Resilience Engineering as a Quality Improvement Method

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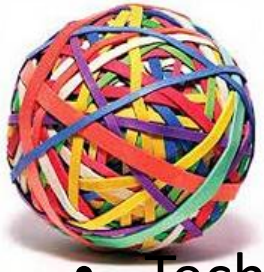
- Collaboration between King's College London, University of Glasgow and Guy's and St. Thomas' NHS Foundation Trust
- Close clinical and governance links
- Quality improvement - drivers and approach
- Sites for in depth work –
  - Emergency Department
  - Older Person's Unit

Traditional approach to safety - Safety I

- Reactive – aims to prevent future problems
- Potential future problems are identified by examining what has already gone wrong in the past
- Errors and adverse events are categorised and counted –
  - More measurement is better – National Reporting and Learning System in UK has over 4 million events recorded
  - Error taxonomies developed
  - Audits and targets
- Humans are seen as unreliable, the weak link in a system – focus on “human error”

Safety I

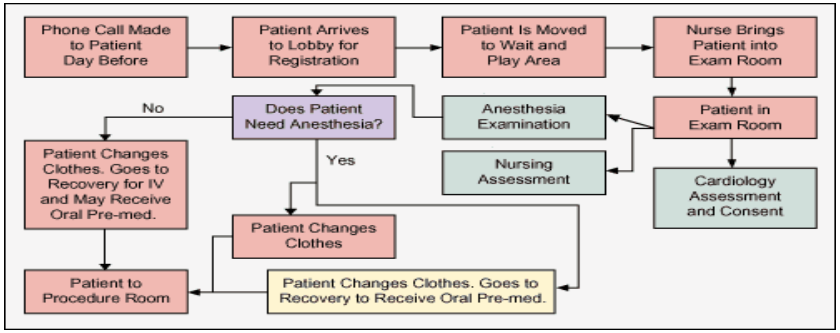
- Assumptions and solutions
  - Learning can be transferred from other industries
  - We need more accountability – professionals should be made to do the right thing
  - There is evidence available that we should just apply
    - Never events in the UK
  - Slogans help – “Put the patient first” “Every day is patient safety day” “1000 lives”
  - Interventions have a predictable linear effect
  - Stability of cause and effect relationships

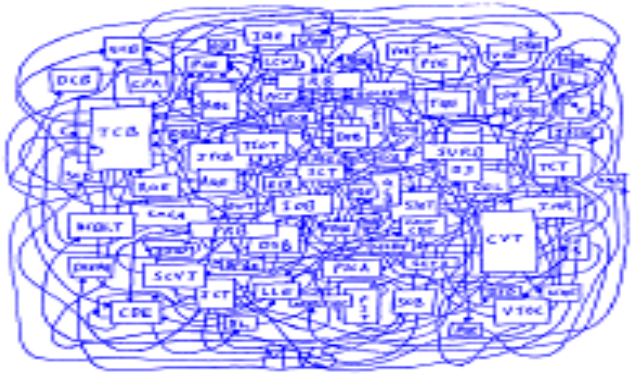


Safety I - philosophy

- Technical-rationality (Marcuse, 1941)
  - Dominant approach to social advancement, based on positivism, and adopted by most professions, especially medicine
  - Dominated by a search for general laws and empirical knowledge on which to base action/interventions
  - Application of scientific theory and techniques to solve problems
  - Assumes that a problem can be clearly defined and a technique is available to solve it.
  - Assumes stability of causes and effects

But clinical work is rarely simple and straight forward





- How to find the REAL cause of the problems?
- Simplistic search for ONE cause
- How will a change affect the WHOLE system?
- What causes outcomes to emerge from this complexity?
- What is it like to work in a system like this?

Safety II – Resilient systems

- Proactive systems approach aimed at anticipating and preventing problems
- Based on the reality of clinical work –
  - Dynamic and sometimes chaotic
  - Determined by social interaction and negotiation
  - Relies on co-ordination and articulation across groups, physical locations, time
- Organisational resilience, or safe adaptation is necessary for a system to function

Resilience

- Used in many disciplines – contested definitions
  - Psychological stress
  - Burnout
  - Ecological systems
  - Supply chains
  - Organisational resilience
  - Common concepts – robustness, flexibility, recovering from disaster, adaptive, coping with pressures

Resilience – emerging consensus

- Resilience is “the intrinsic ability of a system or an organisation to adjust its functioning prior to, during, or following changes and disturbances, so that it can sustain required operations under both expected and unexpected conditions” Wears et al 2015
- Four cornerstones – anticipating, monitoring, responding and learning Hollnagel, 2009

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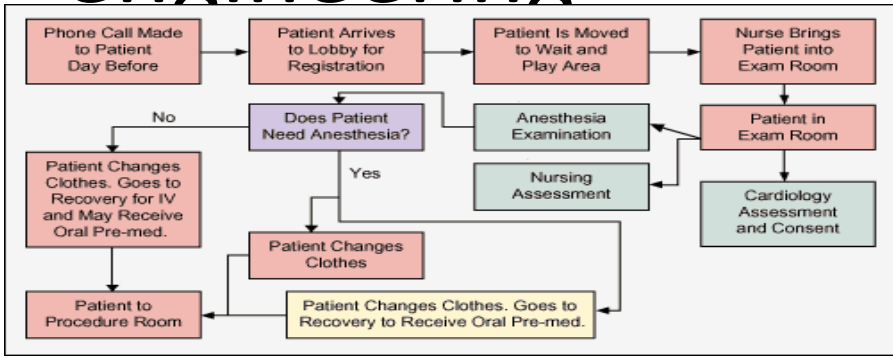
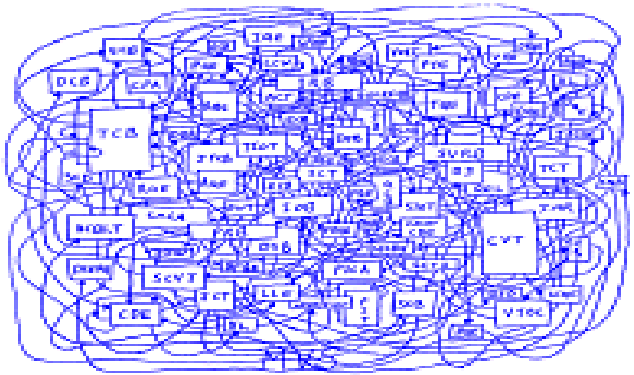
Resilience engineering

- Key concepts
  - Work as imagined is different to work as done – **input variability**
  - Pressures and challenges require the ability to **adapt and work flexibly**
  - **Outcomes are variable** and what is defined as successful **depends on the context**
  - We need to find ways to help things go right more often by studying what the pressures are and understanding how success is achieved

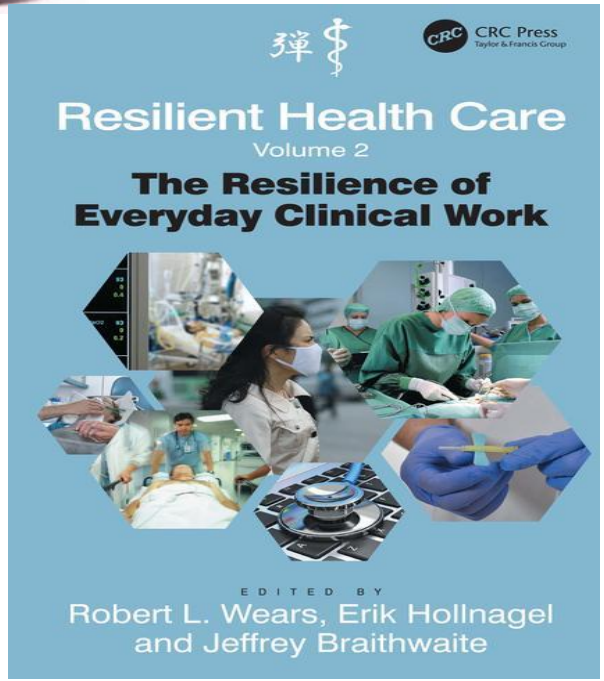




Resilience in everyday clinical work

- In order to make systems work people
  - trade off competing goals
  - develop work arounds for system problems
  - improvise solutions to novel problems
  - find ways to do things with minimal time and effort
- To understand resilience we need to understand all these things

Resilience in everyday clinical work



- Consensus in resilience engineering that studying and understanding everyday work is vital
- Some focus on disaster recovery and unplanned major events

What is resilience?

- It is a response to something – a pressure or problem
- It must be present before it is needed
- It is an action that is taken
- It is likely to be variable and expressed differently by people in different roles and at different levels

Problems

- We can’t see resilience so how do we study it?
- Hindsight bias – well things worked out therefore we were resilient!
- Inherent in action that needs to be understood in context
- Suggests in depth qualitative research is needed
  - Observe work
  - Understand from the worker’s perspective

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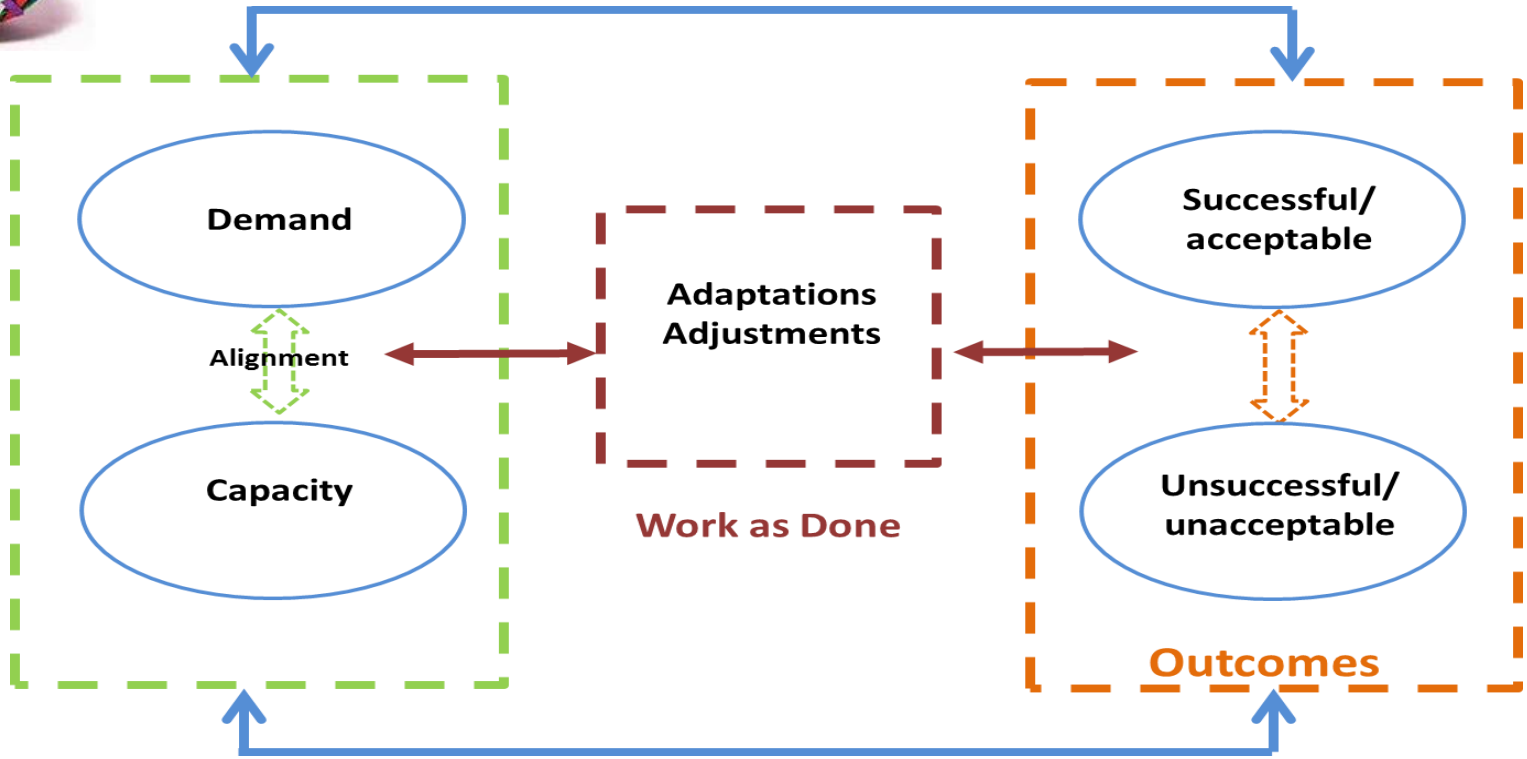
Working model



Methods

- Observations – 50+ hours, non participant
- Focus on co-ordinating mechanisms – MDT meetings, board rounds, ward rounds, staff meeting, handovers, shadowing staff
- Extensive field notes, documents, artefacts, interviews
- Initially broad, becoming more focused as familiarity increased and areas of interest identified – cycles of data collection, reflection, and interpretation

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Analysis Process

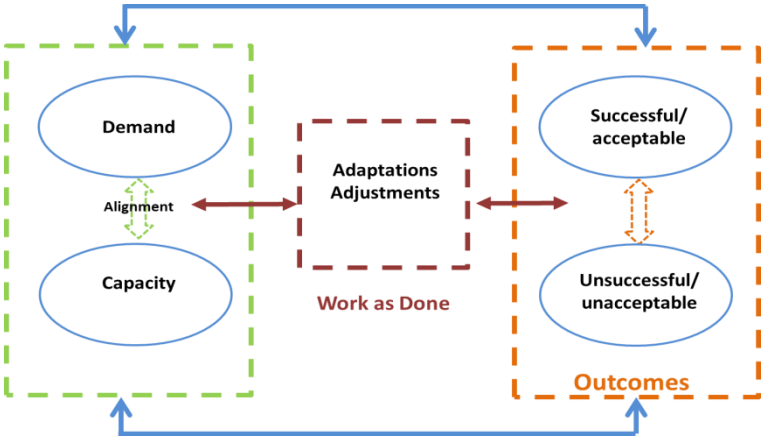
- Categorised according to functions
- Resilience narratives
- Review and validation
- Mapping to theory
- Identifying QI interventions

Resilience narrative - discharge

An experienced staff nurse, returning to the Nurse in Charge role after a holiday, found it difficult to troubleshoot issues associated with the discharge of patients. Time away from the ward meant that the nurse was unable to reconstruct or make sense of decisions that were made. This resulted in time consuming activities such as the reading of all patient notes and making telephone calls. There is a need to maintain knowledge of patient status over weeks, rather than days or hours, and time away made it difficult to reconstruct an up to date view of the patient yet this was crucial to ensure timely discharge.

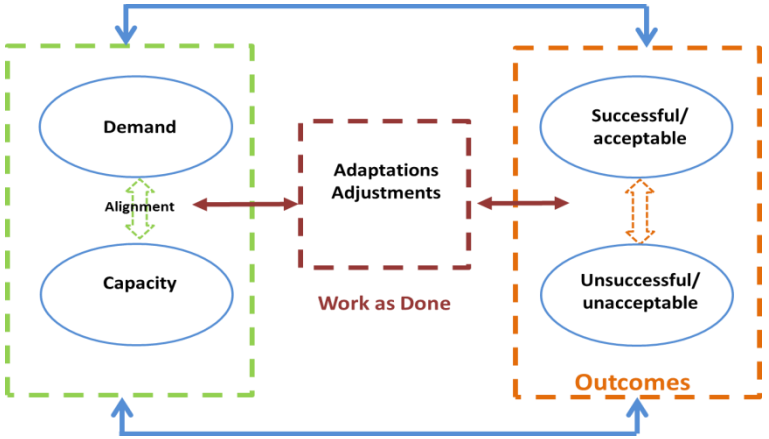
Adjustments - discharge

- Co-ordination of discharge tasks across staff, agencies, families and carers is complex and time consuming
- Misalignments between demand for services post discharge and availability
- Variability due to patient factors – carers, preferences, home environment



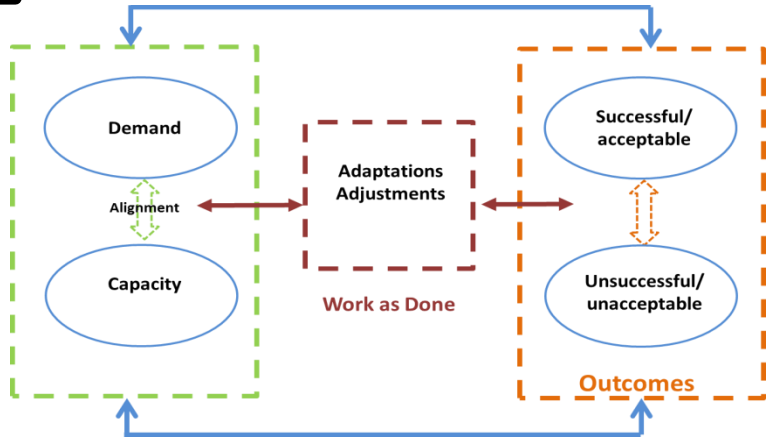
Adjustments - discharge

- Goal trade offs are common – discharge may be speeded up because of infection, weekend approaching, or delayed because of safety concerns
- Monitoring progress towards discharge is difficult because there is no shared artefact
- Need for anticipatory monitoring of discharge actions



Potential interventions

Improved documentation or an electronic artefact to allow for shared monitoring of the discharge process



Resilience narrative – acute disruptions

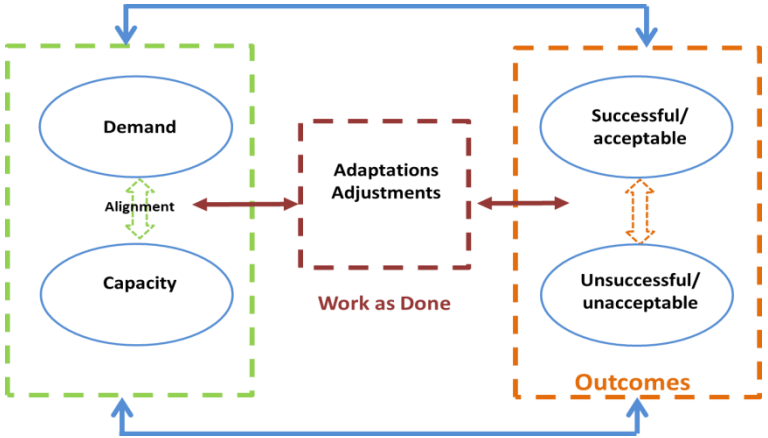
A cardiac arrest resulted in three or four nurses working on one patient until the full Crash team arrived ten minutes later. Two Nurses were then with the patient for the next forty five minutes along with the Nurse in Charge and the patient's assigned Band Five nurse. This meant that the other Band Fives had to cover for the Nurse in Charge and the other five patients of the Nurse who is away from the Ward. This meant that surveillance capacity was reduced and one patient nearly fell while trying to get out of bed.

Adjustments

- Short term acute disruptions
- Due to patient factors
  - Cardiac arrest
  - Absconding
  - Aggression or mental health problem
- Resources concentrated on resolving problems leaving other patients potentially vulnerable

Potential interventions

Team training to deal with short term disruptions and ensure that surveillance of all patients is maintained at such times



Resilience narrative - ED

No criteria are used to evaluate if flexing has achieved its desired outcome and there are no clear triggers to determine when a member of staff should return to their pre-assigned role. This has led to confusion. In one scenario a Resus consultant who was flexed to Majors returned when it felt less busy. However, this left loose ends and one nurse could not locate the consultant to talk about the patient's blood test results

ED Adjustments

- Four hour patient flow target
- Two hourly meetings are held to review patient flow
- Actions taken to fix problems, anticipate bottle necks
- Includes flexing staff, expediting processes, requesting patient reviews
- No specification of anticipated effect of adjustments, how long to maintain changes, whether they had the desired effect

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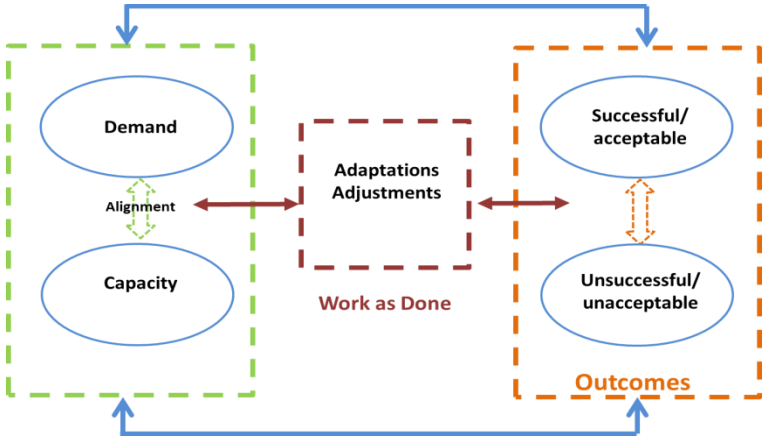
Potential interventions

Making adaptations more visible and more easily monitored by re-designing documentation used during patient flow meetings



Resilience narrative - ED

There are multiple pathways for patients who have been treated in the ED – admission to the hospital or into the community. Four patients were approaching breach time. They were to be admitted but there was no sign of an available bed. Central Majors area increasingly chaotic with staff acting with increased urgency. Flow Co found out no beds available in the unit she had been talking with, SNP is in the ED directly allocating beds that are not appearing on the IT system. Considerable confusion about pathways eg EMU, Frailty and OPU into the hospital.

ED adjustments

- Hospital bed status is not updated regularly and is not visible to all in the department
- Beds for patients are difficult to find – availability is constantly shifting
- Process of difficult negotiation
- Reliance on outsiders eg SNP

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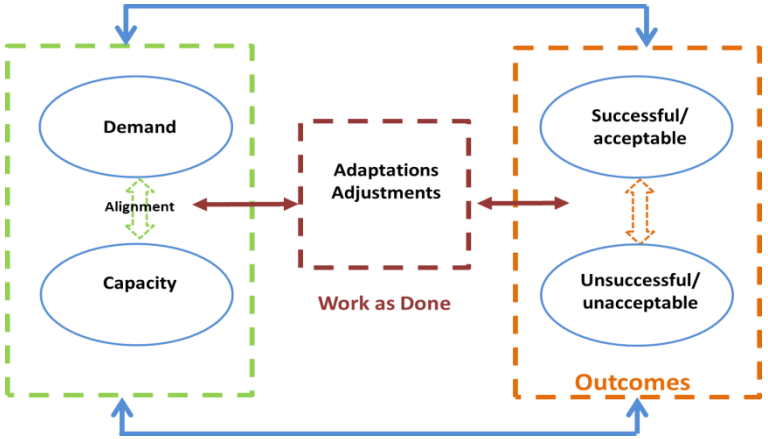
Potential interventions

Regular huddle between ED and OPU clinicians to exchange information about older people in the ED, ensure timely assessment, and forward planning for admission



RE as quality improvement

- Systematic process for identifying what should be improved
- Improved intervention design based on a deep understanding of how outcomes arise from the interplay of pressures and adaptations - WAD

Can quantitative data inform resilience QI?

- One NHS Foundation Trust – **emergency department** and older person's unit
  - Main performance metric in ED is patient throughput in four hours or less – mandated target – proxy for care quality
- Data collection over 24 months - 2014-2016
- N=230,992 patients (~2,500 records deleted due to inconsistencies, missing data)

Variables modelled

Patient variables	Organisational variables
Age	Seen by consultant
Gender	Numbers in ED
Arrival mode	Incidents in last six hours
Source of referral	Ambulance arrivals in last hour
Triage	Registered nurse numbers
Readmission	Unregistered nurse numbers
Primary presenting complaint	Senior medical staff covered (n)
First location	Senior medical staff not covered (n)
Speciality	Junior medical staff hours covered
Day of week	Junior medical staff hours not covered
	N equipment repairs
	Bed occupancy in hospital

Approach

- Compiled data – driven by theory and pragmatics
- Identified specific research questions to be answered with multi-variate modelling
- Identified predictors of outcomes using
  - Percentage accurate prediction
  - Effect size calculation for all significant variables (chi-square/df)
  - Odds ratios to identify which groups are different
  - Interpretation and induction

Outcome variables

- Targets
  - 1 hour to be seen by a doctor
  - 4 hours to be treated and discharged
- Incidents
  - Security and violent incidents
  - Other incidents – medication errors, falls, etc.
- Mortality

Results - Four hour target

- Model the probability of breaching the four hour target – logistic regression
- Modelling the odds of a breach
- Discharges intensify as the four hour target is approached – work oriented to this hard boundary

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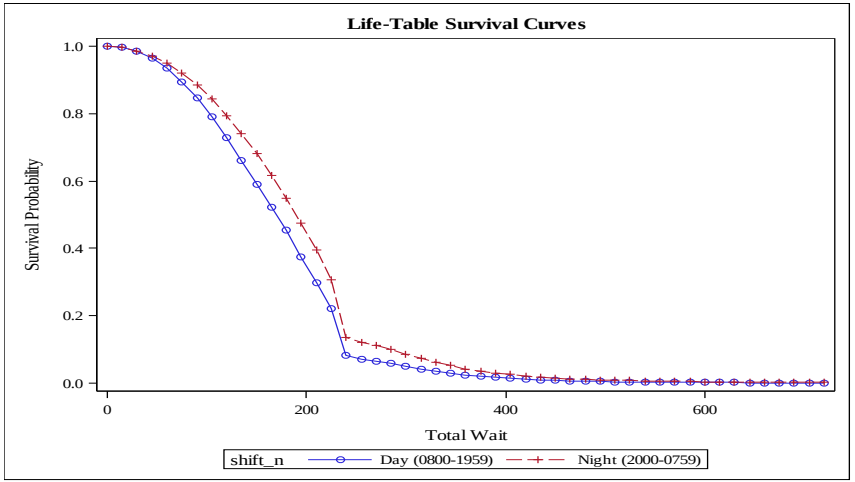
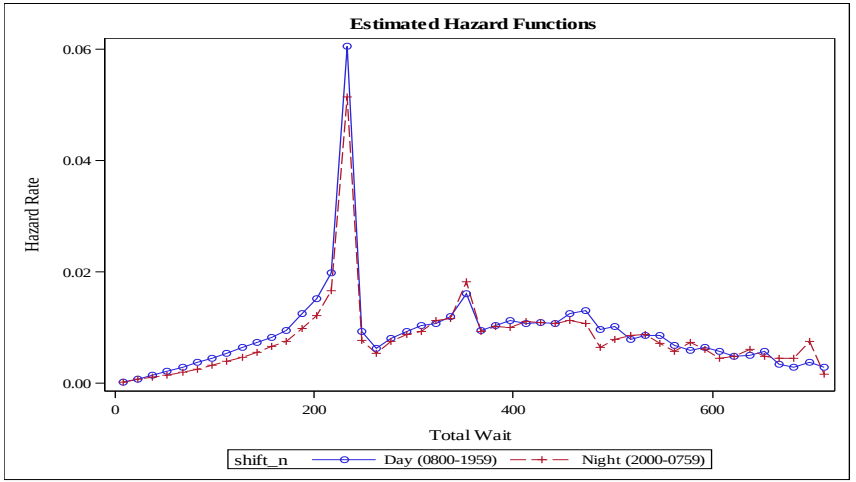
Time and rate of discharge





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Four hour target

Variable	Effect size	Interpretation
Shift	1143.1	Night shift twice as likely to breach as day shift
Specialty input needed	406.69	Cardiology, HDU, renal, haematology, HIV, ITU, respiratory, stroke input needed increases breach risk
Number of people in ED	369.86	Strong linear effect – as numbers increase breaches become very likely
First location	119.72	UCC patients are half as likely to breach (also left department)
Arrival mode	96.81	Ambulance arrivals twice as likely to breach as other modes of arrival
Primary presenting complaint	99.65	Unknown PPC 5 times more likely to breach than other PPCs
Triage	72	Urgent, very urgent and unknown slightly more likely to breach
Senior medical staff not covered	59.2	More staff not covered increases risk of breach
Readmission	48.96	All readmissions slightly more likely to breach
Day of week	42.47	Lower risk of breach Mon, Tues, Wed, Fri. Higher risk Saturday
Senior medical staff covered	30.07	More staff covered means lower risk of breach
Equipment repairs	19.82	More than 7 pieces of equipment being repaired increases breach risk
Bed occupancy	27.43	Bed occupancy over 70% increases breach risk

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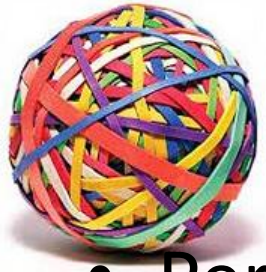
Four hour target

Variable	Effect size	Interpretation
Gender	17	Males are slightly less likely to breach
Age	17.76	Linear increase in risk of breach with increases in age from age 18 - plateau at 75
Source of referral	13.18	Lower risk if referred by same or other healthcare provider
Seen by consultant	7.46	Lower risk if seen by consultant
Registered nurse numbers	7.3	Generally lower risk if more nurses, but if over 23 higher risk of breach
Incidents in the last 6 hours	6.28	Risk of breach increases if 2-5incidents in last 6 hours, 6+ associated with lower risk
Ambulance arrivals in last hour	5.8	Risk of breach increases if more than 2 ambulance arrivals in last hour
Junior medical staff hours covered	5.06	Risk of breach increases as junior hours increase over 30
Junior medical staff not covered	4.18	As number not covered increases risk of breach decreases
Unregistered nurse numbers	3.45	Mixed – trend towards higher risk if more unregistered nurses



Predicting violent and security incidents

- Percent concordant 79.9

Variable	Effect size	Interpretation
Gender	92.16	Males more involved than females
Readmission	51.45	All readmissions more likely
Shift	50.43	Night shift more likely than day shift
Primary presenting complaint	38.29	Alcohol, mental health, unknown, more likely than minor ailments
Arrival mode	14.16	Patients arriving by foot
Triage	14.26	Standard triage is less likely than all others to be involved
First location	18.49	UCC patients less likely to be involved majors and resus more likely
Source of referral	9.17	Other more likely

Predicting other incidents

- Percent concordant 79

Variable	Effect size	Interpretation
Primary presenting complaint	45.35	Much higher risk for mental health patients, alcohol and unknown.
First location	38.32	Higher risk for resus and majors patients
Readmission	37.17	All readmissions have higher risk
Triage	12.26	Much higher risk for all compared to standard
Age	8.29	General linear increase as age increases especially from 60 on and for 90 and over
Arrival mode	7.24	Ambulance arrivals at higher risk of incidents
Source of referral	7.05	More likely if referred from health care provider
Incidents in last six hours	2.49	3 or more incidents in last six hours increases likelihood of incident
Day of week	2.35	Increased risk Wed, Thurs, Fri
Senior medical staff covered	2.17	More staff covered increases risk of an incident – marginal effect

Implications

- Confirmed previous research showing importance of crowding, patient age, bed occupancy, and intensification of effort approaching 4 hours
- Demand on the system (ED and hospital occupancy) in terms of patient numbers is important, but so are other demands – equipment failures, incidents and sick patients
- Evidence that sicker patients are prioritised but also take longer to get through the system and have more incidents
- Highlights organisational failure to match demand and capacity – eg night shift and specialty input
- Senior medical staff numbers important
- Could streaming different patient groups be helpful – readmissions in older patients for example

RE as quality improvement

- Find out what makes adaptation difficult
- Are there system level changes that could support adaptation?
- Focus on strengthening processes

Conclusions

- RE is an emerging paradigm that has the potential to increase the effectiveness of QI
- Conceptualised as
  - Continuous improvement method
  - Complementary to existing improvement methods

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