Why do I have to wait so long at the emergency department?

Complexity and Hospital Emergency Departments

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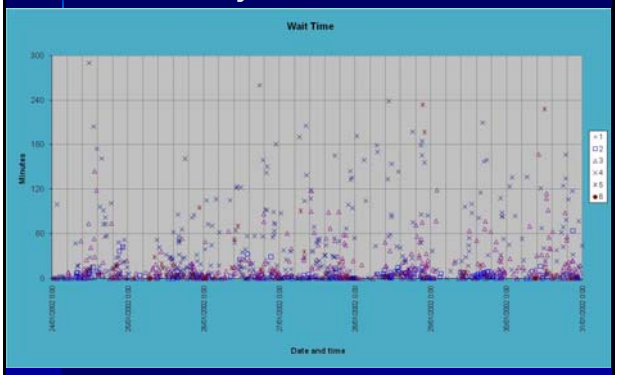
What's a long wait?

- 15 minutes?
- 30
- 60
- 120
- More?

Waits in reality



The dynamics of waits

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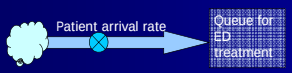

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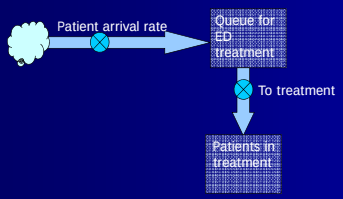

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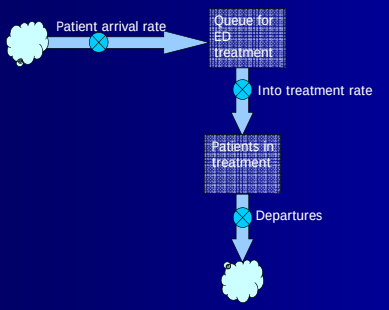
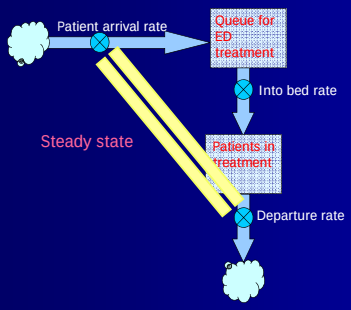
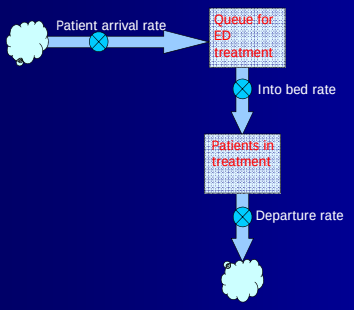


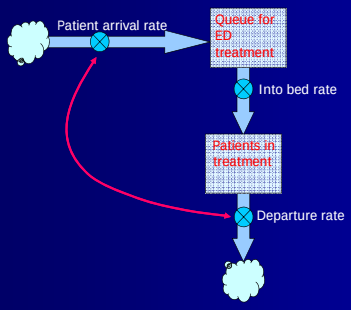
No Queues #1



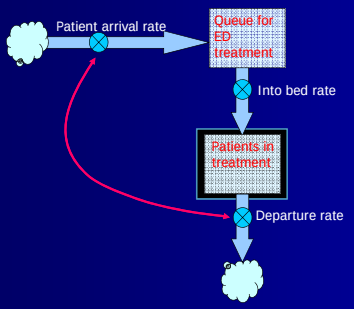
No Queues #2



The dynamics of waits

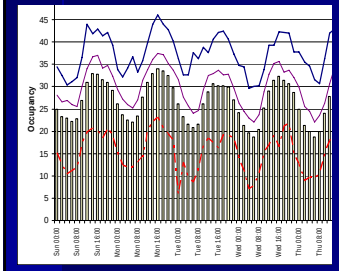


The dynamics of waits

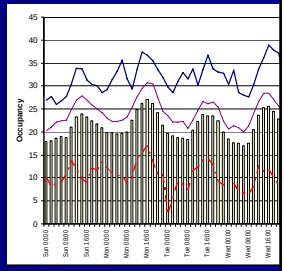


ED Blockage

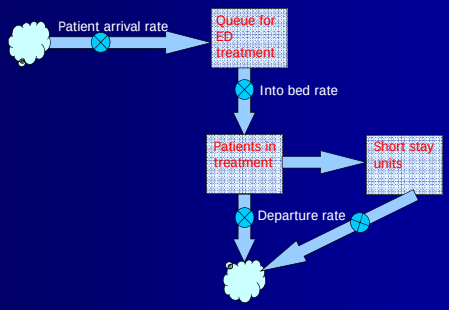
All ED



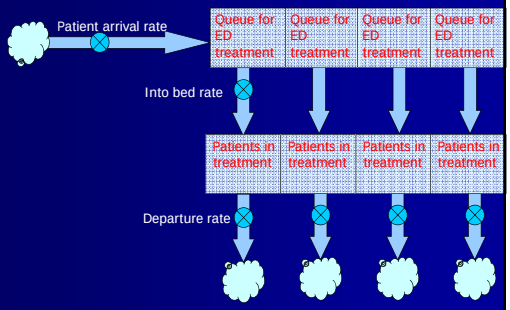
Admission



Initiative 1 to decrease waits



Initiative 2 to decrease waits

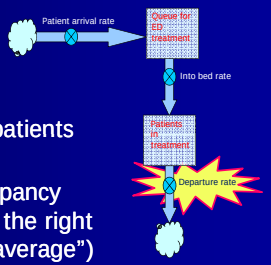


Other things to do to reduce waits

1. Get departure rate up
2. Work harder, faster, smarter
3. Lower the arrival rate (attack the demand)
4. Forecast when long waits are likely

1. Get departure rate up

- Tetris problem
  - Need to match patients to wards
  - So hospital occupancy has to be low in the right wards (not "on average")



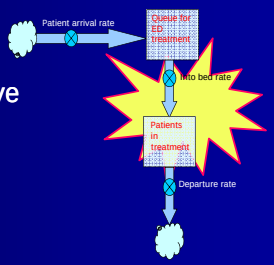
Patient ward destinations

Urg	Disp	Treatment	Typical symptoms
3	A	3	intake related vomiting, diarrhoea
3	A	1	general malaise
2	A	8	cardiac or respiratory
2	A	1	general malaise

Problem is not hospital capacity, but rather "Tetris" problem of matching hospital bed types to patient types

2. Work harder faster smarter

- Clinical imperative
- Unions
- Etc.

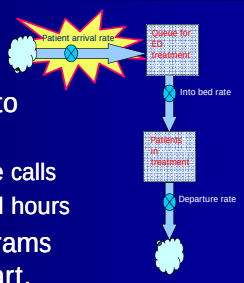


ED Workload by patient type

Urg.	Disp.	Treat	Time	Count	Weighted impact (TxN)
3	Admit	3	476	2003	
3	Admit	1	438	1828	
2	Admit	8	524	1816	
2	Admit	1	457	1252	

- Patient bed time AND number of (type of) patients is key NOT just length of stay

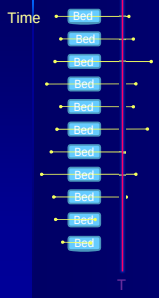
3. Lower the arrival rate



- Educate people to attend GP
  - But no GP house calls
  - GPs work limited hours
- Prevention programs (flu, obesity, heart, etc.)

State of ED

Almost all beds filled with long stay patients



- If new arrivals before T are not long stay, ED state is OK
- If new arrivals are long stay, ED state is blocked

Key Insight

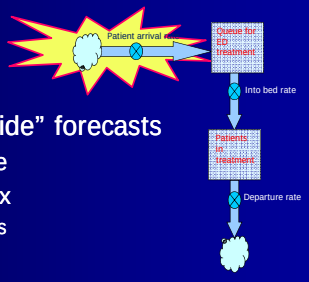
- Not arrival rate but mix of work that is arriving
  - (a generalisable principle*)

**Red's law for complex processes*

Abduction provides...

- Queues result from simultaneous arrival of patient types who will stay extended time in ED beds

4. Forecast



- "From outside" forecasts
  - arrival rate
  - patient mix
    - resources

Problems with “from outside” forecasts of arrival rate

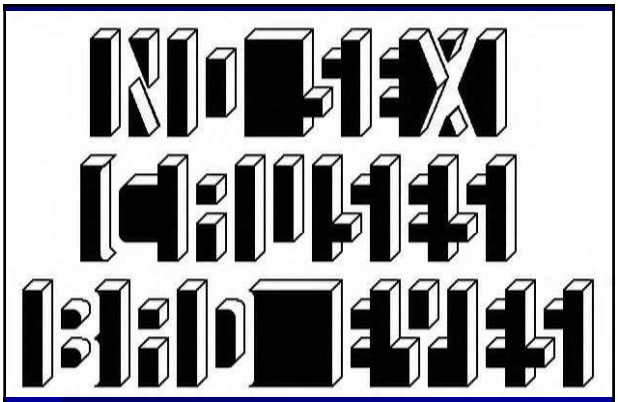
- Retrospective time series used for widely fluctuating factors
- Pertinent data not available, so “cheap” proxies used
- “On average” does not work for crises

How about forecasting “from the inside”?

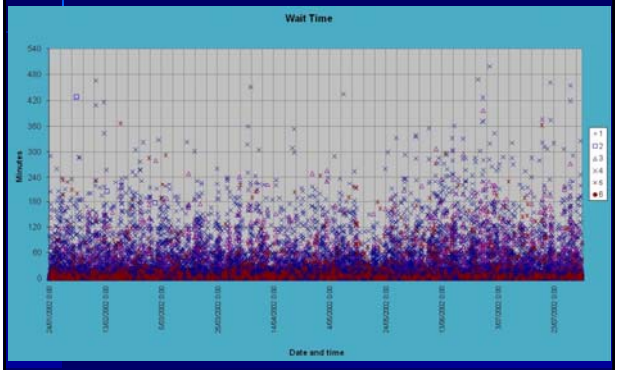
1. Use internal data to define ED state
2. Link change of state to what happens at the (known) boundary
3. Use the boundary condition to predict likely future state

- What did you see first?
- Fish or girl?
- Can you see both at once?

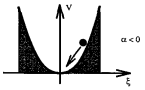
Phase Transitions
Complexity Theory
Synergistics



Phase transition in ED waits



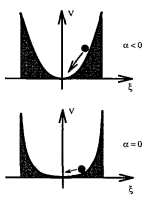
Single order parameter



- Stable position of order parameter (ball) is at bottom of valley

= order parameter

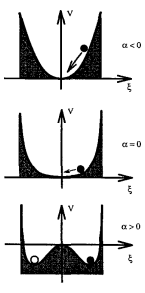
Single control parameter



- Control parameter increased, stable position becomes less defined

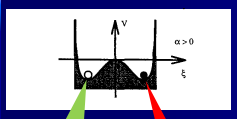
= Control parameter

Single order parameter



- At critical point
- two valleys
- uncertainty which state will result

ED order parameter



- ED control parameter at critical point
- which state will be the outcome?

ED: No wait

ED: Wait

The key is to identify the control variable(s)

Synergistics IN EDs

Micro level (Virus)

Synergistics IN EDs

Micro level (Virus)

Macro level (Sick Human)

Synergistics IN EDs

Micro level (Virus)

Self organisation

Macro level (Sick Human)

Synergistics IN EDs

Macro Macro level (ED queues)

Micro level (Virus)

Self organisation

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Synergistics IN EDs

Macro Macro level (ED queues)

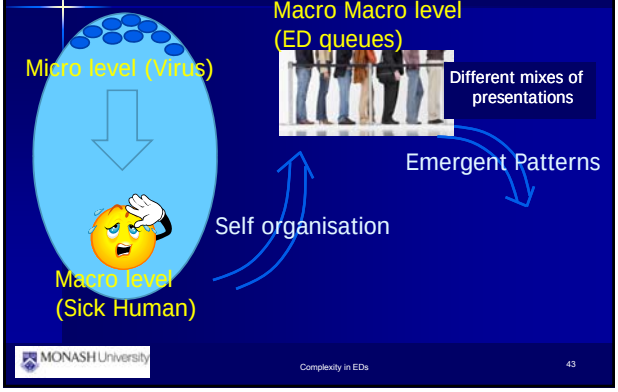
Micro level (Virus)

Different mixes of presentations

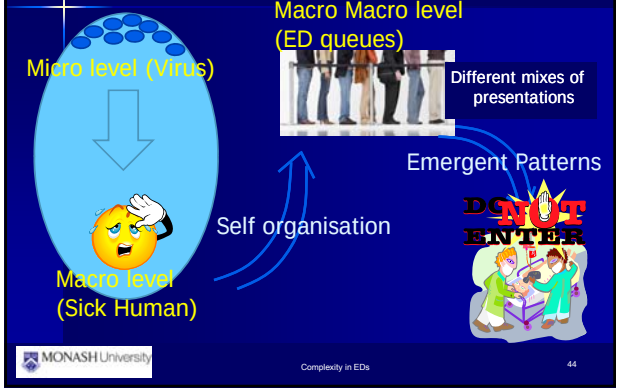
Self organisation

Macro level (Sick Human)

Synergistics IN EDs



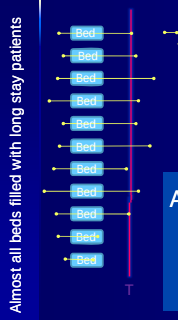
Synergistics IN EDs



Previous insight:

- Queues result from simultaneous arrival of patient types who will stay extended time in ED beds
  - There is a finite chance that particular combinations of patient types will arrive

State of ED



- If new arrivals before T are not long stay, ED state is OK
  - If new arrivals are long stay, ED state is blocked

At a critical time, the arrival of one more "long stay" patient may be critical to the order parameter

The ED Order Parameter

- The key is to determine at what point the order parameter is reaching its critical point

Where to now?

- Prediction of blockage from ED arrivals is futile
  - Blockage can occur at low arrival rates
- Blockage is inevitable, regardless of capacity
  - System becomes more resilient to shocks
- *Mix of patients in queue gives warning of impending blockage*

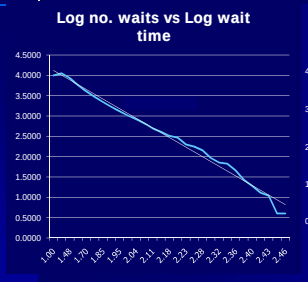
Where to now?

- *Mix of patients in queue gives warning of impending blockage*

Bringing it all together

- ED Patients are independent agents
  - They arrive whenever they want
  - There are emergent patterns to their arrivals (most arrive in the afternoon)
- They have a mix of ailments (and injuries)
  - Emergent mix determines whether the ED will become blocked
- Conclude: The self organising behaviour of patients generates ED blockage

"Proof" in Power laws



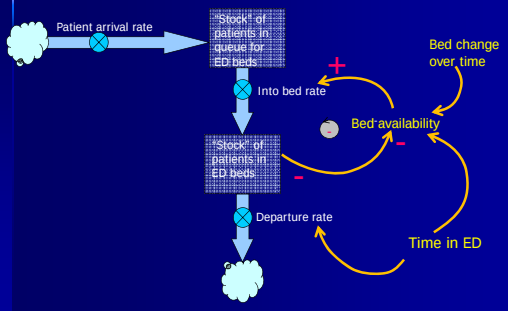
- Power laws => complexity theory

Comments?

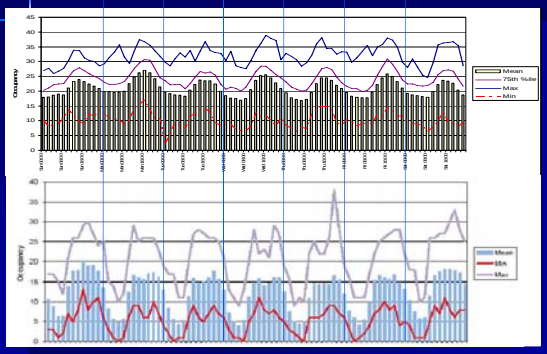
- Suggestions??

- Appendices

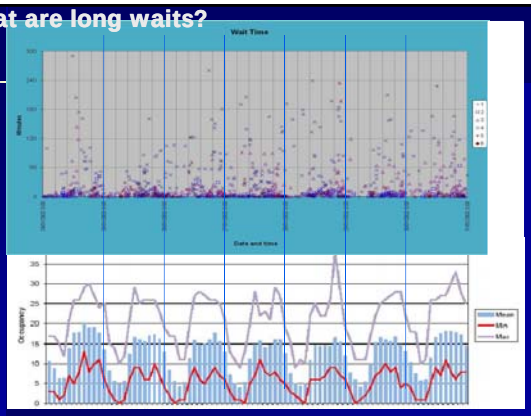
The dynamics of waits



Arrivals to admissions



What are long waits?



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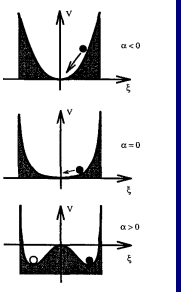

- Stable position of order parameter (ball) at bottom of valley
- Control parameter increased, stable position becomes less defined
- As control parameter reaches critical point two valleys form with uncertainty as to which will be the outcome
- The key is to identify the control variable