from care that is intended to help them
Effective	providing services based on scientific knowledge to all who could benefit, and refraining from providing services to those not likely to benefit
Patient-centred	providing care that is respectful of and responsive to individual patient preferences, needs, and values, and ensuring that patient values guide all clinical decisions.
Timely	reducing waits and sometimes harmful delays for both those who receive and those who give care
Efficient	avoiding waste, including waste of equipment, supplies, ideas, and energy
Equitable	providing care that does not vary in quality because of personal characteristics such as gender, ethnicity, geographic location, and socioeconomic status.

Table 1:Six dimensions of quality in healthcare

What is quality improvement?

Quality improvement (QI) has been described as "an organised system to continually improve processes, outcomes, and service, regardless of prior excellence, in order to be the best we can be." It involves developing theories for change, testing them, measuring their impact with data that is collected in "real time," and refining theories of change using an iterative, trial and learning methodology e.g. PDSA (Plan, Do, Study, Act) cycles. It requires training in QI methodology, an improvement team who know the work involved because they are the ones doing the work, feedback through data, usually in the form of run charts, and support from improvement experts. Changes are tested, over time, and, if appropriate, in different environments, to build knowledge of the system, before they are implemented.

Quality improvement has also been described as a "complex social intervention."[3] Improvement efforts are rarely straightforward, linear, "before and after" processes but can fluctuate, vary over time, and are dependent on context. It can help provide a framework for addressing the gap between what is being done at the moment, and what should be done, or what is possible.

Sean Ninan, Gurjit Chhokar, Anna Winfield, Rebecca Whiting
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What is improvement science?

Quality improvement is also a science, with underpinning theory that draws on foundations from traditional scientific enquiry, psychology and statistics. Over the next few sessions we will start to cover:

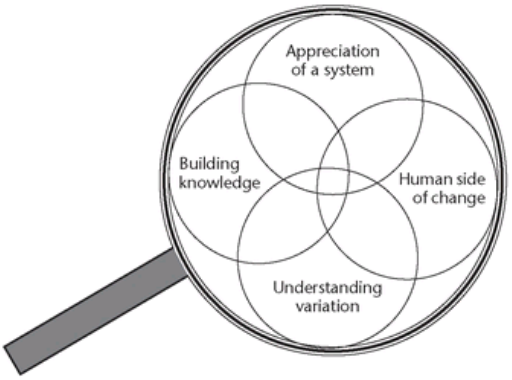

Figure 1:The Science of Improvement (Langley et al)[4]

Appreciation of a system – how to analyse the people, parts and processes that work together to bring about the desired aim. A systems view involves taking a step back and considering how change in one part of an organisation can affect another e.g. delays in discharge on wards can affect crowding in the emergency department (whilst rushing patients out of the emergency department to meet a four hour target may mean patients on trolleys in corridors).

Building knowledge- using principles from traditional scientific enquiry we can analyse a system using PDSA cycles. This involves testing explicit theories of change, (if we do x, I think y will happen because...), measure...), measuring those changes and analyse whether the changes have had an impact. If the changes have worked, we can expand on them and try others. If they haven't worked, we can reflect on whether the change itself didn't work, or whether there was a problem with implementation. This can be used to build knowledge of the system.

Understanding variation – two data points are rarely the same. Understanding what is normal or "common cause" variation and what is statistically significant "special cause" variation is important when analysing whether change has occurred. Gathering data over time, contemporaneously, is the best way to build knowledge of a system.

The human side of change – people are different, and their behaviours may not always reflect their underlying motivation. Understanding motivation, understanding how ideas spread, and using positive deviance to bring about cultural change, are some aspects of the human side of change.

How does it differ from a completed audit cycle?

Audits tend to look at (often large amounts of) historical data to evaluate whether a standard has been met. They are useful for *quality assurance* to see if we are compliant with a given standard.

These standards are often set by professional bodies or external regulators. If an audit demonstrates that we are not compliant with a standard, then the approach may vary from "repeat the audit next year" when it will be mandatory to do so, or by developing a change, and then re-auditing. Whilst audit are to some extent necessary to monitor performance, and may be a useful driver for change - there are many examples of high quality audits that have stimulated real improvement - they can sometimes become a tick-box exercise. "Audits of audits" suggest that many are never completed or re-audited.[5] This is not to diminish the role of audit altogether – it is necessary to audit performance and standards, but quality improvement differs from a completed audit cycle in many ways:

- Quality improvement is not mandatory, does not need to be based on a standard and whilst changes may be based on evidence, they may also be based on a hunch e.g. "What if all Gledhow wards arranged equipment for venepuncture and cannulation identically? Would we save doctors' time? (If you were going to test this theory for a quality improvement project, you may wish to start on just one ward to test feasibility and may also wish to record the effects on workload for staff who organised the equipment room)
- Aims for quality improvement are normally set by the team doing the improvement rather than an external agent. This means that you won't get punished or admonished for not achieving your target, and it something that the team doing the improvement agree is important
- Measurement for quality improvement usually involves frequent (often weekly) small scale data collection, usually collected by the team doing the improvement work. Collecting data from even a small sample of patients on a regular basis enables you to see the effect of changes in real time rather than retrospectively (when it can sometimes be difficult to identify what caused a change) and build up a picture of a system over time. This is more effective than collecting two large before and after samples of data. (This is covered in more detail in the measures session in our Introduction to Quality Improvement Course)
- Quality improvement involves continuous, repeated, iterative tests of change to build knowledge of what works (and what doesn't) in the context of where the improvement efforts are taking place

This isn't to say audit doesn't have a role. It does. It is often necessary to assure ourselves that we are doing what we are supposed to, and national audits can yield rich data. Audit can also be used to develop a QI project and may sometimes be used as part of a QI project.

Bad apples or best practice?

Quality assurance involves a traditional approach to performance management – to ensure a minimum standard of performance. When this approach is used at its worst it can sometimes look like "weeding out bad apples." What about an alternative approach – with everyone learning from the best to continually improve - instead of punishing the worst?

Figure 2:Quality assurance versus quality improvement (Institute for Healthcare Improvement/R. Lloyd)

Removing the worst performers does improve the average performance, but only by a small amount, by removing the outliers

Quality improvement, in contrast, involves learning from the best to bring about radical improvement by both reducing variation and raising the quality of care for all

This kind of radical change (that takes place incrementally, through repeated smaller cycles of change) marks a major difference between quality improvement and quality assurance

What is the Model for Improvement?

The Model for Improvement is made up of a set of three fundamental questions that drive improvement efforts and the PDSA cycle.[6] It has its roots in industry, where a prototype of a product or service is designed before it is produced but has been used widely across the world to drive improvement in healthcare. The three questions are outlined in the diagram. They cover forming a team, setting aims, choosing appropriate measures, selecting and testing changes and evaluating the effectiveness of changes through repeated PDSA cycles. Changes are typically tested on a small scale, to build knowledge and confidence that they work before they are implemented on a larger scale.

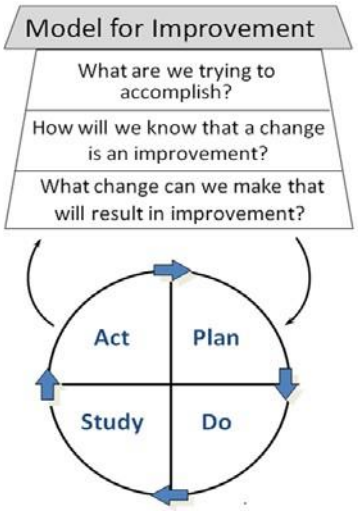

Figure 3: The Model for Improvement (Langley et al.[4])

What does "PDSA" involve?

PDSA cycles are used to build knowledge to answer the three questions in the model for improvement, but are particular useful when testing and implementing changes

Plan

- Predict what is going to happen
- Explain your predictions
- Plan how you are going to measure

When we make a change we are predicting that will we make an improvement, but whilst improvement requires change, not all change is improvement. If you are trying to make an improvement, articulate your theory and make your hypothesis (or hypotheses) explicit – "*If we change X, I think Y will happen because..."*

Planning changes in this way allows team members to see (and challenge) the theory made and prevents hindsight bias.

Do

- Carry out the plan, usually on a small scale.
- Document things that did not go according to plan, and why
- Begin analysis of the data

Study

- Complete analysis of the data
- Compare the data to what was predicted
- Summarise learning

When we move from "do" to "study" we can update whether our theory worked and begin to refine it. "It worked/didn't work *here* but what would happen if we tried it elsewhere?"

If the change is successful, then the team can gain confidence in their planned theories.

If a change is not successful, the study aspect of the cycle allows us to investigate whether this was because the change itself did not result in improvement, or whether there was a problem with executing the change successfully.

In either case, studying the effect of the change allows us to build knowledge of the system that we are working in.

Act

In the Act stage, the team may decide on several things:

- Is further testing required e.g. under different conditions (times, locations, groups of people) to build confidence that the change is successful?
- Does the change need to be modified?
- Does the change need to be abandoned?
- Do alternative changes need to be considered?
- Does the change result in unforeseen consequences e.g. cost/morale that needs to be explored further?
- Is the team ready to scale up change or implement it fully?

Using PDSA cycles to test theories for change and build knowledge has much in common with traditional scientific enquiry

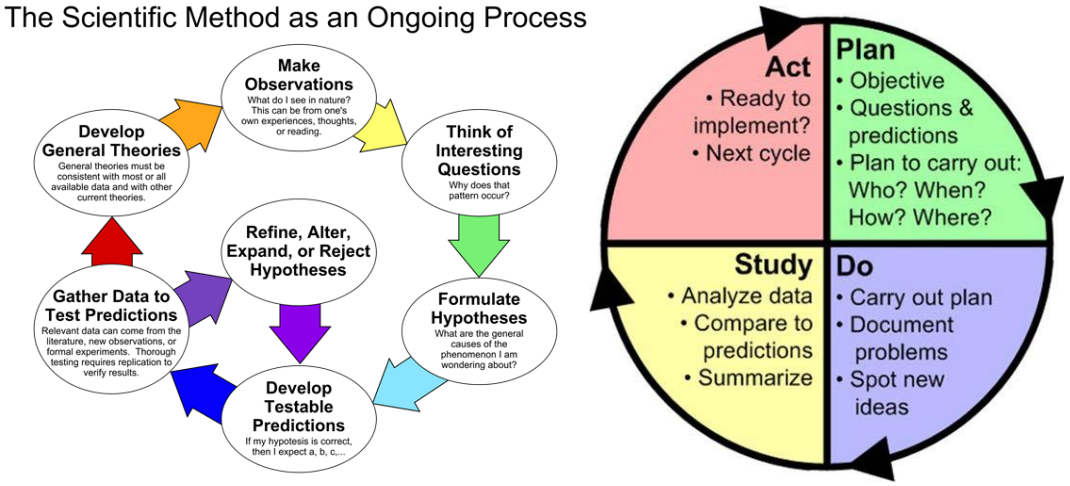

Figure 4: PDSA and the scientific method[7] [8]

Principles for testing change

When we have tested a change that has been successful, we need to consider whether this change will be successful in the future. To do this we need to consider three basic principles:

1. Test on small scale and build knowledge sequentially

Knowledge of the system you are trying to change is built using PDSA cycles whereby

a) You predict what will happen using a theory based on your current understanding of the system
b) You implement the change and test your theories by comparing data to predictions
c) You improve your theory based on the new knowledge you have gained and make further predictions on the basis of this revised theory.

The scale of testing depends on the belief that change will result in improvement, the level of commitment within the organisation and the cost of failure. It is better to build knowledge with a series of changes than trying to have one large PDSA cycle that incorporates all planned changes.

In most cases a small scale test, using willing volunteers (rather than expending energy on gaining "buy-in" from sceptics) is a good way of increasing belief in a change, testing whether it will work in the environment of interest and allowing individuals to experience the change before it is implemented – reducing resistance.

		Current commitment within the organisation		
		No commitment	**Some commitment**	**Strong commitment**
Low degree of belief that change idea will result in improvement	Cost of failure large	Very small scale test	Very small scale test	Very small scale test
	Cost of failure small	Very small scale test	Very small scale test	Small scale test
High degree of belief that change idea will result in improvement	Cost of failure large	Very small scale test	Small scale test	Large scale test
	Cost of failure small	Small scale test	Large scale test	Implement

Table 2: Scale of testing ((Langley et al. [4])

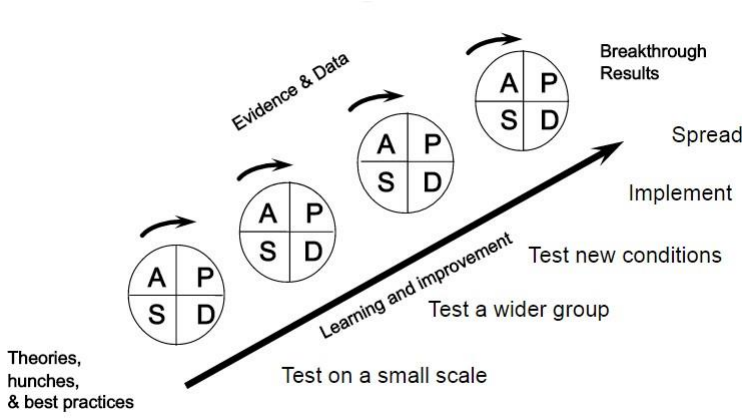

Figure 5: Building knowledge through sequential testing (Langley et al. [4])

In real life our theories don't go exactly to plan, and it is possible to take steps backwards as well as forwards, but if we reflect on these failures using a PDSA approach, we can use failure to build further knowledge of the system. These failures, and the knowledge gained from them are often not reported when we read the summary of an intervention, like a simple checklist that has had dramatic results.

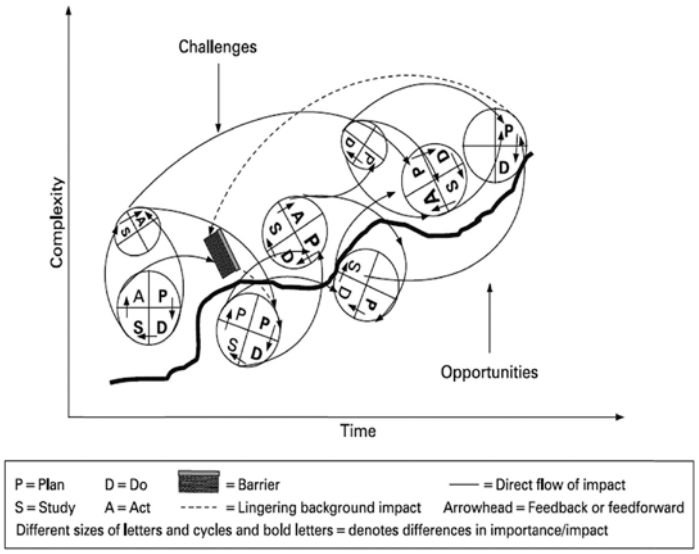

Figure 6:Revised conceptual model of rapid cycle change using PDSA (Tomolo et al.)[2]

2. Collect data over time

   Use run charts to collect data over time. This will be covered further in future sessions

3. Include a wide range of conditions in the sequence of tests

   Collecting data over time allows us to study the effect of changes over different conditions e.g. with different staff, different numbers of staff, different seasons etc. We may also wish to test changes in different locations before spreading change on a larger scale

Learning from Mr Potato head

Although this is a simple example, we learned several QI concepts from Mr Potato head.

We learnt that *repeated cycles of change* helped to build knowledge about what did work, and what didn't, more than prolonged planning to create the perfect process.

We made explicit our theories of change. Over the sessions we have run, not all changes have led to improvement! We have heard people debate whether extra people assembling will be a help or a hindrance. In more complex, real world examples, it can be hard to retrospectively look at a situation and see what changed to bring about improvement. It is important to document PDSA cycles and the learning that comes from them

We learnt about the value of stretch goals (can you do it in 5 seconds?!) and challenging our assumptions about what is possible. Teams tend to initially predict that they will do just a little better than what has been done before even though significant improvements are possible. Sometimes setting apparently "unrealistic" expectations (in a safe environment where you won't be judged) is a good way of stimulating creative thinking. Ask your team *"What would it take to…"* This helps people abandon their current way of thinking which is to do what has been done before. It does not mean that you set an aim which you expect to fail and then judge people on this aim.

We learnt about the value of collaboration. It is rare that you will address an issue that has never been tackled before. Learning from others about what worked, and what didn't, accelerated improvement.

We also learnt about challenging the boundaries of a system to develop new changes. Just because it has always been done this way, doesn't mean it always has to be done this way. For example, some hospitals have reduced duplication of work by using a combined admission proforma which both emergency medicine and acute medicine fill out. If you are considering making radical changes to a system, it is important to gain some support for your changes (and also to test it on a small scale first.)

Useful Further Reading

The Improvement Guide (2ND edition) pp81-83, 97-103, 142-148, 152-153

This book is available online via the library if you have an athens password (click on the link above)

http://www.ihi.org/resources/Pages/HowtoImprove/default.aspx

https://deming.org/theman/theories/profoundknowledge

References

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4. Langley GJ. *The improvement guide : a practical approach to enhancing organizational performance*. 2nd ed. ed. San Francisco, Calif.: Jossey-Bass ; Chichester : John Wiley [distributor], 2009.
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7. Moen R, Norman C. Circling Back. Secondary Circling Back 2010. http://www.apiweb.org/circling-back.pdf.
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Session 2: Aims and Measures

Aims - What are we trying to accomplish?

In session 1, we discussed using the Institute of Medicine's definition of quality to identify areas for quality improvement projects. Once an area has been identified, a specific aim needs to be constructed.

Setting an aim may be relatively easy when a small number of people are involved in a project that affects only their own work, in a simple system where unintended consequences are easily recognised. The more people and groups there are that are involved in, and affected by the improvement group, the more important it becomes to answer the first question from the model for improvement "What are we trying to accomplish?"

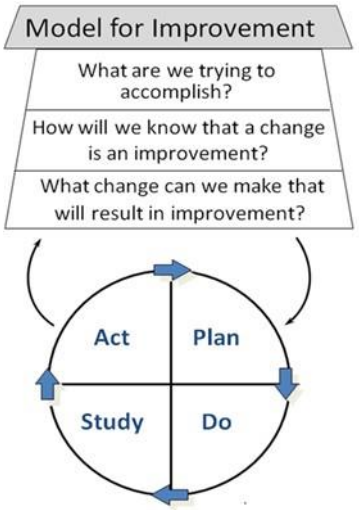


Figure 7: The Model for Improvement[1]

Tips for setting an aim

- Set one now. Don't waste time procrastinating for the perfect aim statement. You can always refine it later
- Make the aim something that the team can get behind and believe in. It should be meaningful. If a team is new to improvement, tackling an area that many team members would like to address is a good place to start.
- The aim should stretch the team. You're aim in a quality improvement effort isn't to get the team to work a little harder, a little faster. It is to bring about meaningful and significant improvement that may challenge current working practices. *Aims in quality improvement are non-punitive*. If you want to reduce inpatient falls by 50% but you reach 49% that's still a great achievement. On the other hand if you reach 50% but note there is still lots of room for improvement, then extend that goal to 70%.

- Whilst it is ambitious, it should be realistic. Ask what other similar teams have achieved. Ask your team what it would take to bring about meaningful improvement.
- A good aim statement should have a numerical target, a clearly defined population and a clear time frame

Examples of effective aim statements

- 95% of patients with severe sepsis on acute medical floor to receive intravenous antibiotics within 1 hour within 6 months
- Reduce inpatient falls by 50% on elderly medicine wards within 6 months
- Admit or discharge 95% of patients attending emergency department within 4 hours at LTHT within 3 months

Moving from a global aim to specific aims and measures

People often have broad aims for improvement like "We want to make outpatients more efficient." This needs to be translated into specific aims that are measurable, with a clear time frame and clearly defined population

e.g. We want to reduce the number of DNAs (cancelled appointments) by 75%

We want to ensure that 100% of patient case notes are available in clinic at the time of improvement.

Forming the team

The team involved in improvement efforts should be involved in setting the aims. If you were to devise an aim statement for reducing inpatient falls on a ward, you may wish to include

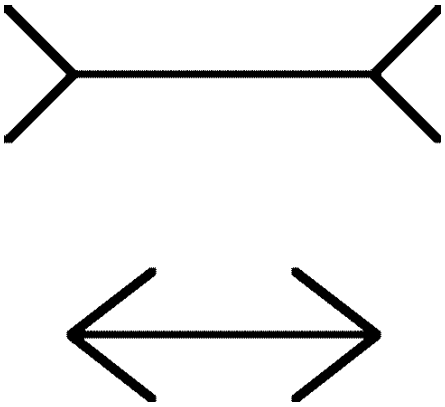
- A day to day leader e.g. ward sister, consultant
- Staff doing the improvement work e.g. band 5 nurse, physiotherapist, healthcare assistant, junior doctor
- An improvement science expert e.g. a patient safety and quality manager
- An executive sponsor e.g. clinical lead/director for a project in your department Whilst the team involved know the nature of their work best, and are best placed to drive improvements, a knowledge of improvement methodology and what has worked elsewhere is likely to result in greater improvement.

Characteristics of an effective aim statement

- Is the aim stated clearly?
- Does the aim contain at least one numerical component?
- Does it include a time frame?
- Does it define the population involved?
- Is it feasible? Yet does it stretch you?
- Will it be clear to the others when the aim is achieved?

Measuring: How Will We Know change is an improvement

The second question in the Model for Improvement is "How will we know change is an improvement?" Sometimes in healthcare, we may feel that things are getting better or worse. But to prove it, we need data. Look at the two lines below. Are they equal length?



It's not easy to tell by looking at them. But they are the same length. Some common weaknesses when relying on observations rather than data include:

- Recent observations tend to weigh more heavily in our mind than observations from the past
- New observations are tempered by context. When we are used to commuting for two hours for work, a new journey of 1 hour may seem like a blessing, whereas it may seem a long time for someone who is used to walking around the corner to work
- We all have biases. Sometimes we can observe what we want to observe and ignore what we don't. This came across in the "secret eaters" video clip in the presentation.

Measurement for judgement, research and improvement

Some of us may be used to measurement for audit and research, but measurement for improvement differs in several respects that is summarised in table 1.

Measurement for Judgement/Assurance	Measurement for research	Measurement for Improvement
Assure, compare, reach target	Gain new knowledge	Improve care/service
Set by external agent/regulator	Scrutinised by peer review	Owned by the team
Large sample size.	Large sample size, "just in case." Large research team	"Just enough," small, regular, sequential samples. Use data already available + few, new measures that can be collected easily and regularly
No hypothesis. Evaluate performance	Fixed hypothesis to be proved/disproved	Flexible hypothesis – may change as knowledge is built and gained
Try to adjust for case mix etc.	Eliminate bias by controlling variables	Design data collection so bias is stable
Data used for public comparison/judgement e.g. ranking	Individual data anonymised. For peer review	Data for purposes of improvement team

Table 3: Measurement for judgement, research and improvement2

Types of measures

Improvement projects use three types of measure: outcome, process and balancing. A range of measures spanning all categories, usually 3-5 in total, is required to measure for improvement.

Outcome measures relate to the overall aim of the project and help us fundamentally answer the question "how will we know change is an improvement." They demonstrate the end result of your improvement work.

Process measures are the steps in the system that affect outcome measures. They are often used within PDSA cycles, are more sensitive to change than outcome measures and a good focus for early improvement efforts.

Balancing measures are measures that look at the system from another angle to ensure that the change(s) implemented do not cause adverse, unintended consequences elsewhere.

Outcome measure	Process measure	Balancing measure
Weight loss in kilograms	Number of hours in gym	Time spent with family
Number of falls per 1,000 days	percentage of high risk falls patients in a supervised bay	Cost of extra staff to supervise patients
Rates of central line infection	Percentage of patients where a central line insertion bundle was complete	Financial costs of improvement programme
Time taken to assemble lumbar puncture equipment	Percentage of days a lumbar puncture pack was available	Cost of lumbar puncture pack
Number of adverse drug events per 1,000 drug charts	percentage of patient drug charts reviewed by a pharmacist.	Cost of pharmacist's time

Collecting data

An agreement of how data will be collected is important to improvement efforts. Wherever possible, existing measures should be used to support improvement work. Organisations routinely collect data such as length of stay, rates of hospital acquired infections, rates of falls etc. You should try to incorporate these wherever possible. For other measures, a plan will be needed to include:

- What data to be collected
- Who will collect the data
- How will they collect data
- When and where will data be collected

Measurement for improvement is not the aim – improvement is. This means that improvement work usually involves collecting "just enough" data to make a judgement on whether a change has been successful. Judgement sampling is often employed in improvement work.

When we sample data, the exact same conditions are rarely seen again e.g. same staffing same patients, same case mix, same workload. Judgement is used to collect a range of samples over time. The team doing the work will know what spread of sampling is required to accurately reflect underlying processes. For example, if we wanted to test whether a falls intervention bundle was being used on a ward we may sample 5 random patients on the ward on Mondays, Wednesdays and Saturdays, knowing that Mondays and weekends have specific pressures which may affect reliability of the bundle being completed.

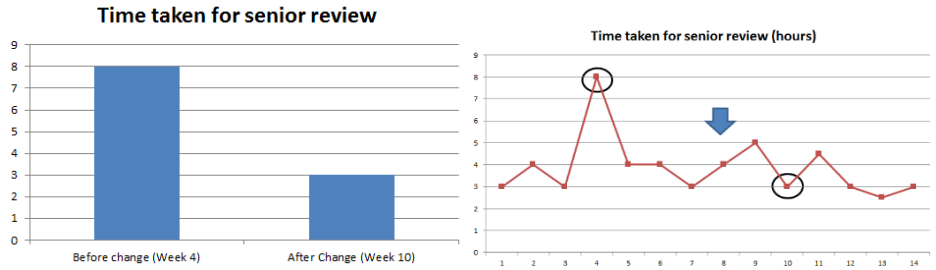
An **operational definition** for measures is also required for measures so that different people are not in disagreement as to what a measure means. Does getting Parkinson's medication "on time" mean within 5 minutes? Or 30 minutes? If a patient manages to lower themselves gently before they hit the ground, is this a fall? (Falls are usually defined as "an event which results in a person coming to rest inadvertently on the ground or floor or other lower level.")

Collecting data over time

In this session, we also covered the value of collecting data over time, contemporaneously, and how that was much more valuable than two time points with large amounts of data. Rarely are two data points the same - collecting data over time allows you to build up a picture of a system, and visualise

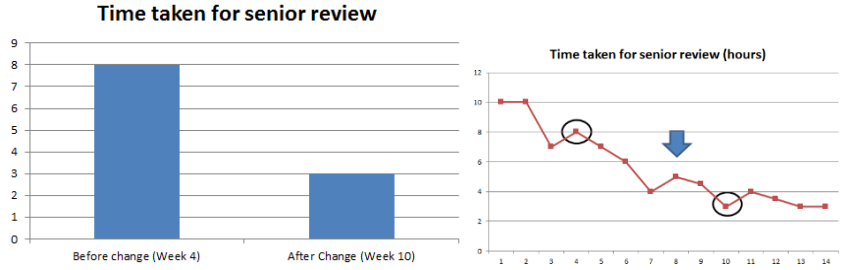
the impact of tests of change. We ran through an example of how before and after data collection may hide week to week variation, blips, possible Hawthorne effect, other factors affecting the data etc.

One example is given here



The two charts show the same data for week four and week 10. A change was made at week 8. If you looked at the bar chart, you may conclude a significant improvement has been made, but looking at a run chart clearly shows that the time taken typically varies between 3 and 5, with an obvious outlier in week 4.

We went through lots of examples, but we'll include just one more. Again, the same data for week 4 and 10, with a change at week 8. But this example clearly displays that the improvement took place before the change was implemented. It's not clear that investing resources in this change will result in further improvement.



Over the course of this session, we have covered two of the questions from the model for improvement:

“What am I trying to accomplish?” and

“How will I know change is an improvement?”

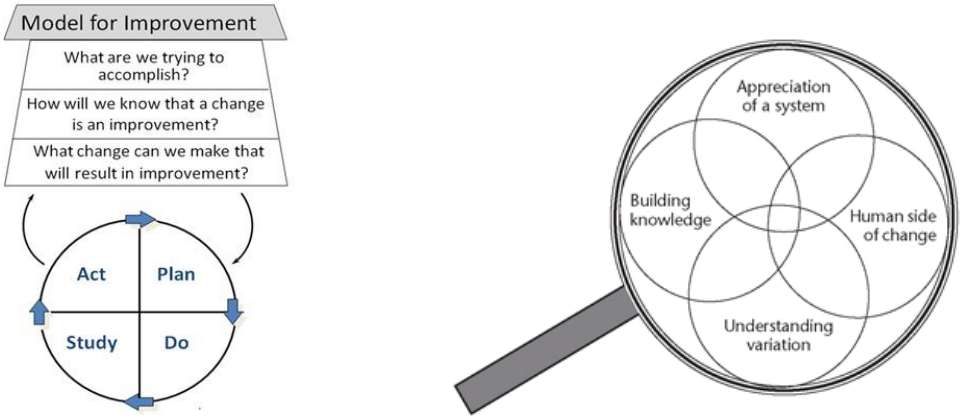


Figure 8: The Model for Improvement and the Science of Improvement

We have also covered one of the key areas from improvement science – understanding variation. Rarely are two data points are the same and usually data needs to be collected regularly over time to understand the variation within a system and help wo answer the question "How will I know change is an improvement?"

As you work through these sessions, try and apply these to your own quality improvement projects - construct an aim statement and choose some measures.

In the next session, we will build on this understanding with an explanation of how to construct and interpret run charts.

Further reading

The Improvement Guide (2ND edition) pp90-96, 103-107, 148-153

This book is available online via the library if you have an Athens password (click on the link above)

http://www.ihi.org/resources/pages/howtoimprove/scienceofimprovementsettingaims.aspx

http://www.ihi.org/resources/Pages/HowtoImprove/ScienceofImprovementTipsforSettingAims.aspx

http://www.ihi.org/resources/Pages/HowtoImprove/ScienceofImprovementFormingtheTeam.aspx

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http://clinicalmicrosystem.org/3-theme-global-aim-statement/

http://www.haelo.org.uk/why-do-we-need-data-over-time/

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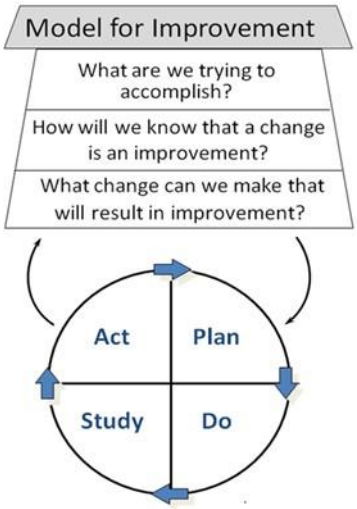
Session 3: Run charts (and Statistical Process Control Charts)

Being able to construct and interpret run charts or control charts is essential in helping us answer the second question in the model for improvement "*How will I know change is an improvemen*t?" They also help us understand the system within which we are working. Data varies over time, and understanding variation over time is a crucial part of quality improvement efforts, or management more generally.



Constructing a run chart

You will have seen run charts in some form many times in your career – they consist of a count of something over time – like temperature on an observation chart, or monthly mortality rates. Constructing a run chart is very simple. We have time on the x axis, and a count or measure on the y axis. We then plot the data points over time, and join up the dots to create a chart.

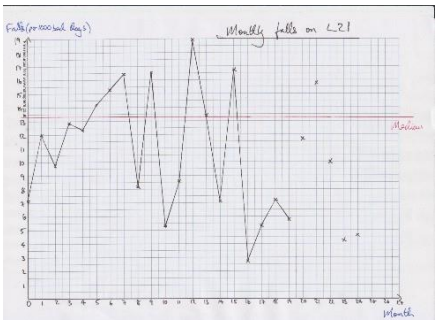


Figure 9: Number of falls per week on a stroke ward

After 10 points have been plotted, we can draw a centre line, the median, where 50% of the points are above the line and 50% are below the line (the median in figure 1 is calculated from data points that partly precede what we can see on the graph). This line is then extended into the future. You

can do this using a pen and paper, as in the example in our session, or an excel chart template, an example of which you can download here (requires free registration).

As well as drawing points on a chart, it's important to annotate our run chart with significant events or tests of change (PDSA cycles) so we can interpret the data in context and see if our changes made an improvement or not.

It's worth at this point, considering the definition of a **run**. A run is any collection of data points, 1 or more, one side of the median. Each of the blue circles in the graph below is a run.

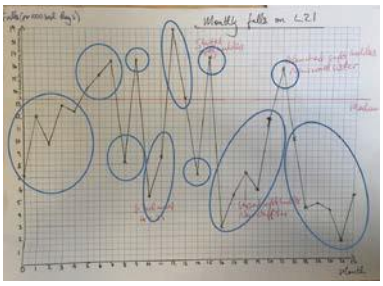


Figure 10: "Runs" on a run chart

Interpreting run charts

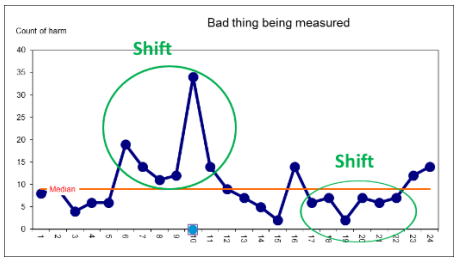
It is unusual for consecutive data points to be the same and almost all things of interest that we count will show variation around a centre line. It is common for people to misinterpret data on run charts in one of two ways

1) They over-react to random variation. Most data - whether it is number of falls on ward, average of length of stay, time taken to travel to work, or the temperature of a patient – will go up and down over time. By chance a count may rise or fall for 2 or 3 points in a row. It is not uncommon for this rise or fall to be accompanied by praise or admonishment by supervisors when a greater understanding of the process reveals this to be the random variation inherent in a process.
2) They miss non-random variation – signals of change in a process – typically because they are focussed on targets or ratings e.g. a process may show significant improvement, yet because it is still rated "amber" this improvement is not noted by a regulator.

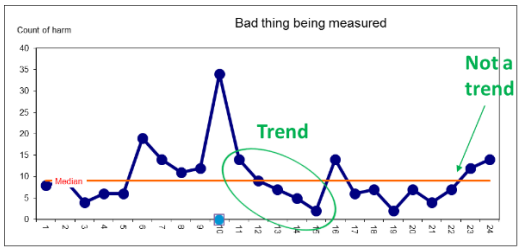
Run chart rules

There are four "rules" for interpreting run charts

1) **Shift** – 6 or more consecutive points either above or below the median. Skip values that land on the median and continue counting



2) **Trend** – 5 or more consecutive points all running in one direction i.e. at least 5 consecutive points going up, or at least 5 consecutive points going down. Skip points that are exactly the same and continue counting. The line may cross the median.

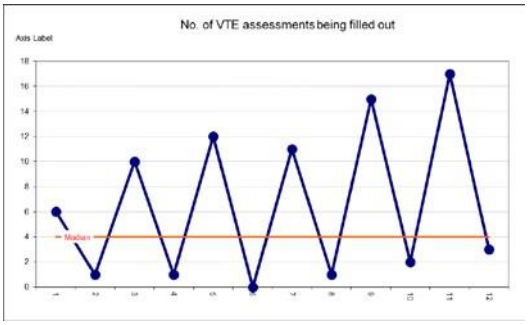


3) **Too few or too many runs.**

Count the number of runs as in the example in figure 2 – or count the number of times the line crosses the median and add one to find the number of runs – you will get the same answer.

Count the number of points on the graph that do not fall on the median and then consult a statistical table to see if there are too few or too many runs.

Number of data points that do not fall on the median	Lower limit for number of runs	Upper limit for number of runs
10	3	9
11	3	10
12	3	11
13	4	11
14	4	12
15	5	12
16	5	13



In the example above there are 12 points not on the median and 12 runs. Too many runs indicates two separate distributions of the data. Perhaps the data has been collected every 12 hours and the night team are better than the day team. Alternatively, if the data was collected daily, perhaps there are two consultants on this ward and one is better than the other at filling out VTE assessments.

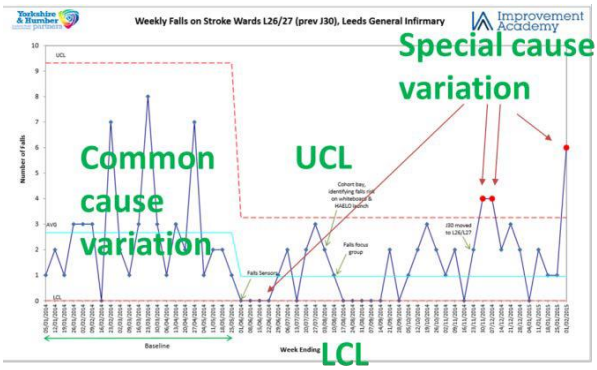
4) An astronomical data point is one that is obviously, blatantly different from the rest such that two people viewing the chart would not disagree that is an astronomical data point.

Each set of data will have a high point and a low point – that does not mean they are astronomical data points. This is subjective, unlike the previous rules.

Statistical Process Control Charts

For most of us doing simple quality improvement projects at a ward level, a run chart with paper and a pen will be the limit of our statistical analysis. Data using run charts may also be presented at national conferences. However, if you get really into quality improvement, or attend management meetings or board meetings, you may see data presented as an SPC (statistical process control) chart. These are sometimes referred to as control charts or Shewhart charts.

SPC charts look like run charts in that the y display a count on the y axis and time on the x-axis. However, they differ in appearance in that there is an *upper control line*, a *lower control line* and a *mean* centre line (rather than median). SPC charts have more "rules" that run charts and are better at distinguishing between random variation, known as *common cause variation* and non-random variation, known as *special cause variation.* There are 8 rules for SPC charts, rather than the 4 for run charts and they vary e.g. in terms of points below the centre line required for a shift, so to avoid confusion, we'll save these for another time! You need special software, or a good grasp of excel to construct SPC charts. The instructors of this course have never constructed one - we ask someone who knows how to do one to help us out instead!



Common cause variation is the day to day variation inherent in the system where peaks and troughs are a result of chance causes or random variation.

Special cause variation, by contrast, is when there is a change that cannot be accounted for by chance causes or random variation - there is a *special cause* or variation that is said to be *assignable* Something has happened for this variation to have occurred, and this needs further investigation that we can learn from to understand our system better.

A simple example of this may be your journey time to work. Let's say it take me about 30 minutes to get to work. Actually it varies, from 25 minutes to 40 minutes but the average time is 30 minutes. I shouldn't be praised on days that it takes me 25 minutes, and there shouldn't be investigations as to

why it took me 40 minutes. This is the *common cause* variation that is a result of variation in traffic, weather etc.

However, let's say one day it takes me an hour to get to work. This would be displayed on an SPC chart as outside the upper control limit. This is *special cause* variation that is assignable, perhaps because of an accident on the road, or a flat tyre. A 15 minute journey because of a bank holiday would also be an example of special cause variation.

Further reading

Perla RJ, Provost LP, Murray SK. The run chart: A simple analytical tool for learning from variation in healthcare processes. BMJ Quality & Safety. 2011 Jan;20(1):46-51. Available at http://www.wales.nhs.uk/sites3/Documents/841/Run%20charts%20%28August%202011%29.pdf

A nice 6 page article containing everything you need to know about run charts, including those tables for too few, or to many runs

http://www.ihi.org/education/IHIOpenSchool/resources/Pages/AudioandVideo/Whiteboard7.aspx

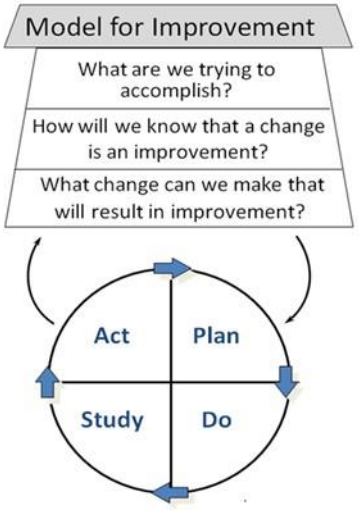
http://www.ihi.org/education/IHIOpenSchool/resources/Pages/AudioandVideo/Whiteboard8.aspx

Two short videos covering much of the material on constructing and interpreting run charts

The Health Care Data Guide (Provost and Murray) pp85-106. This book is the bible for data and available online via the library catalogue with an LTHT Athens account using the hyperlink. The suggested pages cover issues such as when should we apply and extend the median? What about run charts for rare events? Etc.

Session 4: Quality Improvement Tools

In sessions 1-3 we discussed the IHI model for improvement, how to set an aim, form a team and the importance of continuous measurement. We then covered how do construct and interpret run charts. This session focuses on the last question in the model for improvement "*What change can I make that will result in Improvement*?" This is the part of your QI project where you can get your creative juices flowing!



You may have an idea of something you want to improve and some ideas of how you might improve it. You may have identified an area of frustration and know things should be better but not be quite sure how to take these forward.

The following are some suggested tools that can be used to help you develop your improvement efforts.

Process Mapping

This involves mapping out a system to define the steps involved from start to finish. It is often used to view the system from a patient perspective e.g. what does admission for an elective surgical procedure look like for a patient? It is also a good team building exercise in improvement as administrators, nurses, clinicians, therapists and patients can sit down and view the system overall and understand each other's work.

This task is best done by getting the team together with post it notes on a wall or a very large piece of paper like wallpaper.

The benefits of process mapping may include:

- Identifying bottle-necks and delays

- Identifying waste e.g. duplication, over-processing, inappropriate use of staff skills, poor scheduling, poor design, too many hand-offs or unnecessary steps that do not add value for patients or staff
- Using “fixes” instead of prevention

Process mapping may also allow us to see a process in parameters we can measure e.g. time, distance, cost, etc. This will allow us to focus our initial efforts on the areas that take the longest or cost the most.

Fishbone Diagrams

Also known as an Ishikawa Diagram or Cause-and-Effect diagram, this helps to make sense of complex systems by splitting them into components. Start by considering all the different aspects that make up a system, the five common ones being: People, Methods, Materials, Equipment and Environment.

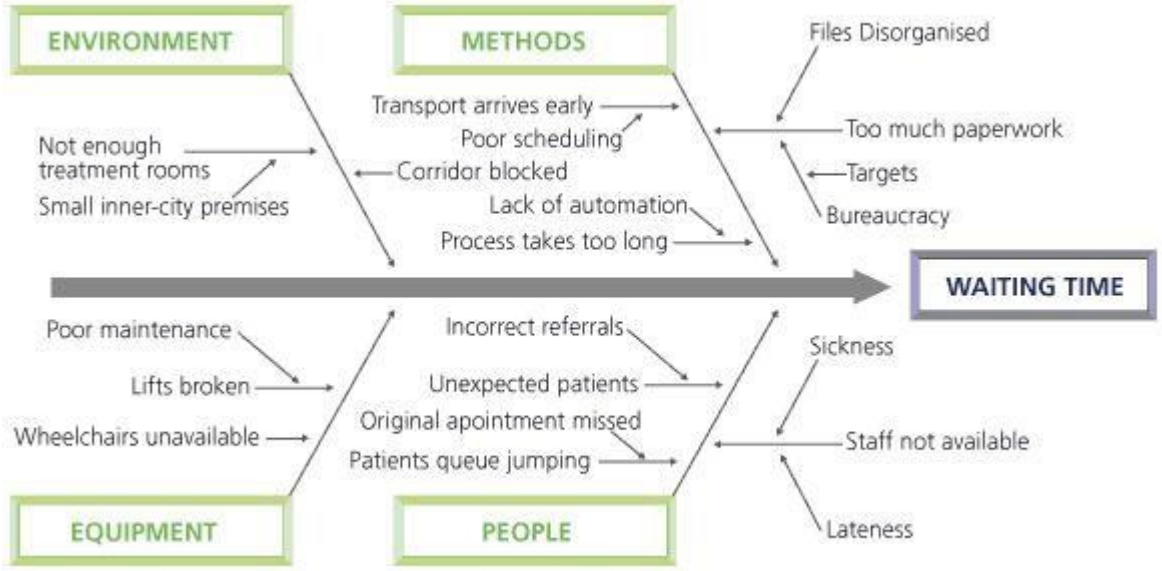


Figure 11: Example of a Fishbone diagram from http://webarchive.nationalarchives.gov.uk/20121108091830/http://www.institute.nhs.uk/quality_and_service_improvement_tools/quality_and_service_improvement_tools/cause_and_effect.html

This can allow teams to build a visual theory about potential causes and effects that can be used to guide improvement work. Rather than allowing people to focus on problems that come easily and quickly to them e.g. “we don’t have enough time” it helps facilitate deeper and broader thinking about the factors that may help result in improvement.

Tips for creating a fishbone diagram:

1. Review the specific aim you want to work on

2. Clarify the effect or outcome of interest. This can be stated as an undesired result such as increased waiting times or desired result such as reduced falls.
3. Determine major categories of causation that contribute to the effect and brainstorm to identify the detailed causes within the larger categories.
4. Share the fishbone diagram with others and use feedback to improve it.

Brainstorming

We didn't talk about brainstorming, to save time, and because the principles are pretty simple. This is a great way of generating ideas. The focus is on **quantity** *not quality*. (The ideas generated can then be critiqued later.) If done early on in a process it is also a useful way of building team rapport and produces ideas that are new and different from those usually offered.

Some key principles for a good brainstorming session are:

- All ideas are acceptable – no judgements
- Fun, uninhibited, humorous
- Quantity not quality
- Build on ideas proposed by others
- Every person/idea is equal

It is useful to get a flip chart and scribe or post-it notes as a way of capturing fast, free-flowing ideas.

Driver Diagram

A driver diagram is a systematic way of laying out aspects of an improvement plan which we can then discuss and agree upon. We touched on this in session 1 but we'll cover it in this hand-out.

Aim: this should have a numerical component and a timeframe.

Primary drivers: are factors or areas that must be addressed if we are to achieve our aim. These are straightforward statements.

Secondary drivers: these are specific processes we believe will individually and collectively help us achieve our aim. They should effect at least one primary driver. They should have an evidence base or a clear theory for positive impact.

For example we know that to reduce falls we need a safe environment. I could brainstorm with my faculty for ideas to make a safer environment. Someone may suggest reducing clutter around the bed that patients could trip over. My PDSA could be that at the start of every shift we tidy the bedside areas of each of our patients. My prediction would be that they would fall over these things less.

This may reduce falls on my ward by 10% so my next PDSA may look at improving team working.

A good way of creating a driver diagram is to brainstorm tests of change and then group similar changes that you would PDSAs into secondary drivers that can then be grouped into primary drivers

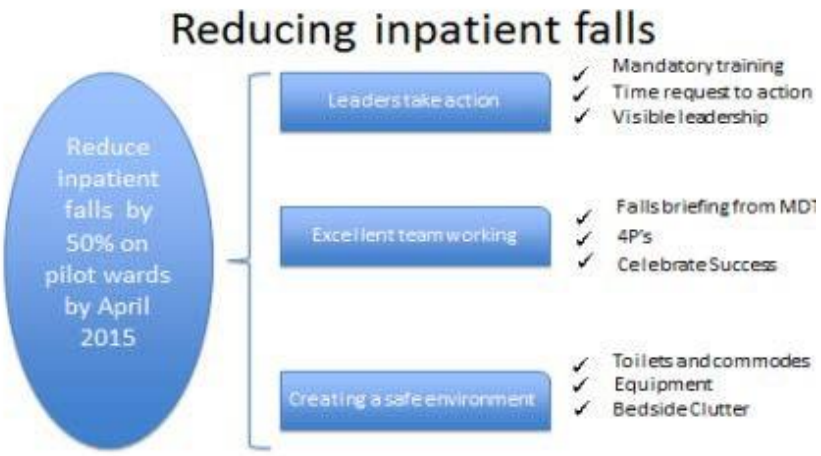


Figure 12: Driver diagram for reducing inpatient falls

Pareto Principle "80/20 rule"

This principle is attributed to Vilfredo Pareto who early in the 20th Century found that 80% of the peas that he harvested in his garden came from only 20% of the pods. He was an economist and calculated that 80% of Italy's wealth was held by the richest 20% of people. Its application in industry came much later in 1975 when Joseph Juran (who named it the Pareto Principle) proposed that 80% of problems are caused by 20% of the defects.

Put simply, not every situation will fall exactly into the 80/20 brackets but it serves as a reminder that there is usually one or two significant factors leading to most of our undesired issues (delays, costs, errors, etc.). If we focus on identifying and eliminating / improving these to begin with we will get the most from our efforts, show bigger improvements and find it easier to engage people in our efforts.

The First Follower

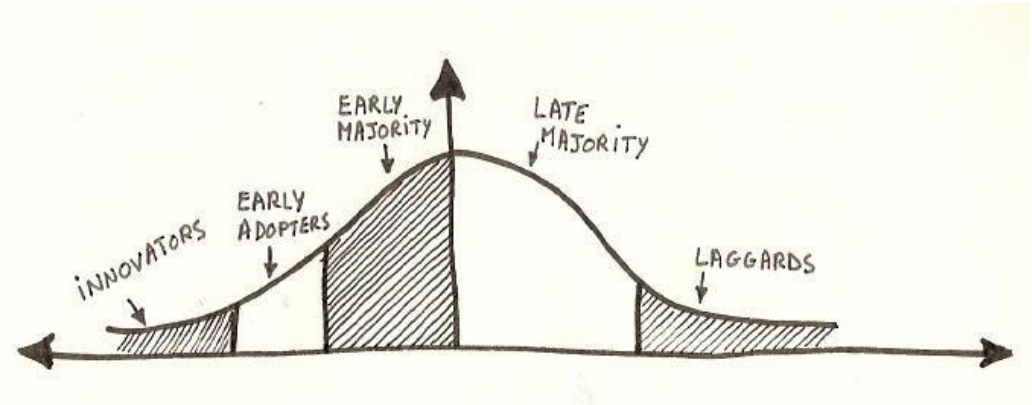
Whilst a charismatic leader can be successful at driving change, you are more likely to succeed if you take people with you. In our improvement work we have often visited wards to ask about a project for someone to say – "Oh that's Claire's project. But she's on leave now." You don't want everything to rely on one person, and you're more likely to have people join you if you nurture your first followers, rather than being just the "lone nut."

Rodger's Diffusion of Innovations

Having come up with an idea for improvement, there will be people who like your idea and are willing to try it. These are your early adopters who don't need to see the effect - they buy into the idea. They will help you to implement your idea and gather evidence to see if it works. Once they are part of your team and implementing your ideas, others will follow. When you have reached around 16% of your population / target audience you have reached "the chasm". Assuming your idea/ change is good, then after this point the "early majority" who were waiting to see what this change was all about will come on board. By the time these people are using your product or

carrying out your change, the late majority have little choice in implementing or getting left behind. The “laggards” will eventually follow, in their own time.

Look for the early adopters. They’re the ones who will give your change a chance. By being conscious of this, you will avoid spending your early days fruitlessly trying to convince sceptics who may be in the late majority or laggard camp. It will be much more productive to focus on those people who are already believed in your idea. (Think about people listening to music via mp3s or similar format. If you were trying to get digital downloads to start off, there’s not much point in trying to convince people who love record album inserts or vinyl enthusiasts, at the beginning of that movement)



Stakeholder Analysis

A stakeholder analysis encourages you think of all the people who will be involved in or affected by your changes and how do you need to interact with them. Those with high power but little impact on implementing your changes need to be satisfied. You will want to keep them updated. This will depend on your context but may be someone like the Clinical Director or Head of Nursing. If someone has a lot of power and also a lot of impact on the implementation of your changes, such as the ward consultant or ward sister, they will need to be managed. This means keeping them very close, continuously updated and preferably part of your improvement team. People with low power and low impact can be of lower priority. However those with low power but high impact are also very important. These are usually people on the frontline or the patients that your changes aim to benefit. They can be very useful if they are with you but if not your project is likely to fail. You must keep them informed as much as possible.

Further reading

Process Mapping

http://webarchive.nationalarchives.gov.uk/20121108100808/http://www.institute.nhs.uk/quality_and_service_improvement_tools/quality_and_service_improvement_tools/process_mapping_-_an_overview.html

Quality by Design: A clinical microsystems approach pp296-307

(Available online via the library catalogue, using the link above)

Fishbone

http://webarchive.nationalarchives.gov.uk/20121108091830/http://www.institute.nhs.uk/quality_and_service_improvement_tools/quality_and_service_improvement_tools/cause_and_effect.html

Quality by Design: A clinical microsystems approach pp316-320

(Available online via the library catalogue, using the link above)

Brainstorming

https://www.mindtools.com/brainstm.html

Quality by Design: A clinical microsystems approach pp323-330

(Available online via the library catalogue, using the link above)

Driver Diagrams

http://www.ihi.org/education/IHIOpenSchool/resources/Pages/Activities/GoldmannDriver.aspx

Stakeholder Analysis

Sean Ninan, Gurjit Chhokar, Anna Winfield, Rebecca Whiting
The Leeds Teaching Hospitals NHS
NHS Trust

http://webarchive.nationalarchives.gov.uk/20121108103627/http://www.institute.nhs.uk/quality and service improvement tools/quality and service improvement tools/stakeholder analysis.html

Session 5: The psychology of quality improvement

Having spent time learning about the "nuts and bolts" of quality improvement, and answering the three questions in the Model for Improvement it may seem that we are ready to embark on our QI project.

But one of the hardest things within QI work is convincing people to change and in this last session we covered some ideas from the worlds of psychology, advertising and design that may help us with our QI efforts.

We may sometimes assume that if we give people enough information and evidence, then this will be enough to persuade them to change. But as we briefly covered in Rodgers Diffusion of Innovation Model, not all people are receptive to change and some may actively resist it. As well as using data, it can be helpful to use stories, and as well as using logic, it can be useful to use emotion as a means of persuasion.

System 1 and Type 2 Thinking: Emotion versus Logic

We talked about how the advertising world draws on the work of Daniel Kahnemann to tap into people's emotions rather than logic to sell. As an example, the John Lewis advertising campaigns have been very successful at raising sales by making them feel warm and Christmassy despite providing no information as to the quality of a John Lewis as a store.

Kahnemann describes two types of thinking that we employ.

System 1 thinking is fast, automatic, emotional, intuitive, subconscious thinking. It is the type of gut reaction we employ when we see a smiling face and assume the person is happy, or the easy, "autopilot" thinking we employ when we drive a car down an empty road.

When you have expertise in something such as driving or taking a blood test, you often perform this task automatically, using shortcuts in a way that novice may not.

When we receive news from someone who we like and warm to, then we are more likely to listen to this news favourably compared with someone who we do not get on with. These are all examples of system 1 thinking

System 2 thinking is slow, effortful, calculating and conscious. It is the type of thinking we may employ to multiply 17 x 24, or listen to complex arguments. It is the type of thinking that novices employ when learning a task.

Humans more commonly employ system 1 thinking then system 2 thinking. Even people who say they like data may often use a mix of system 1 and system 2 thinking. The lesson here is to use both emotion and logic when trying to persuade people, but be aware that different people may respond better to one or the other and tailor the balance of your argument for persuasion appropriately.

Fundamental attribution error

We then talked about a concept in psychology where we view our own behaviour as a result of the situation around us "I am grumpy today because I didn't sleep well, the computers are slow and it's too hot" but assume other people's behaviour reflects their internal characteristics "What's his problem?! He is so rude!" Try not to assume that other people's behaviour represents their characteristics but take some time to understand the context.

Social styles

It sometimes comes as a surprise to us that other people don't see the world the same way we do. They may think differently, use their time differently, handle emotions differently and communicate differently to an extent that this may result in conflict when people with different preferences talk to each other and work with each other.

It may sound sensible to "treat people as you yourself would want to be treated" but perhaps we would do better if we *treated people as they would want to be treated.* This requires a little understanding of what the other person is like. While "personality type" models may have their flaws, they may at least help you recognise other people's preferences. We discussed the social styles model where the population is divided into four different social styles.

Drivers	Analytical	Expressives	Amiable
Assertive	Less assertive. Indirect	Assertive	Less assertive
Fast paced	Deliberate, careful	Fast paced, chatty, long winded	Patient and easy going
Results/task orientated	Task orientated	People orientated.	People orientated.
Happy to work alone Less focus on people.	Happy to work alone Less focus on people.	Like working with and meeting new people. Needs recognition.	Team player. Focussed on needs of others
"Let's get it done." Happy to take risks	"Let's do it right"	"Let's do it!" Impulsive. May jump from topic to topic or project to project	"Let's do it together"
Big picture	Details - may agonise over these	Big picture	Effect on team important
Organised. efficient	Likes careful planning	Likes to improvise	Likes to help
Likes data	Likes data	Likes stories. Goes with hunches and intuition	Likes listening to stories
Direct, maybe even blunt	Cautious, reserved	Wears heart on their sleeve. May be overwhelming	Dislikes conflict

Knowing how others see you - positively and negatively - is important. And knowing what type of person someone else is might help you to tailor information to them. Skilled salespeople use this kind of training when they are trying to sell you products. You might use something similar to sell your ideas.

The Behaviour Change Model

In the NHS we have traditionally relied on tools such as policies, guidelines and training as ways of improvement - these may or may not help address issues related to lack of knowledge. We also employ posters, emails and checklists - these may or may not help issues related to remembering to do the right thing.

The COM-B behaviour change model is a useful framework for thinking about barriers to change, and how to address them

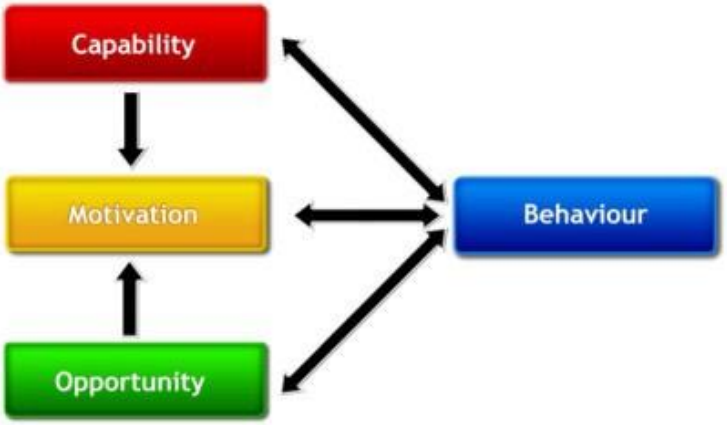


Figure 13: COM-B Behaviour change Model (https://implementationscience.biomedcentral.com/articles/10.1186/1748-5908-6-42)

The following table gives an example of the COM-B model applied to the behaviour of healthcare professionals cleaning their hands. This model has been used in a research setting using questionnaires but can also be used by getting a group of stakeholders or staff together and having a structured discussion using the COM-B components. Depending on where the major barriers to behaviour change are, then different interventions may be required. For example, if staff do not believe that washing their hands is likely to make a difference, then you may wish to focus on this (using a mixture of evidence/logic and emotion/stories) rather than training them on how to wash their hands properly. Not all categories are applicable in every desired behaviour change but it helps you think more laterally.

COM-B component		Explanation	Example
Capability	Physical	Physical skill or strength to perform behaviour	Staff will have the physical ability to wash their hands
	Psychological	Knowledge, psychological skills to engage in the necessary mental processes to perform the behaviour	Staff have been trained in proper hand washing technique
Opportunity	Physical opportunity	Sufficient time, resources and adequate environment to perform the behaviour	There are enough sinks and hand gels available for staff to wash their hands. These are prominently positioned.
	Social opportunity	Interpersonal influences, social cues and cultural norms that affect the behaviour	Strong emphasis on safety culture. Senior staff model best practice in hand washing. Poor practice is called out and frowned upon in a culture where people are not afraid to speak up and challenge each other.
Motivation	Reflective motivation	The self-conscious intention to perform a behaviour and people's underlying beliefs about what is good or bad.	Staff believe that washing their hands is a good thing and make plans to try to remember to wash their hands
	Automatic motivation	Automatic processes involving emotional reactions, desires, impulses, inhibitions and reflex responses,	Routines and habits reinforced so that hand washing becomes "automatic." e.g. recorded message asking people to wash their hands as they enter or door handle that releases hand gel as you pull door open.

Desire paths

Human beings like to use the shortest, easiest path between their start point and destination. In the picture below, you can see that someone has carefully designed a path for pedestrians but that many people prefer to cut across the grass as it is quicker. You may notice desire paths in parks, hospitals or near shops.

Figure 14: Desire path in hospital grounds

https://www.flickr.com/photos/alanstanton/32907107380/in/pool-desire_paths/

Designers have started to use this concept when planning paths by e.g. only paving paths after spending a period of time to see where desire path emerge. An example of desire paths being used in healthcare is the co-location of GPs/walk-in centres and pharmacists with emergency departments. Rather than tell patients to go their GP or pharmacist instead of ED, some departments have recognised the desire path and brought these services beside the emergency department to reduce demand. So if you want to improve flu vaccine uptake amongst staff, think about setting up a "drop in" stand by the hospital café rather than an email inviting people to come to the occupational health department.

Nudge theory

This is a subtle way of prompting desirable behaviour. We gave the examples in the talk of highlighting day 3 of the drug chart to review antibiotics, and of the fly in the Schiphol airport urinals – nudging individuals to do the right thing. This address the "automatic motivation" we mentioned in the COM-B behaviour change model – it helps us with routines and habits but does not address "reflective motivation" - whether we believe this behaviour is a good thing.

Sean Ninan, Gurjit Chhokar, Anna Winfield, Rebecca Whiting
The Leeds Teaching Hospitals NHS
NHS Trust

The Keystone Initiative

Lastly, we talked about one of the best known examples of quality improvement in healthcare, the Keystone Initiative in Michigan where a quality improvement programme resulted in a reduction in central line infections by two thirds. The headline was of a "simple checklist" that saved lives but work by Mary Dixon Woods demonstrated that the programme was more like a "complex social intervention." The checklist, and a central line trolley were "technical interventions" that were adapted to each organisations. Checklists were "95% the same" but there were around 100 different versions of them so that organisation could own them – a degree of autonomy increased the likelihood of an intervention being accepted. The projects were led by experts in patient safety, with regular feedback on data comparing them with other organisations. There was a professional community that worked as a grassroots movement sharing ideas and challenges at regular networking events which evolved to contain features like a "cocktail hour" – not in the original protocol! Using stories and hard data, central line infections were re-framed as a social problem – one that could be solved by human action and behaviour rather than an inevitable consequence of work in an ICU. Nurses were asked to observe doctors inserting lines and monitor aseptic practice – a radical departure from previous practice. To make this work, senior doctors had to role model this approach, and nurses needed to know they would be supported by senior doctors to challenge poor practice – and ask the doctors to start again if asepsis had been breached.

There was a lot more to this programme but what this brief summary highlights is the error we can make by assuming a "simple checklist" can be used to bring about quality improvement without being part of a much wider programme. Proponents of a "simple checklist" sometimes assume that the problem is staff *forgetting* - the "automatic motivation" we discussed in the COM-B model - when in fact there may be several different barriers to improvement efforts. Use of a "simple checklist" may be unsuccessful unless and may thus reduce confidence in "quality improvement." Interestingly the "Matching Michigan" project in the United Kingdom had much patchier success. The reasons for this are explained in one of the references below.

Reference and Further Reading

System 1 and System 2 Thinking

Thinking Fast and Slow by Daniel Kahnemann https://www.amazon.co.uk/Thinking-Fast-Slow-Daniel-Kahneman/dp/0141033576 (also available via the library)

Social styles

https://www.tracomcorp.com/social-style-training/

Sean Ninan, Gurjit Chhokar, Anna Winfield, Rebecca Whiting
The Leeds Teaching Hospitals NHS
NHS Trust

https://www.amazon.co.uk/People-Styles-Work-Beyond-Relationships/dp/0814413420

The Behaviour Change Model

https://implementationscience.biomedcentral.com/articles/10.1186/1748-5908-6-42

The Behaviour Change Wheel by Michie, Atkins and West http://www.behaviourchangewheel.com/ (ebook £3.99) also available via the library

Desire Paths

https://www.ted.com/talks/tom_hulme_what_can_we_learn_from_shortcuts (Interesting to see the hospital's response to a desire path!)

http://99percentinvisible.org/article/least-resistance-desire-paths-can-lead-better-design/

Nudge

There is a long list of "nudges" at https://www.stir.ac.uk/media/schools/management/documents/economics/Nudge%20Database%201.2.pdf.

The Keystone Initiative

Reality Check for checklists http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(09)61440-9/fulltext

Explaining Michigan https://www.ncbi.nlm.nih.gov/pmc/articles/pmid/21676020/

Explaining Matching Michigan https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3704826/

Where can I learn more?

The Institute for Healthcare Improvement have a wealth of quality improvement training materials. Trainees are also able to access e-learning materials in quality improvement and patient safety for free which provides you with an IHI basic certificate in quality and safety.

The library have made "The Improvement Guide" available online to anyone with an Athens password (you can get an Athens password by registering here or visiting the library). This is widely considered to be the bible for improvement science and much of the material we teach draws heavily on it.

You can also learn by doing! Learning the theory of quality improvement without practicing it seems a shame, and doing quality improvement without the theory is unlikely to lead to as great an improvement. If you have an idea for a QI project, start it.

We are happy to be contacted for advice:

Anna.winfield@nhs.net

Sean.ninan@nhs.net

Rebecca.whiting2@nhs.net

khurram.mustafa@nhs.net

a.cracknell@nhs.net