On the predictability of chaos

Allan Cameron
Glasgow Royal Infirmary
On the predictability of chaos

- Identifying the tipping point
- How we get there
- How we find the cause
- How we prevent it
- Evidence based service
What do the following have in common?

- Patients boarding on surgical wards
- Patients admitted directly to medical wards
- Patients admitted to “winter wards”
- Patients diverted to another hospital
- Patients on trolley waiting overnight for a bed
<table>
<thead>
<tr>
<th>Patient group</th>
<th>Problems in common</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgical boarders</td>
<td>Not in area designed for them</td>
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<tr>
<td>Direct admissions</td>
<td>Don't benefit from QC / efficiency of AMU</td>
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<tr>
<td>Winter ward patients</td>
<td>Uncertainty about ownership and governance</td>
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<tr>
<td>GP diverts</td>
<td>Not seen on formal AMU ward round</td>
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<tr>
<td>Case-by-case transfers</td>
<td>Seen later in the day</td>
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<tr>
<td>Trolley waits</td>
<td>Delayed investigations, treatments, discharge</td>
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<td></td>
<td>Increased length of stay</td>
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<td></td>
<td>Confusion and anger about being there</td>
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</table>
Home

Emergency Department or Assessment Unit → AMU → Medical ward

AMU → Home
Spill – The unifying diagnosis

• Acute medical patients should be:
  – Seen promptly at the front door
  – Admitted to AMU if hospital admission is needed
  – Transferred to specialist ward for ongoing care if required
  – Kept in that specialist ward while their illness still needs inpatient care

• Unplanned deviations are undesirable

• The deviations have different names, but the same causes and consequences

• Patients have *spilled* into areas that are not designed to deal with them
Finding the cause

• There must be an imbalance
• Intuitively, we look at the busiest area and think that's where the problem lies...
• ...but intuitions lead us astray!
• We have to stop theorising and start being empirical
• We have a digital goldmine of information that we do not use
How we use data

Data source

- National Data
- Board level data
- Hospital data
- Departmental data
- Patient level data
How we use data

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Data analysed by
- ISD
- NHS Board
- Clinician
How we use data

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Informs
- National policy
- Regional policy
- Hospital policy
- Departmental policy
- Direct patient care
How we *should* use data

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  - Board level data
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- **Data analysed by**
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- **Informs**
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  - Direct patient care
Histogram of daily registrations to AAU
Poisson distribution

Non-stationary Poisson Process

Original arrival times

Time rescaling procedure

Transformed arrival times

Stationary Poisson Process

$$\tau(t, a) = \frac{\delta T}{n_T} \left( \hat{\lambda}_a \left( \frac{t}{\delta} - (a - 1) \right) + \sum_{k=1}^{a-1} \hat{\lambda}_k \right); \quad (t: (a - 1)\delta \leq t < a\delta); \quad (a: a \in \mathbb{N}_1, 1 < a \leq rs)$$
Hourly activity on weekdays

Rate of arrivals

Hourly average

7am  8am  9am  10am  11am Noon  1pm  2pm  3pm  4pm  5pm  6pm  7pm  8pm  9pm  10pm  11pm Midnight  1am  2am  3am  4am  5am  6am
Hourly activity on weekdays

Rate of arrivals
Rate of doctors seeing patients
Rate of patients leaving

Hourly average

7am  8am  9am  10am  11am  Noon  1pm  2pm  3pm  4pm  5pm  6pm  7pm  8pm  9pm  10pm  11pm  Midnight  1am  2am  3am  4am  5am  6am
Discharges from all downstream medical wards by time of day in August
Discharges from all downstream medical wards by time of day in August

Ward round finishes 1pm: 6.1 beds available
Discharges from all downstream medical wards by time of day in August

- Ward round finishes 1pm: 6.1 beds available
- Ward round finishes 11am: 2.6 beds available
Moving all downstream discharges to 3 hours earlier

Ward round finishes 1pm: 17 beds available

Number of discharges by time

Time (24h clock)
Wider uses of departmental data analysis

- Inform useful simulations
- Measuring QIs on every patient (not just samples)
- Personal audit (eg for appraisal)
- 30 day readmission rates & case reviews
- Large observational studies of service & demographics
  - Admission prediction from triage
  - Identifying GI bleeders suitable for OP management
  - Effects of weather on receiving numbers
Resources

- Ordnance survey
- Google Maps API
- National Census data
- ISD Scotland
- Department of Health
- Comprehensive R Archive Network
- NHS Hack Day
- Sourceforge.net
Summary

● Spill shows we have reached a tipping point
● We need bottom up approaches to prevent it
● We should be empirical about improving our service
● We urgently need access to a full searchable database of our departments' data
● The evidence base for how we deliver treatments is just as important as the evidence base for the treatments themselves
Questions