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# Improving Ambulatory Care in a Large Tertiary Emergency Department.

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## Abstract

NHS unscheduled care performance has been deteriorating progressively over the last seven years. In early 2018, the Staffordshire Clinical Commissioning Group (CCG) commissioned an innovative improvement approach as part of a package of measures to support University Hospitals of North Midlands (UHNM) NHS Trust. Four front-lines teams were trained in the foundation principles and practice of health care systems engineering (HCSE) as the first phase of developing embedded capability in complex adaptive system (CAS) improvement-by-design.

This is the story of two of those teams: The emergency department (ED) and the transformation team (TT).

The collaborative ED microsystem design team (ED MDT) focussed their attention on the ambulatory stream of ED patients, 70% of which do not require hospital admission. An experienced HCSE practitioner facilitated the ED MDT sessions and coached the individual members of the team in the practical skills required.

The outcome is a first wave of HCSE Level 1 competent NHS staff in one organisation who have learned the important lesson that when the co-ordinated, collaborative HCSE approach was used the ED ambulatory stream performance significantly improved, and when a less coordinated approach was employed the ED ambulatory stream performance significantly deteriorated.

(195 words)

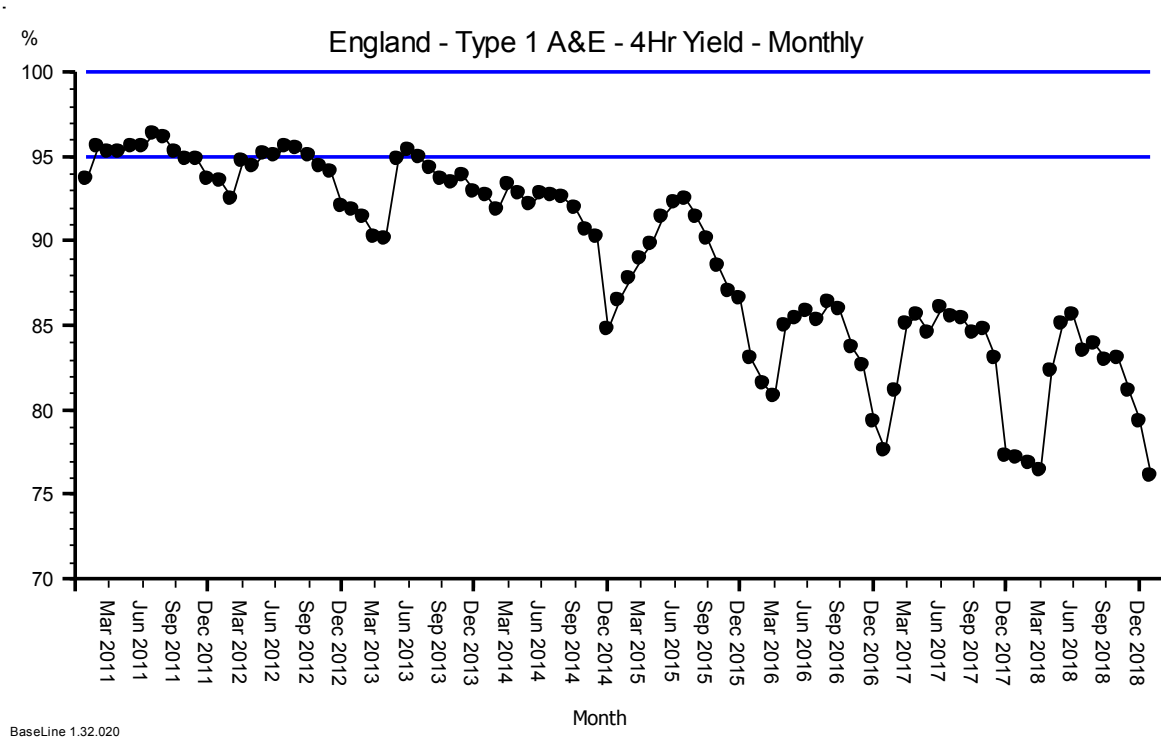
## Keywords

Health Care; Emergency Department; Ambulatory; Health Care Systems Engineering (HCSE); Training; Carveout;

## Context

Over the last seven years the NHS in England has experienced a progressive, year-on-year, deterioration in the performance of emergency departments (ED) as measured by the 4-hr target yield; the percentage of patients who are admitted or discharged within 4 hours of arrival in the ED [Fig 1].

*Figure 1. Monthly, aggregate, A&E 4Hr Target performance for Type 1 EDs in England. Source: NHS England. The blue lines indicate the required average performance (upper and lower specification limits). The data also shows an annual cycle with "winter troughs" that are increasing in magnitude over time.*




This deteriorating aggregate performance represents a system-wide increase in risk and a system-wide deterioration service quality and there is considerable debate around the root causes and the required interventions to reverse the effect and restore both safety and quality. This aggregate performance obscures the fact that there is wide variation between hospitals with some able to maintain performance consistently above 95%, even in winter. The reasons for this are also debated and the lessons from these 'positive deviants' do not seem to be spreading naturally across the system of emergency care.

A system can be defined as ''*a collection of hardware, software, people, facilities, and procedures organized to accomplish some common objectives*'' and the science of how to engineer systems emerged in the 1950s in the domain of defence and aerospace [1]. An early example was putting a Man on the Moon on July 20th, 1969 - almost exactly half a century ago. Systems engineering (SE) is responsible for many of the essential services that we take for granted such as energy generation, transport, communications, supply chains and the ubiquitous Internet, and is now being starting to be applied to 'softer' systems such as health and social care.

Inspired by the work of Dr Kate Silvester [2], in early 2014, NHS Scotland commissioned an innovative project that applied the same health care systems engineering (HCSE) theory, techniques, tools, and training in the improvement in ED performance in one acute hospital in Lanarkshire. The essence of the Monklands project was two experienced clinical systems engineers, Kate Silvester and Simon Dodds,

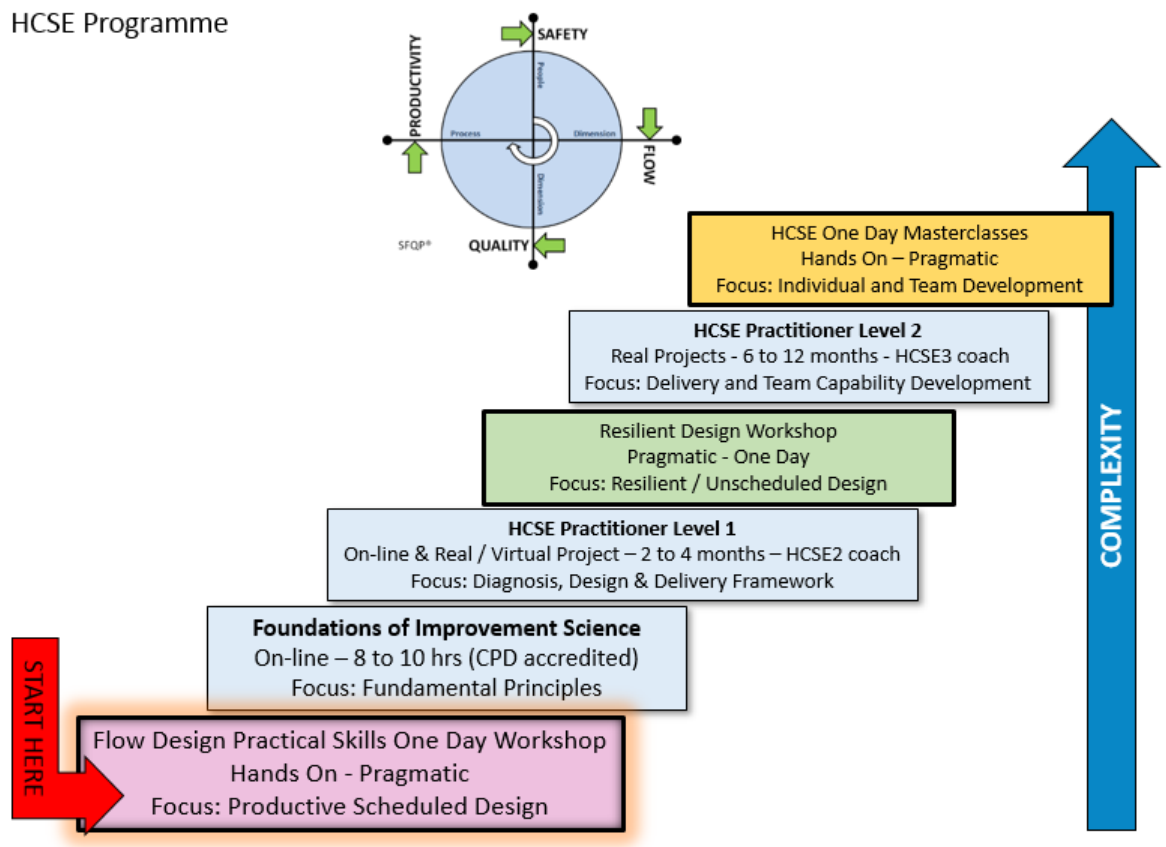
trained and coached a small multi-disciplinary team (MDT) in the science of improvement-by-design. The primary objective was to develop the required embedded capability to diagnose, design, and deliver the desired improvement, and to maintain it.

The measured effect was a step-change increase in ED 4-hour performance from about 80% and falling to above 95% and stable, and this improvement has been sustained [3].

Almost three years later, a similar question was asked. *Could this HCSE approach be applied to achieve similar results in a large acute trust in England? And if so how?* The question was asked by Rob Lusuardi, Director of Acute Care for the Staffordshire CCG – and the large acute trust in question was University Hospitals North Midlands (UHNM) which was formed when the University Hospital Stoke and Mid Stafford Foundation Trusts were merged in November 2014.

In the intervening three years, an innovative HCSE training programme had been developed, verified and validated and was already being delivered by a small but growing community of health care improvement practitioners (CHIPs) [Fig 2]. So, it was possible to answer the question – *Yes, and the first step is to develop enough embedded HCSE level 1 capability to support the required HCSE level 2 skills needed to redesign an unscheduled care pathway*.

*Figure 2. The HCSE programme uses a pragmatic, hands-on, learning-by-doing blend of practice then supporting principles combined with real-world projects and coached by experienced practitioners.*




This essay retells part of the story of the first year of the UHNM HCSE Level 1 Programme – and it is told by some of those who were and are still involved: Alex Hart, an ED consultant at UHNM, Jayne Garrett, a

project support manager and part of the Transformation Team, and Simon Dodds, an independent clinical systems engineer.

## Simon:

01/10/2017 – Met Rob L at the Owl in Lichfield to talk about UHNM and HCSE.
20/10/2017 – Email from Rob L saying he was struggling to get engagement at UHNM.
22/10/2017 – Email to Rob L suggesting they come to a Flow Design Workshop and see for themselves.
15/11/2017 – Rob L and Julie N come to the Flow Design Workshop at Moor Hall.
14/12/2017 – Teleconference with Rob L and Jan P to agree the outline of the HCSE Level 1 programme.
05/01/2018 – UHNM HCSE Level 1 Programme commissioned by Rob L, first workshops arranged.
24/01/2018 – First Flow Design Workshop at UHNM.

## Jayne:

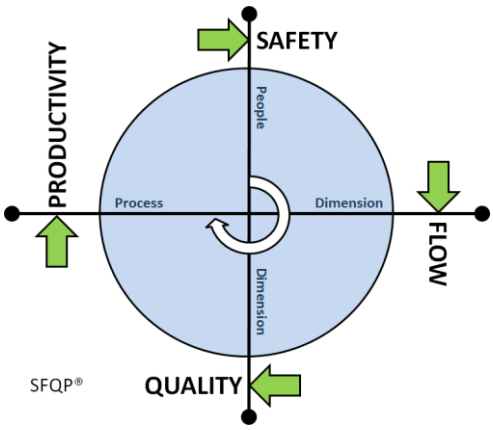
I joined UHNM in January 2018, I was new to an acute hospital setting and one of my first learning experiences was to participate in the Health Care Systems Engineering (HCSE) two-day workshops, which had been commissioned into the Trust by the Clinical Commissioning Group (CCG) and was being led by Simon Dodds (SAASoft).

The thought of participating in a workshop with clinicians was a little overwhelming initially, my thought process was that I wouldn't be able to contribute and understand a lot of what they would be talking about. How wrong was I? I felt very included in the workshops and the training from them was very clear and enabled me to gain a better understanding of how some clinics operate currently and how they could be improved.

"So, what are we being taught?", "What is Health Care Systems Engineering?", "How does engineering fit into health care?" It soon became clearer during and after the workshops.

HCSE is about bringing together the skills, expertise and knowledge of both Health Care (Complex Adaptive System (CAS)) and Systems Engineering (knowledge in aerospace and communications) – this is where Simon is highly skilled in both areas with his career as a systems engineer and a Consultant in General Surgery. Through HCSE we become better able to improve Safety, Flow, Quality and Productivity ... at the same time. That didn't sound possible when I first heard this.

*Figure 3. HCSE approach to improving whole system performance*.




Step 1. Safety – is about avoiding unintended harm and creating a safe system that can be trusted.

Step 2. Flow – is about on-time delivery and efficient use of resources and is important for a stable, well-managed system.

Step 3. Quality – is about effectiveness and high quality is only available when the system is safe and stable.

Step 4. Productivity – follows on from Steps 1 to 3 being followed and adhered too i.e. value for money.

To improve the SFQP, the workshops focused on the correct structured approach of what HCSE is all about, and the key to this is to **Study** what we are being asked to review, **Plan** how we want to use best practice for the project and **Do** what we say we are going to deliver.

*Figure 4. The structured HCSE approach uses a framework called 6M Design®.*


The workshops were delivered with a hands-on approach to getting all attendees involved with some live imitations of how scheduled clinics operate with and without clear processes. This was so interesting! The attendees were given a variety of roles to play: Receptionist, nurse, doctor, radiographer, plaster room, patient. The role plays commenced with the patients turning up to the clinic/receptionist on an ad-hoc basis, each patient was provided with a slip of paper which had a section on for each possible area of visit and depending on the patient needs they would move through the clinic. At each touch point the role player would write down the arrival time, colour in their section and then write down the patient departure time.

The clinic felt chaotic on occasions as the patients were in no scheduled time order, it was all down to the judgment of the nurse which patient went next …… yikes! The waiting room was certainly chaotic.

After 18 patients had passed through the system, we were shown how to capture all the data onto a Gantt chart. This was like being on Blue Peter! We had coloured pens and paper (representing each role), glue, and scissors and it really did get all the attendees actively involved and made for a fun environment to learn.

Following review of the Gantt chart and in-depth discussion of “niggles” and “nuggets” from the experience, the exercise was repeated in a more structured and defined manner, the scenario was mapped, each patient was given a scheduled appointment and the staff had a much better flow coming through their clinic. We repeated the same step of the Gantt chart exercise – more fun again!

Reviewing the Gantt charts from the second run of the clinic, it was clear that the process was 110% better, there was no long waiting times for patients, staff we not too busy or underutilised and the overall lead times were dramatically reduced and with no additional costs to the clinic. This was just too good to believe, and you could see all attendees were amazed by this achievement – so what could be achieved in the ‘real world’?

After attendance at the workshops I signed up for the online Foundations of Improvement Science in Healthcare (FISH) course which would give me further knowledge and understanding for service improvement using the HCSE methodologies.

FISH [Fig 2] was very interesting, although a little mind-blowing initially trying to understand all these new processes and terminology, but it created the base for me to set off on a new journey in the service improvement world.

Some Emergency Department (ED) consultants were in attendance at the workshops and they were very keen to put into practice what we had been taught. Within a couple of weeks, an ED Multi-Disciplinary Team (ED MDT) was created for the department to look at areas within the Division and how the HCSE approach could be implemented. I was invited to attend the ED meetings to provide support from the Transformation Team – this felt very exciting. It was going to enable me to understand the work which

goes on in an A&E department, build relationships with clinical staff and put into practice what we had learnt from the workshops.

## Alex:

My story begins as perhaps many healthcare related innovations do: Rife with cynicism. *"What can some random surgeon tell me about running my Emergency Department?"* I asked myself (and Googled).

The project began in January 2018, but it was not until late March that I attended a webinar with Simon. At last my eyes had been opened, and I was hooked.

I had been invited along as I had been our department's lead for our ambulatory area, a separate place from 'minors' and 'majors', where unwell medical patients attended. From historical arrangements, it had become a bloated coverall for all the hospital's admission portals. Such that local GPs simply sent the patient to the Emergency Department (ED) for ongoing management rather than go through the laborious task of direct specialty referral. There was also evidence that the ED managed these patients better than the specialties and added a financial boost to the ED coffers.

In recent years, this increasing demand coupled with staffing issues was significantly affecting performance. There were many problems, much negativity, and loads of possible solutions. What we lacked was the essence of Level 1 Health Care Systems Engineering (HCSE) training, and with incredible irony, to our own medical careers: A diagnosis!

The Level 1 HCSE training was commissioned by the CCG as part of a package of measures designed to help the trust improve its performance, particularly unscheduled care (consistently in the proverbial relegation zone with respect to 4 and 12-hour performance). Several members of the ED Consultant team stepped up along with a cohort of transformation officers to begin learning the skills needed. It was clear however that Level 1 training was only a stepping stone; designing systems is at least a Level 2 challenge due to the need to coordinate multiple different sub-systems. Our journey had begun, but already it was clear we would need ongoing training after Level 1.

The absolute key point needs re-emphasising here. We have no idea what is actually causing our problems, and just hammer on about the generic problems everyone has assumed they are the same problems here. HCSE teaches us to look at *our* system in a structured way to find out *our* problems.

The great irony being, this is exactly what we do with our patients. Take *their* history, examine *their body* and find *their* diagnosis.

After the diagnosis, conventional medicine and industry do things differently. We use evidence-based medicine (scientific trial and error) to determine the treatment. Industry however designs the solution in theory, tests it to know which design is correct, then tests it in reality.

There is much criticism of applying "airline industry" rules to healthcare. But we can look at building a plane as a perfect example of how we *should* be designing our urgent care systems. The first time an actual new plane flies it *will* fly as expected because the modelling has proven it will.

There is no reason we cannot copy this example in healthcare, and HCSE, particularly level 2 training teaches us these methods.

# The ED Project

## Simon:

An important first step in any systems engineering (SE) project is called a needs analysis, and this has two parts: The first is the outcome that is desired (the need to get), and the second is how that outcome will be delivered (the need to do). The first part is easier to define, and it is important to have a realistic expectation of what can be achieved in a defined time frame with a defined budget. This is where an experienced systems engineer adds most value because avoidable errors at this stage become exponentially more expensive to correct later. I made it clear at the start that a realistic objective for a one-year time window was four embedded microsystem design teams (MDTs) trained to HCSE Level 1 capability. I was equally clear that it was **not** realistic to expect to deliver a redesigned urgent care system because that would require a minimum of HCSE Level 2 embedded capability across the system.

What we did not know at the start was who would step up to the HCSE-1 challenge.

Four teams stepped up: The Emergency Department (ED) team led by Dr Julie Norton; the Ambulatory Emergency Care (AEC) team lead by Dr Zia Din, the Outpatient Team led by Jane Boughey and the Transformation Team led by Alan Tonge. The plan was for the Transformation Team to assist the other three with their projects. The economy-of-scale effect this created meant I was able to facilitate the weekly face-to-face MDT sessions directly.

This is the story of the ED / Transformation team project.

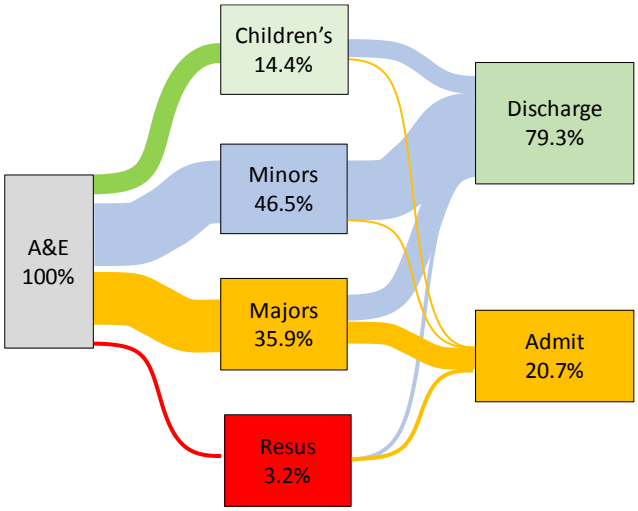



*Figure 5. Sankey chart showing the distribution of patient flows through the UHNM Emergency Department. The width of the line is proportional to the flow.*

*About 50% of adult patients arrive by Ambulance (Mode 1) and the other 50% are classed as Ambulatory (Mode 2).*

*About 60% of ambulance adult arrivals are admitted and only 30% of ambulatory arrivals are admitted.*

## Alex:

The project began and finished as a team project. Clinicians giving their perspective, and the Transformation Team bringing their new skills to support us.

We decided to focus on ambulatory care because this area was most under our control and was a significant chunk of the whole department's workload (~50% of attendances). Most of the patients attending went home, so performance would not rely on flow out of the department (i.e. exit block).

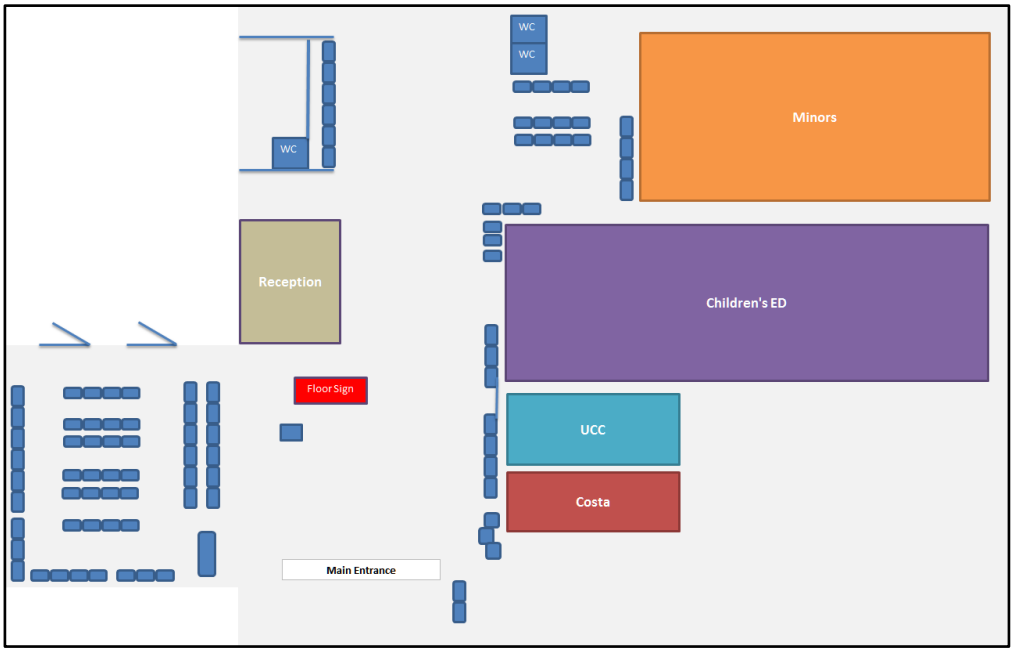
We started by looking at the area quite generally. We were guided to stop looking at it through our own eyes, or indeed a commissioner or exec looking at a spreadsheet of poor data. This analytical process led, unsurprisingly to the beginning of the process: Triage.

We started learning about mapping and measuring by concentrating on this initial step in the ambulatory process. How do we know all the problems in ambulatory care aren't entirely related to the triage step and nothing else? Our team hadn't even considered this as an issue and had no idea how to look at it specifically.

## Jayne:

After attending the weekly meetings with ED Consultants, the Transformation Team and Simon, conversations took place about which areas could be reviewed within the ED, and the question arose **"What if there was no queue in the ED?"** From some in-depth discussions, the ED MDT proposed a solution to the current system design issues within the ED ambulatory stream team by the introduction of an Ambulatory Rapid Assessment and Triage (ARAT). This puts a senior medical decision maker to be the first point of contact for patients streamed to the ED and would allow for an early assessment of patient needs and for all relevant investigations to be started much sooner. Furthermore, there would be the opportunity to divert patients away from the ED at this stage to a different care setting or home where appropriate.

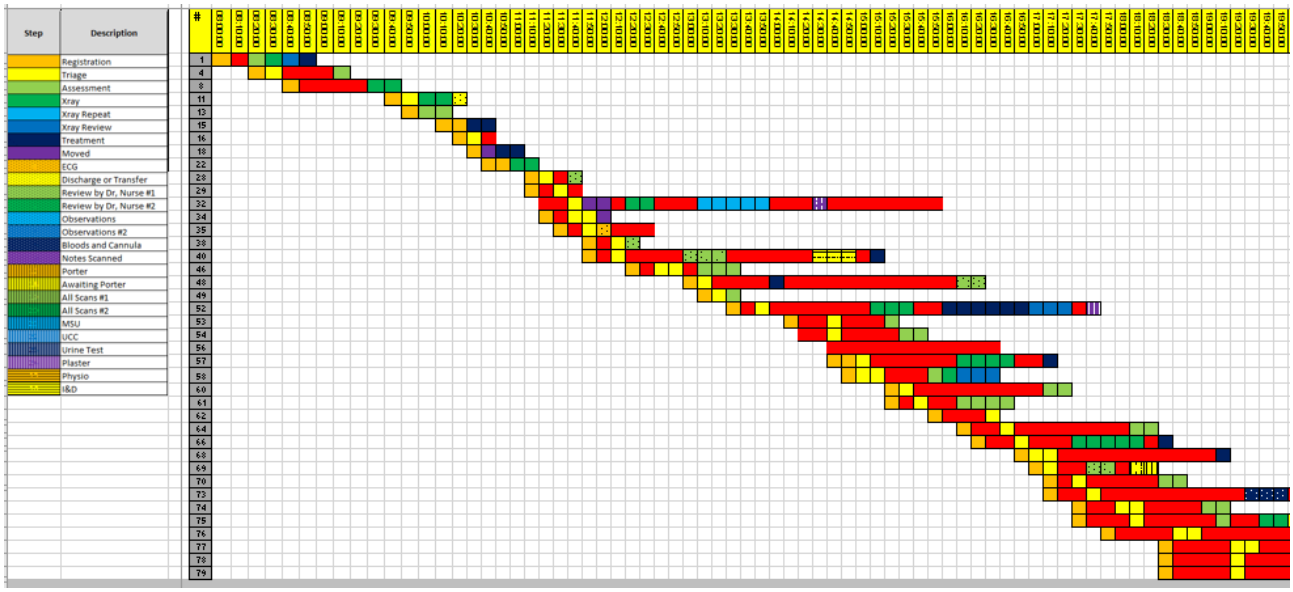
*Figure 6. A floor plan map of part of the ED department showing the entrance for ambulant patients. Patients arriving will queue at the Reception to be booked in before being directed onwards. Adult patients awaiting Triage wait in the area on the bottom left, children are directed straight to the Children's ED. UCC = Unscheduled Care Clinic (see below).*




A 12-hour measure of the triage touch time was undertaken on 14th May 2018 between the hours of 08:00 and 20:00.

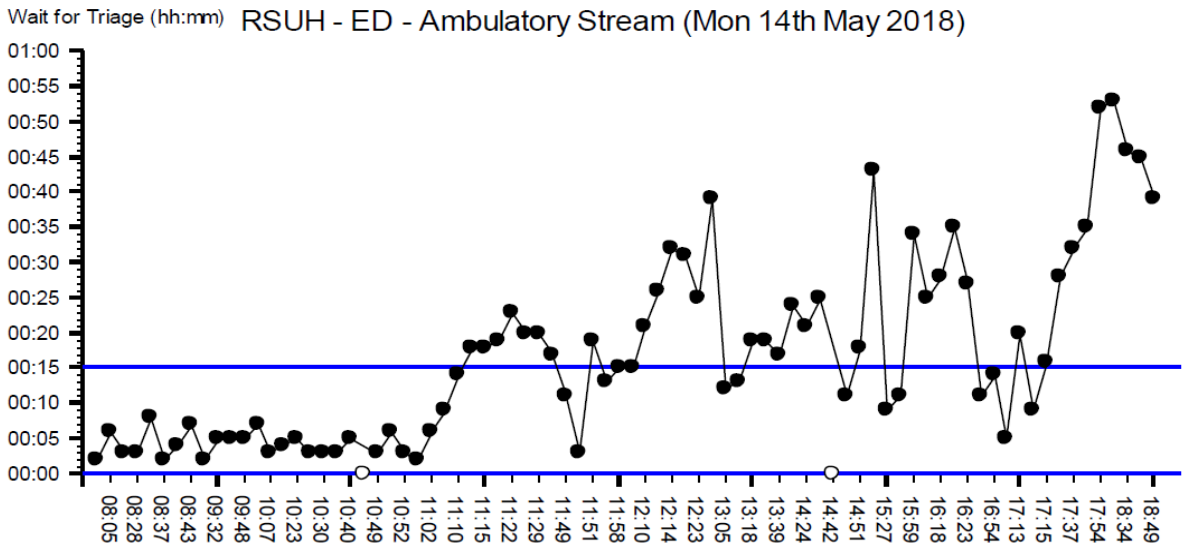
The average touch time was just over 4 minutes and the data collected was put into a Gantt chart – this was certainly interesting from learning how to use Excel.

*Figure 7. Gantt chart of the Ambulatory stream from 08:00 on 14/05/2018. Vertical columns are 10 minutes wide. Orange=Reception, Red=patient waiting, Yellow=Triage. The chart shows that the rate of arrival is relatively steady but there is a growing 'red wedge' in the afternoon that indicates a flow bottleneck.*




A run chart of the manually measured time from starting to register to starting triage for ambulatory stream is shown below [Fig 8].

*Figure 8. Run chart of waiting time for triage by time of arrival. The blue lines show the safety specification range of a maximum of 15 minutes. This chart shows an unstable process that progressively deteriorates across the period.*




## Simon:

The second step in an improvement project is to study the current process – which requires mapping the process before measuring it because the raw data requires context to make it informative.

## Alex:

With support, we soon identified our first major problem. Patients were waiting far too long for triage. This was an immediate safety concern (Rule #1: Safety First [Fig 3]) and focussed our minds on this significant issue.

To reiterate, we were starting out to look for flow performance improvements (CCG commissioned the HCSE level 1 training so quite reasonable). We found a safety problem, and this had to take priority. How can we ignore a basic patient safety issue (extreme waits for initial triage assessment) and instead focus on flow performance alone? This is a key point contradicting years of NHS systems to game the figures. As long as performance is OK, nothing else (or so it has felt) matters.

The HCSE system focuses on SAFETY, then FLOW, then QUALITY, then finally PRODUCTIVITY.

If we get the first step right, we can move on. The key issue being, excellent performance takes care of itself if we get the first three parts right (i.e. everyone wins).

We worked on supported solutions to this issue (NB. at level 1, we were not expected to design or model something yet) and came to the generally accepted idea of senior presence at triage to better filter/stream the urgent queue: This was named ARAT (ambulatory rapid assessment and treatment). We did some small measuring experiments looking at this process and found it took a minute on average for a senior doctor to decide a patient would go; home, the GP, a specialty, or into the ED [see Fig 8 below].

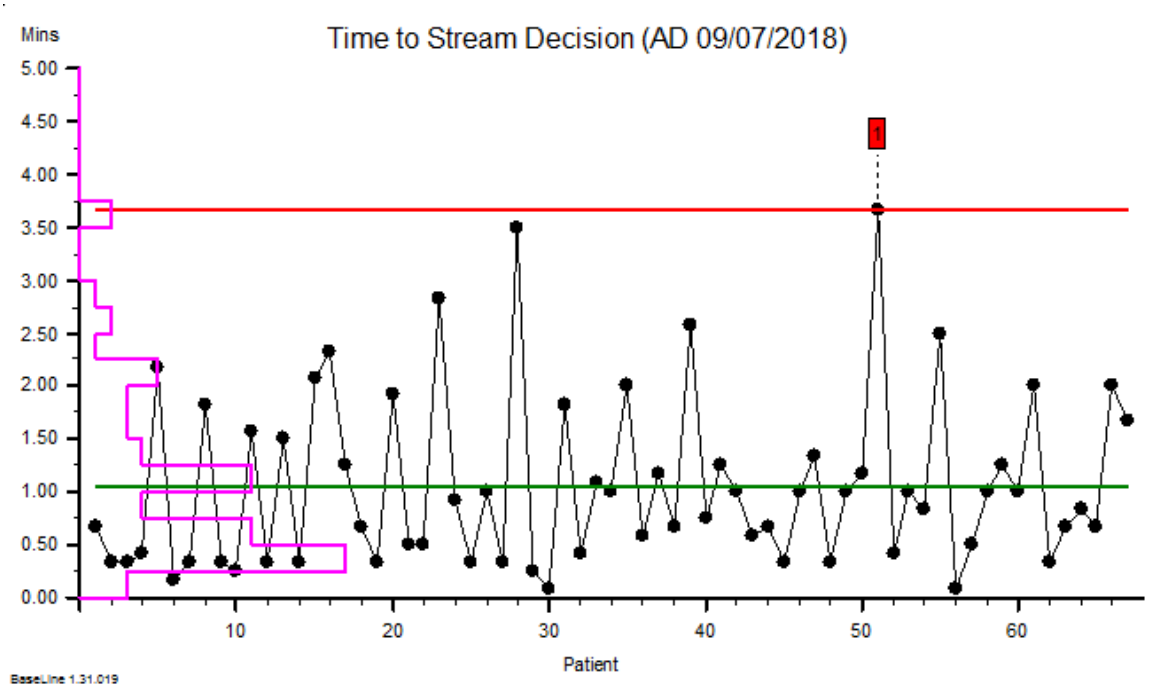
## Jayne:

It was agreed that a pilot for ARAT would take place on Monday 9th July 2018. The clinical staff within triage were briefed on the proposal. Data was collected by Dr Andrew Davy between 09:00 and 17:00 for ambulatory patients attending the ED who were triaged in Room 1. In parallel to the triage process, a clinical decision was made by the GP using the ARAT criteria in parallel and the presenting condition and length of time to make the ARAT decision were collected.

In total, 67 patients were reviewed during the exercise and from these 31 patients were diverted as follows: General Practitioner (GP)=11, Ambulatory Emergency Care (AEC)=13, Discharge=3, Specialty=3, Surgical Assessment Unit=1.

From the data collected, we calculated the triage start time to the decision time and Simon plotted the results on a run chart [Fig 9], which shows the average is 1 minute and that is a lot shorter than the average triage cycle-time which was 7 minutes.

*Figure 9. Run chart of time from starting triage to the senior clinician deciding where to direct the patient to. Green line = average. Red line = upper process limit (mean + 3 x sigma where sigma is a measure of variation). Note the skewed distribution and that most patients require less than 1 minute to decide the next step.*




The data showed that a proportion of patients passed to triage were directed to providers other than ED (Minors, A Bay, B Bay and Resus) and 14/66 (21%) would be directed home or to their GP. This also suggests up to 30% of ED walk-ins are not urgent and can be reassured and redirected and therefore do not add to the queue or workload in ED.

After review of the data collection from Monday 9th July 2018, the ED MDT decide to schedule an extended trial using supernumerary workforce for Thursday 19th July 2018, 9am-7pm. The trial would be of an assessment team and consist of a senior doctor, a nurse and a nursing assistant and would include starting investigations such as bloods etc. linking in with the team in A bay.

The trial was an attempt to help iron out some of the "niggles" involved in transporting patients around, performing and checking ECGs, taking bloods etc. The data collection would measure the time of entry into the triage room, time to decision of which stream the patient will enter, which stream the patient is to be allocated to and the time they leave the triage room.

The Transformation Team was involved in capturing the data through a planned rota throughout the duration of the day. From my prospective it was very exciting and useful to play a part in capturing the data live as this also helped me to put into practice what I am learning through the HCSE Level 1 Brainteasers.

Being from a non-clinical background it felt great to be part of a clinical exercise and it helped widen my understanding on the type of patients coming through A&E and to see first-hand what the clinical staff deal with to ensure safe and appropriate treatment and flow for patients. I felt quite nervous about how I would be accepted into the department capturing the data and asking questions but the clinical staff were very welcoming and made me feel at ease, even when some patients were difficult or they were in the

room with injuries (I kept my nerve and didn't faint at any sight of blood ☺), and the patients were also accommodating to me being in the room.

The streams from triage were as follows:

1. Home/GP/UCC etc (i.e. discharge)
2. Treat and home
3. Admit (e.g. Resus, AEC)
4. Bloods and review
5. Imaging and review
6. Bloods and imaging and review

It was then agreed through the ED MDT, that trial measurements were to be conducted over a longer period than one day, therefore, a trial for ARAT was implemented for a 5-day period. The number of patients captured during this period was as follows:

Monday 23rd July (09:24am – 21:23pm, 12 hours) – 89
Tuesday 24th July (9:40am – 23:59pm, 14 hours) – 70
Wednesday 25th July (08:00am – 16:57pm, 9 hours) – 60
Thursday 26th July (9:15am – 15:51pm, 6.5 hours) – 55
Friday 27th July (9:04am – 13:28pm, 4.5 hours) – 22

***Number of patients seen in total: 296***
**Number of patients streamed to the different locations/ diverted away from ED: 126**
= **42% of ambulatory patients diverted from A&E**

Simon attended the weekly ED MDT meetings and would provide us with some new teaching and knowledge every week. This was brilliant, every single week I would come away with the feeling that I had learnt something new but most of all I was being valued by the ED clinical time by playing a pivotal part in attending the meetings and putting what we were being taught by Simon into practice.

## Simon:

The improvement-by-design framework that the team were learning has a critical step between Measure and Modify; this step is called Model and it has three parts – Diagnose, Design and Decide. The most important step is **"diagnose"** because, as in medicine, without an accurate diagnosis we run the risk of designing and delivering an ineffective and potentially counter-productive treatment. The diagnosis that emerged from the first maps and measures was that the ambulatory triage step was struggling to manage the workload at the rate it was arriving (Fig 4) and that by putting a senior clinical decision maker at the triage step a significant proportion of lower urgency workload could be directed away from the ED, and that the required tests for the others could be initiated earlier. So, provided the triage flow capacity stayed as it was, the ARAT design was predicted to deliver a shorter and safer wait-time-to-triage.

## Alex:

ARAT was tested and worked. Then things fell apart. Due to external pressures (management quickly cottoned on to the benefits of ARAT) it was "introduced" the following week.

We were falling victim to our naivety, our lack of training, and our poor planning. We assumed management were in charge of our department and how it ran.

We also became frustrated as it felt that we weren't being given the space to learn before we made improvements. We had failed to get a dialogue going with our direct managers as to what we were doing. We also spent a lot of wasted energy on the "typical NHS" narrative – ARAT looked promising in theory, and with some basic modelling, but was forced on us and we felt powerless to stop it.

At the same time, we learnt cruel lessons of improvement science failure. Other critical things happened in the department that directly affected our ARAT system. We were running uncontrolled experiments, how were we supposed to know if our new ideas were any good?

Due to a separate reorganisation imposed on us, our ambulatory area was combined with our Minor injuries area and they occupied the same cubicle space as the original Minors area. Suddenly 100 patients were flowing through one area *designed* for 40! The original department had never been designed for the number of patients attending or their specific requirements. We were given a big space (having previously been in a tiny old department) so we carved out as many areas as possible and we made as many cubicles as we could.

A second important lesson learned was about "carve-out", the NHS's favourite system to manage workload. Ever-increasing specialism of space and beds (think: majors, minors, ambulatory, paediatrics, ambulatory medicine, AMU, SAU, ambulatory SAU etc). Unfortunately, it spreads resources more thinly, and thanks to the beauty of the maths, exacerbates the effects of varying demand. In essence, one doctor running minors will struggle to cope with a demand between 5 and 20, meaning constant juggling, queues and stress. A whole department of 20 doctors will cope far better with 380-400 patients. It is critical to note - the scale of variation is much lower for a larger number. In ED we do the opposite, thinking more and more smaller pots are better.

Therefore, when this change occurred to our department, everyone was in uproar. The science told us this would likely not be the case. The science was correct. In fact, and importantly so, the feeling was the ambulatory area ran better after the change. There was a pooling of doctors, seniority and efforts. Despite the relative lack of space (relative is key, as the literal truth is unknown), the area functioned as well as ever.

Introducing ARAT reduced the number of patients entering the area. It felt calmer, it felt better.

Unfortunately, another major change occurred at the same time. The re-introduction of the front door urgent care streaming service called Vocare. They would see all walk-ins before ED (excluding injuries, chest pain, and ambulance walk-ins) and either send to ED, send to the GP, or send home/elsewhere. When they had previously worked pre-ED, they had dropped our ambulatory patient numbers by a third.

## Jayne:

It was pivotal as a team that we kept a close dialogue for the next steps in the process for ARAT and ensuring that it continued to progress and work with SFQP in mind. We were shown the 'Right to Left Map' (R2LM) – this is a system engineering technique for creating a design and a delivery plan to achieve the specified outcome [Fig 10]. It is one of the maps used in the first phase of 6M Design®.

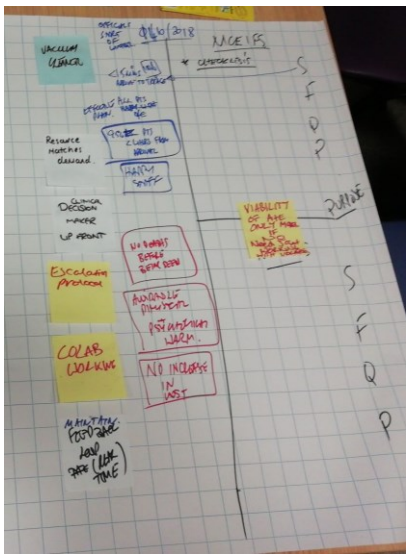


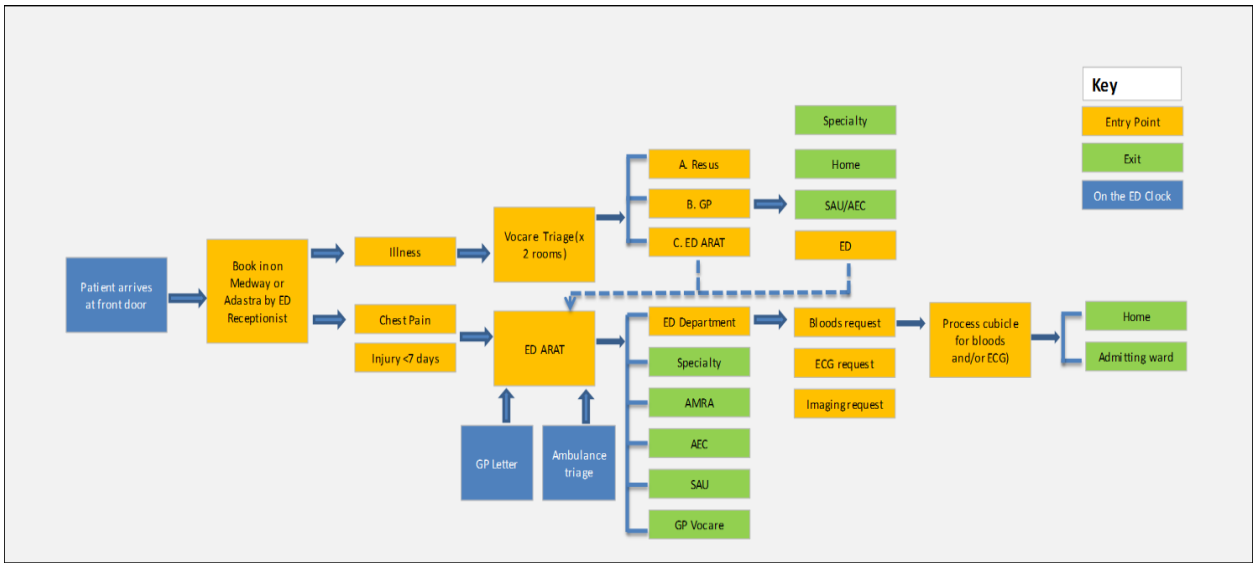
*Figure 10. Sample of part of the R2LM that the ED MDT created illustrating the desired SFQP outcomes.*

In early September 2018, other independent changes were proposed to have all A Bay and Minors patients flowing through the current Minors floor space, and to engage an external organisation (Vocare) to stream patients before they were triaged in ED and direct appropriate ones to an Urgent Care Clinic (UCC).

The Transformation Team met with Dr Andrew Davy on 14th September 2018 and mapped out the current ambulatory flow under the proposed new model [Fig 11].

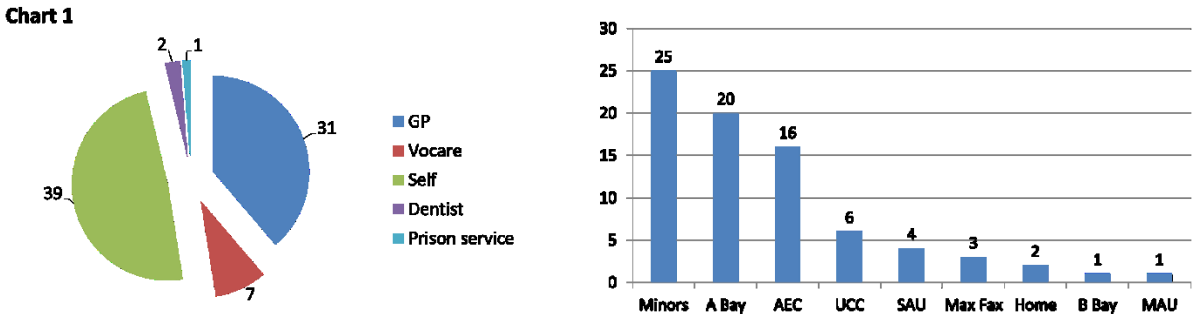
This revealed that the two triage rooms currently used for ARAT would be used by Vocare and that only a single cubicle in Minors was allocated for ARAT.

*Figure 11. Flow map of the proposed pathway after re-introduction of the Vocare service.*




On Monday 17th September 2018, a further ARAT trial was undertaken between 09:00 and 17:00 and in addition to a GP and ED triage nurse, a Healthcare Support Worker was present to take bloods and undertake ECGs. A total of 80 patients were seen at ARAT.

*Figure 12. Chart 1 shows that, after implementing the new pathway, 31 (39%) of patients seen in ARAT were referred to the ED by their GP and the bar chart shows how many patients were signposted away from ED (Minors, A Bay and B Bay).*




The ARAT design for the triage step is fit for purpose on safety, flow and quality metrics and should be considered as a viable design option. There is a monthly rota in place which ensures that we have a clinical lead on every shift to be in attendance with the triage nurse, this rota is developed by the ED team. Since the implementation of the ARAT trials, it has definitely made a positive difference to the patient experience when they attend our ED department and it has also improved the way our clinical staff liaise with each other to make this possible. I'm sure there are still some areas in the department which may be improved further and this can be captured when the ED MDT continue to meet on a regular basis, review data and also involve the staff with regular meetings and ensure we continue to capture any of the 4Ns – Niggles, Nuggets, No Nos, and Nice Ifs.

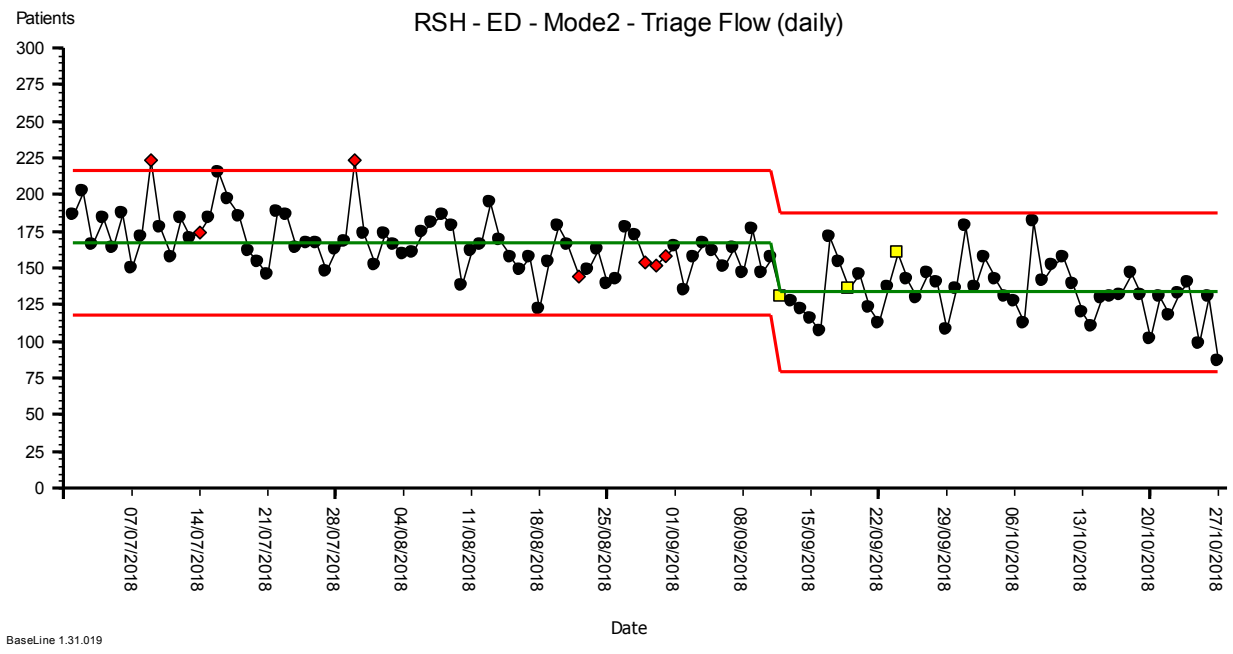
## Simon:

One of the critical elements of an effective and efficient flow design is to ensure there are no severe flow bottlenecks that will generate queues, delays, chaotic behaviour, reduced quality, increased risk and additional costs. The first study phase showed that the Triage step was already struggling with its existing resources [Fig 8]. Many people do not appreciate that even if there is enough resource to meet the workload on average, just the expected variation inherent in an unscheduled service is enough to trigger the development of chaotic queues. This is called the 'Flaw of Averages' error.

## Alex:

A critical issue, and a failure of our own work, was that the Vocare service took over two rooms in our ED; the two we were using for triage ourselves. We had little choice (at this time, as we had not planned properly) and we were left with only one triage room. We learnt that people make well intended changes (they did not intend to cripple ambulatory triage by bringing Vocare into our rooms) but the lack of a system wide approach and plan led to those changes causing more problems than they solved.

*Figure 13. Run chart of daily Ambulatory (Mode 2) Triage activity. Green = average. Red = limits of natural variation (average +/- 3 x sigma). Red points indicate non-random signals. The data is split when the pre-ED streaming service (Vocare) was re-introduced in Sept 2018.*



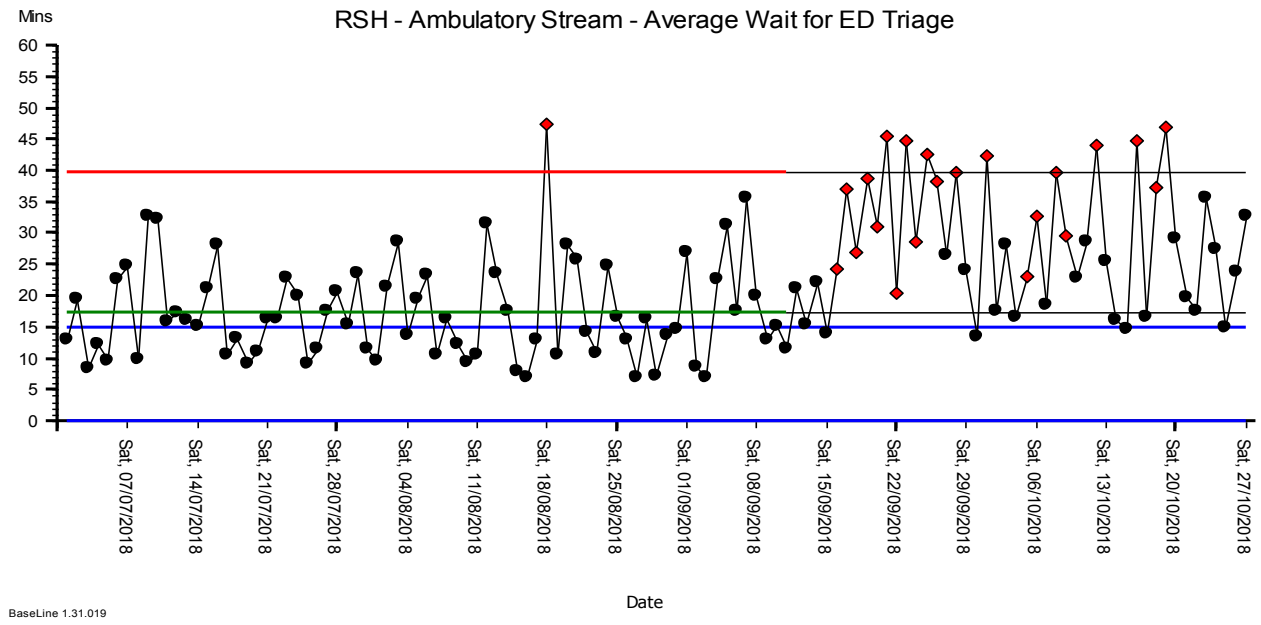

The chart shows the ED attendances that walked in (Mode 2) per day. The green line is the average, and the red lines being the extremes within which most data falls. The red points are outliers that indicate that something unusual outside the normal variation occurred. The consistent pattern changed when Vocare was introduced showing a clear drop in average from 166 to 135 (approx. 20% drop).

So, what happened to the department data after all these independent changes?

Our original assessments of triage found that even with two nurses operating throughout the key demand window (10:00-22:00) we were frequently unable to keep our triage waits down [Fig 7]. Despite two nurses we frequently had very long waits. This pressure also meant any streaming the triage nurses could do (and often did) was abandoned. The ambulatory area filled up with anything and everything; and then patients waited ages to be seen.

Well, triage times didn't improve. With only one triage nurse, despite the 20% drop in demand, we could not ever hope to keep up.

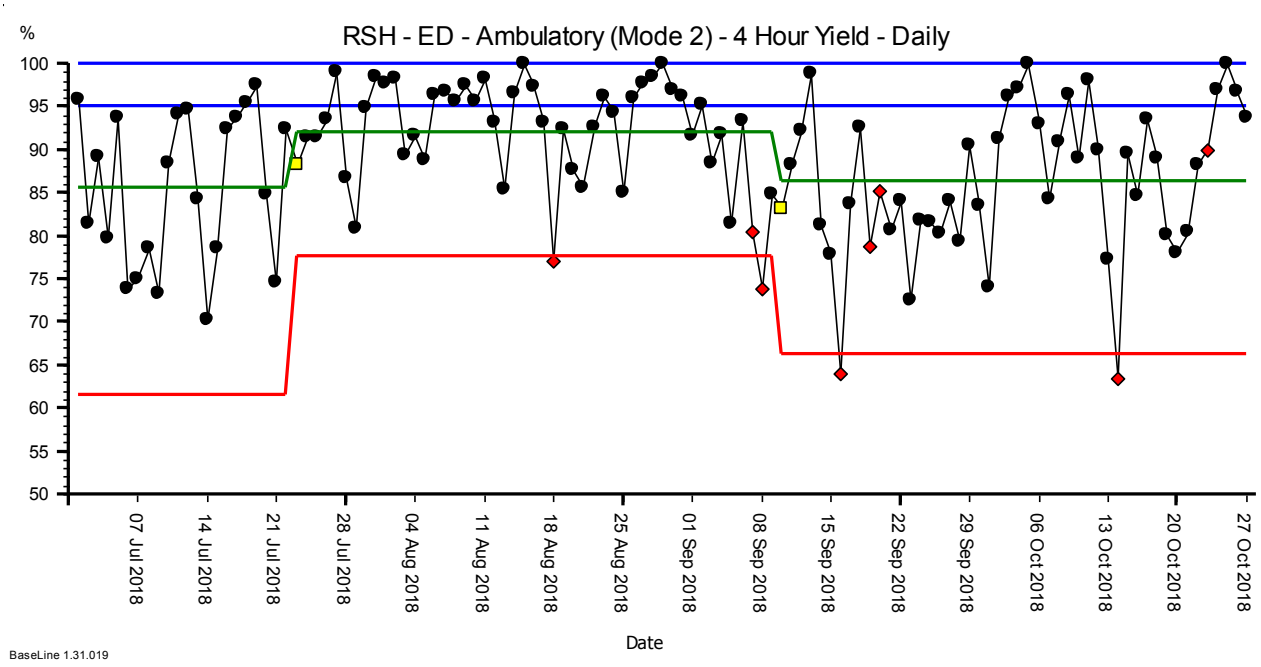
*Figure 14. Run chart of the daily average wait for triage from 01/07/2018 to 01/11/2018. The new Vocare pathway was implemented in mid-September and is associated with a significant increase in triage waiting time as indicated by the cluster of red flags.*




In Minors, it felt better, with less to see, and more organisation (a lot of effort from one consultant went into embedding a style of working in the new area), but performance figures were worse. The red markers on the graph above show a change in the figures that is significant – there are multiple flags after the September changes – i.e. performance is significantly worse. Note also this graph shows **average** wait per day. We know demand is much higher from 10:00-22:00 (80% of attendances) and the individual patient wait for triage is frequently **much** worse than this average

The four-hour target performance also worsened. Patients spent consistently longer in Ambulatory [Fig 15].

*Figure 15. Daily 4 hr performance for the ED Ambulatory stream from 01/07/2018 to 01/11/2018. The improvement from 23/07/2018 is associated with the introduction of ARAT and the deterioration from mid-September is associated with the re-introduction of Vocare.*




Long triage waits meant it was often up to 90 minutes before a doctor could see a patient. Leaving only 2.5 hours to see, treat and discharge/admit.

This exposed other downstream issues preventing good performance, and it all got worse. We suddenly realised much more needed to be done downstream to improve performance, and we hadn't even fixed our original issue!

We are yet to fix the issues of triage, as it appears evident getting patients rapidly through triage benefits the downstream. The addition of ARAT, many feel, is still a sticking plaster to mitigate other issues. That opinion ignores the benefits of an early senior assessment, and our focus moving forward is utilising the benefits and fixing the reasons it is a sticking plaster!

## Simon:

One of the dangers associated with any complicated system improvement are 'uncontrolled experiments' where multiple, well-intentioned and reasonable changes are made independently and at the same time, but without sufficient attention paid to the interdependencies. Systems engineering does not use this trial-and-error approach. In HCSE we model the proposed designs before implementing anything and focus on eliminating design errors as early as possible, and then implement in a step-by-step way with careful monitoring of the effect and comparison with the predicted impact. This fast-feedback loop allows unforeseen issues to be identified and mitigated quickly before they can escalate, and lessons to be learned and shared that avoid similar problems in the future. In my experience, despite me warning about the risks of uncontrolled experiments, it seems that sometimes an inexperienced improvement-by-design team needs to learn these lessons the hard way, and then share that knowledge!

## Personal Reflections

### Jayne:

As well as attending the weekly ED MDT meetings and working closely with the ED team to implement the variety of observations for ARAT, I have been completing the online HCSE Level 1 Brainteasers (BT) and interacting with Simon regularly, to further expand and learn more around the 6M Design® method.

Some weeks I was completely baffled by some of the terminology being discussed in the MDT meetings by both Simon and the ED Consultants – don't forget I'm non-clinical, still really new in the role and still learning about UHNM on a daily basis – but this didn't phase me, it made me more determined to want to understand more about ED and the differences which could be made for staff and patients.

To-date it's been a wonderful learning journey and one which has taught me so much of how to understand the 'Study, Plan and Do' process to make any project a success. I'm still learning and need to be putting what I am being taught into practice, for me this is just the start of my HCSE journey.

### Alex:

The activity I can truly claim as my own was running a short workshop with the Consultants and Specialist Registrars (SpRs). We ran the *carveout workshop* that demonstrates the problems associated with chopping up your service into smaller sections (typical in every ED). It applies well to our ED, where we have 6 or 7 different streams, and juggle our doctors around constantly.

The exercise was fascinating, highlighting well my first sentence about cynicism. Some simply didn't get it, assuming that we do it this way, so it must be correct. Given it was a simplified exercise, all they could do was find fault with the simulation and how it wouldn't be applicable to ED. Despite the evidence unfolding in-front of them to the contrary. However, some did understand. We are working to spread the message.

We have an ambulatory area (minors and medical combined). Our anti-carveout policy is that all patients in that area are to be treated as a single queue. Preferably including the paediatric area as well. It is unacceptable to have a zero wait for minors, but a 3 hour wait for children's ED. The compromise in ED is that it is probably useful to have some carveout (e.g. a permanent clinician in paediatrics and resus – spare capacity for emergencies in essence) but that much more of the clinician cohort should be working on the whole queue. More is required to be done on this issue, but I feel the message is creeping through.

The project, as a whole, is difficult to write up and summarise as it was quite scattergun. Some of this represents the challenge in applying the methods to such a complex area as ED. Particularly an ED so scarred by its own history, very entrenched and untrusted by its own organisation. We also struggled with a consistent team, organising around our ED rotas and other activity. We also ultimately struggled to engage with the online training until quite late meaning certain developments were only stuttering through most of the year.

It has been repeated many times that ED is a terrible place to begin to learn HCSE methods. Our colleagues from the Transformation Team have had some excellent experiences from outpatient clinics and other simple systems. I think we have been strong to stick with it and complete Level 1 training.

In one view, it is unfortunate you cannot learn HCSE in a bubble, or with theory only. As soon as we started making tiny suggestions that were obviously going to help, good old short-termism NHS improvement came into play. I remain frustrated by the external interference, and lack of understanding. I am fascinated by

my inability to translate HCSE into lay-speak. It has taken 8 months, but I now have a fundamental understanding of the Level 1 science and feel a little like an alien race visiting in my space ship where the local population think my technology is magic or fake or nonsense (despite the fact I have flown light years in it), or Galileo irrefutably proving the earth is not the centre of the universe coming up against religion.

It has taken me 8 months, learning from an expert, so my colleagues therefore must be given considerable slack when they've got to learn it from me!

Level 1 training has been the bedrock in the process. But now I need a house to live in. I have seen working examples of Level 2 training and technology and believe it can absolutely help us to design a safe, productive, effective ED system. We have unlimited energy and effort to change things, but simply trying harder isn't going to work. I am on a learning curve where I am now acutely aware of how bad things are, and that there are ways to change. I need the tools to make those changes, Level 2 is calling.

There are too many lessons I have learnt to list them all here. There are some overall messages from everything I have studied and done.

1) You don't know the solution, so stop suggesting solutions.

2) Study your system first. Actually **study** it and don't assume you know it (you don't). Map and measure what is happening on the shop floor.

3) Gap (not studying properly) plus Guess (assuming you know) = Gaffe (break your department).

4) Treat change like you would a clinical RCT. Know what you are changing, control the variables, change only one thing, and have a reliable set of ongoing data that shows whether your change worked or not.

5) Only "you" can fix your own problems.

6) I really need HCSE Level 2 training.

## Simon:

Improvement implies change. Change does not imply improvement. So just changing things is not enough – we need to change the right thing in the right way at the right time to avoid making things worse. That implies we need to design the change, and test it, and implement it in a disciplined way. This is how health care systems engineering (HCSE) is structured. My experience of introducing NHS teams to HCSE is that there is a predictable and emotional roller-coaster ride that typically goes desperation-shock-denial-anger-guilt-depression-resolution-delight. Not everyone completes the course, and one of my responsibilities a HCSE coach is to keep the car on the track and the passengers in the car. The verbatim, warts-and-all stories that Alex and Jayne have shared are what it feels like to be in the car on the HCSE-1 roller-coaster. They have earned their HCSE-1 Certificates of Competence and their HCSE-1 badges and they are keen to take it to Level 2.

We achieved what we set out to: A cohort of HCSE-1 competent practitioners embedded in the organisation, on time and in budget. And at the start I could not have predicted how exactly we would achieve it. That is the nature of complex adaptive system improvement … the path emerges … while the purpose remains fixed: Improved safety, flow, quality and value-for-money. All at the same time.

## References

1. Buede DM. *The Engineering Design of Systems (2nd Edition)* 2009. Wiley. ISBN 978-0-470-16402-0.

2. Silvester KM. *Unblocking a Hospital in Gridlock*. 2013 Health Foundation.

*The aim of the Flow Cost Quality improvement programme was to explore the relationship between patient flow, costs and outcomes by examining patient flow through the emergency care pathway, and developing ways in which capacity can be better matched to demand. The programme ran in two NHS hospital trusts: South Warwickshire NHS Foundation Trust and Sheffield Teaching Hospitals NHS Foundation Trust. Dr Kate Silvester, a dedicated clinical systems improvement expert, supported the teams in both organisations.*

https://www.health.org.uk/sites/default/files/UnblockingHospitalGridlock_SouthWarwickshireFlowCaseStudy.pdf

3. Dodds SR. Systems engineering in healthcare. *Future Hospitals Journal* 2018; **5(3**): 160-3.

*Increasing demand and growing complexity of the delivery of health care is associated with worsening performance in safety, delivery, quality and affordability. Systems engineering (SE) is an established body of knowledge that is widely used outside healthcare in domains such as aerospace and communications. Health care represents a complex adaptive system (CAS) and a combination of 'hard' and 'soft' systems engineering techniques have been successfully combined and piloted in primary, community and secondary care improvement projects as part of an emergent programme for developing embedded NHS capability in health care systems engineering. The current barrier to wider adoption appears to be a gap in awareness, belief and capability but the mounting evidence from a growing number of health care systems engineering (HCSE) practitioners is that this capability chasm can be crossed.*

http://futurehospital.rcpjournal.org/content/5/3/160.abstract

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## Authors

Alex Hart trained in Medicine in Birmingham and began his career in the West Midlands along with a spell learning about other healthcare systems in Australia. He returned to the UK to undertake his training in Emergency Medicine (EM), and was appointed as a Consultant at the Royal Stoke Hospital in 2016. He immediately became involved in the improvement of the ambulatory system in the ED. He has a separate interest in medical education completing a cert. MedEd in 2017 and is currently the EM specialty tutor.

Jayne Garrett has provided project support within both the Private and Public sector and joined the NHS in 2013 and has been involved in Service Improvement and Project Management projects within various settings. In 2018, Jayne joined the University Hospital of North Midlands (UHNM) NHS Trust as Project Support Manager within the Transformation Team and has primarily provided project support within the Emergency Department (ED) and Outpatients Department.

Simon Dodds studied medicine and digital systems engineering before following a career in general and then vascular surgery. In 1999, he was appointed as a consultant surgeon at Good Hope Hospital in North Birmingham and applied his skills as an engineer and a clinician in the redesign of the vascular surgery clinic and the leg ulcer service. In 2004, the project was awarded a national innovation award for service improvement. This led to the design, development and dissemination of Health Care Systems Engineering (HCSE).

## Sponsor

Kate Silvester originally trained and practised as an ophthalmologist. In 1991, she retrained as a manufacturing system engineer and spent seven years in management consultancy transferring manufacturing principles to service industries such as banking, airlines and healthcare. Later, she re-joined the UK's National Health Service and worked on many national programmes improving the flow of patients through the system; addressing timeliness, cost and quality. Between 2010 and 2012 she was sponsored by The Health Foundation to lead an *'Inquiry into Flow, Cost and Quality'* with South Warwickshire Hospitals NHS Trust and Sheffield Teaching Hospitals NHS Foundation Trust.

## Statement of Originality



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