

Agency in complex social systems - from natural to social sciences

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UCL Global Business School for Health

Symposium on Complexity Science - Henrik's 70th - 15th May 2026

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Complexity science is transversal (and multiple)

Natural sciences

Com

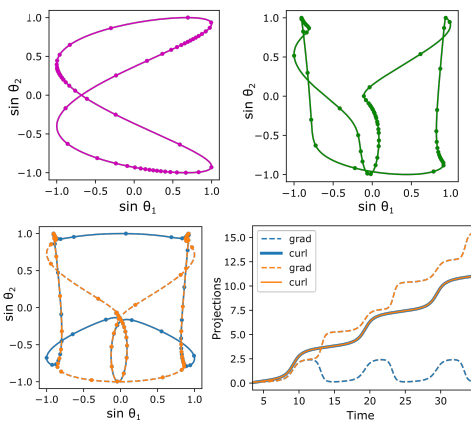
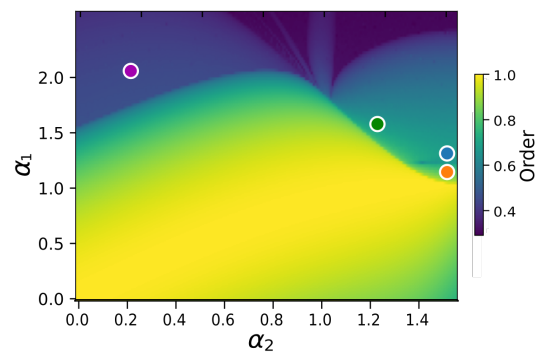
Mathematics Data sciences Neuroscience

sciences



Vasiliauskaite *et al.* Physica A

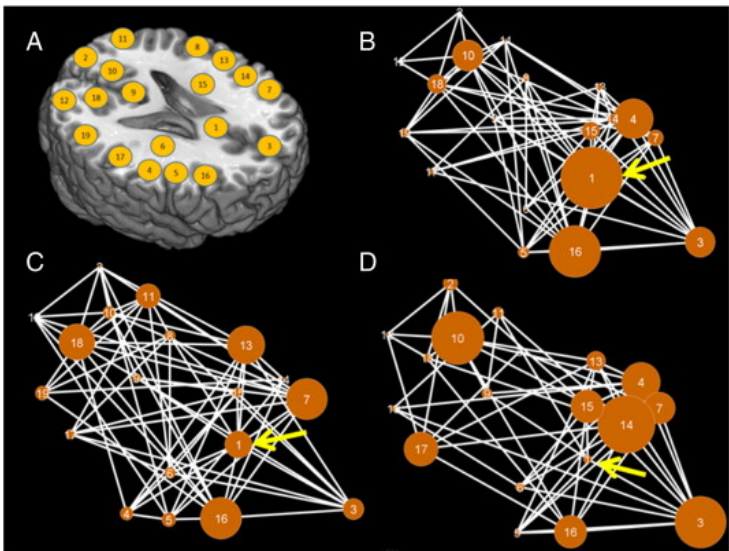
$$\dot{\theta}^{(k)} = -\alpha_k - B_{k-1} \sin \left(B_{k-1}^T \theta^{(k)} \right) - (B_k^T V_{k+1})^- \sin \left(V_{k+1} B_k \theta^{(k)} + \alpha_{k+1} \right)$$



Arnaudon *et al.* Nat. Com. Phys.
Nurissa *et el.* Arxiv, submitted to Chaos



Petri *et al.*, JRSIF

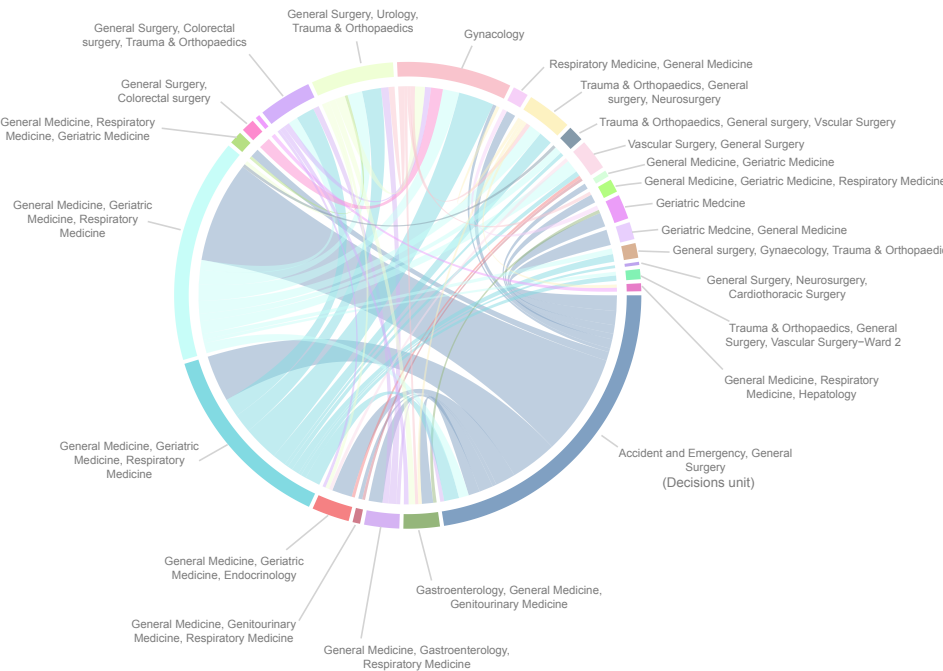


Lord, et al., NeuroImage



LIBERAL-ARTS MAJORS MAY BE ANNOYING SOMETIMES,
BUT THERE'S NOTHING MORE OBNOXIOUS THAN
A PHYSICIST FIRST ENCOUNTERING A NEW SUBJECT.

XKCD, 793
Li Pi, et al, Medarxiv



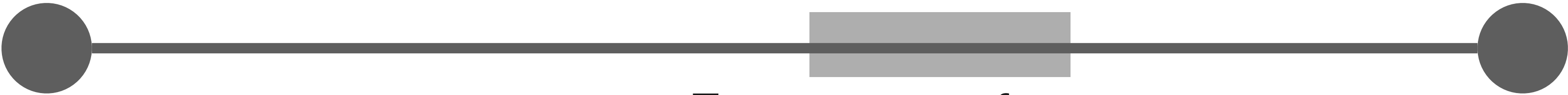
Mendelsohn et al., Sci Rep

Complexity science is transversal (and multiple)

a.k.a System thinking on the right hand side of the spectrum

Natural sciences

Computational social sciences



Emergence of agency

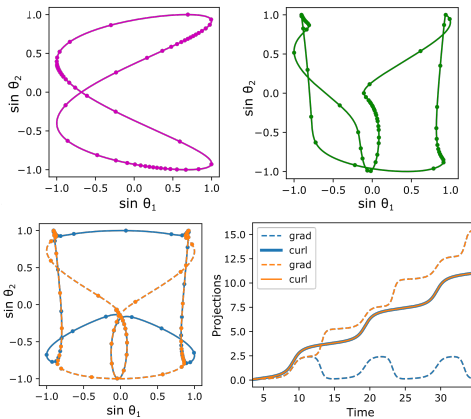
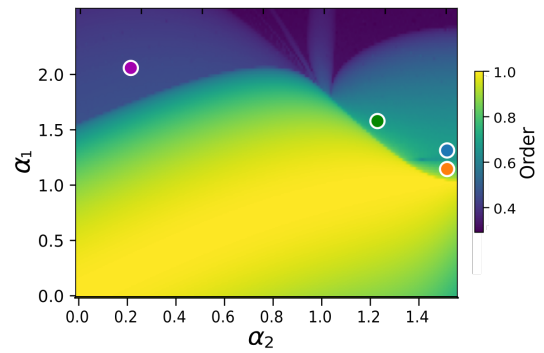
Mathematics Data sciences Neurosciences

Social sciences

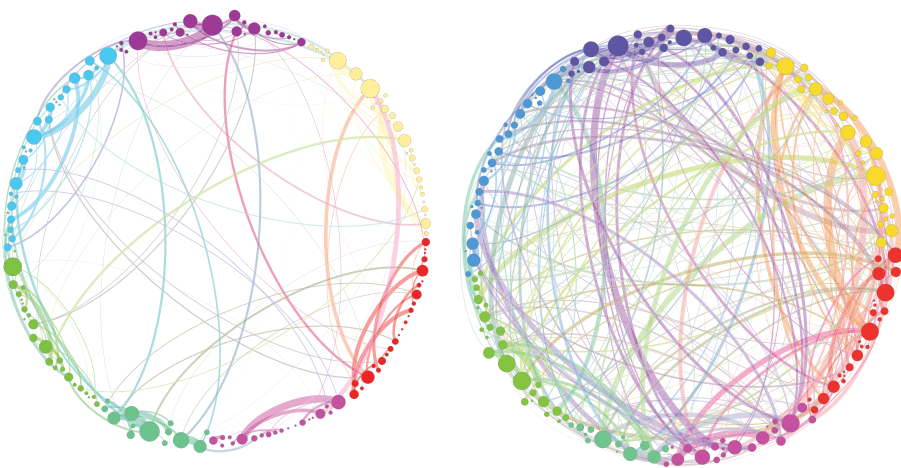


Vasiliauskaute *et al.* Physica A

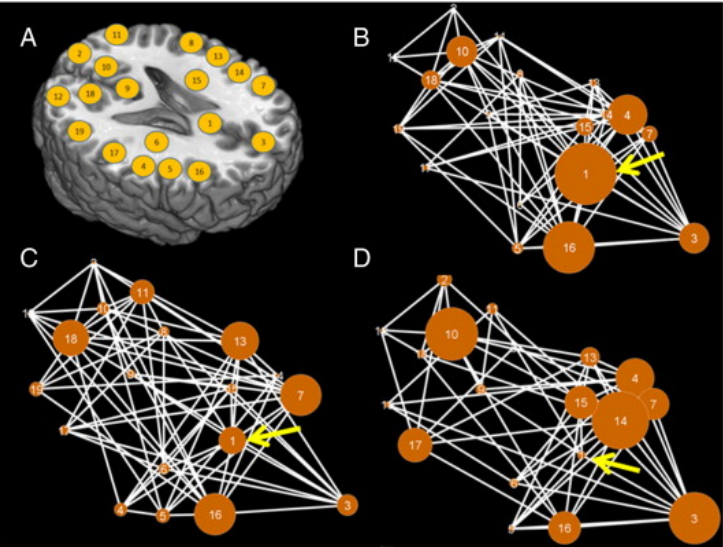
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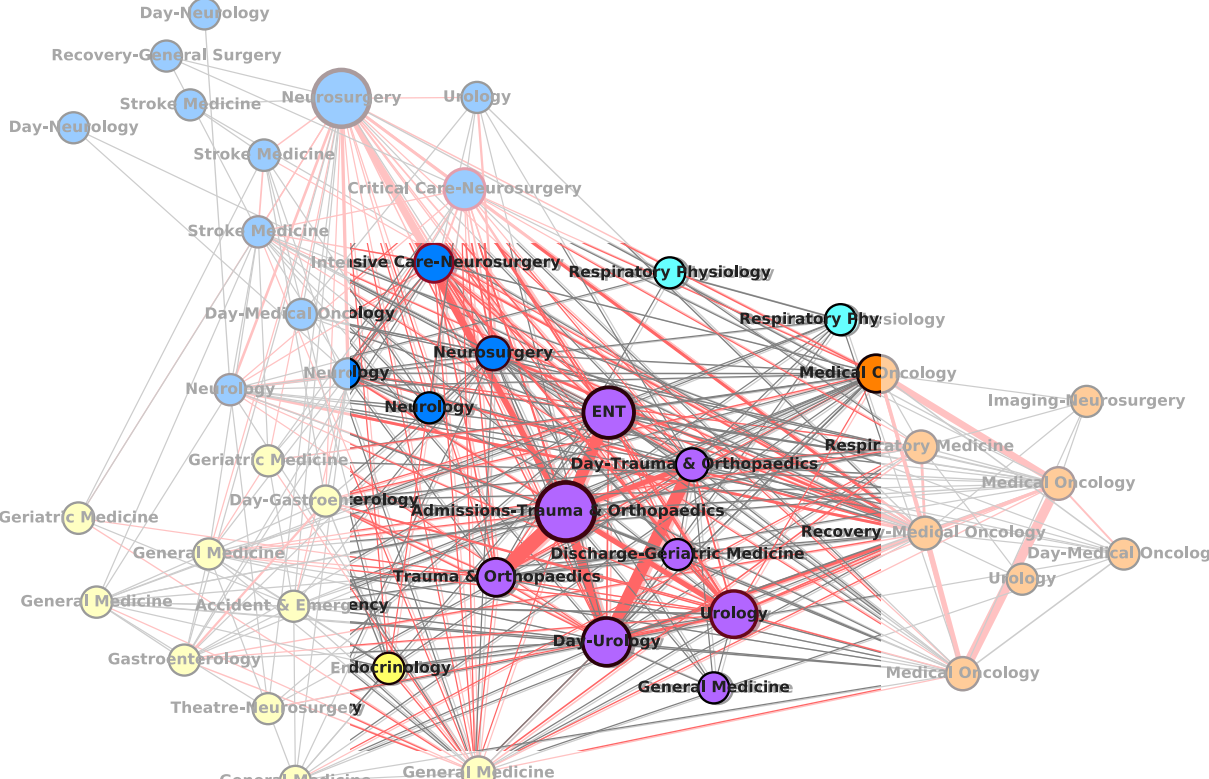
Arnaudon *et al.* Nat. Com. Phys.
Nurissa *et el.* Chaos



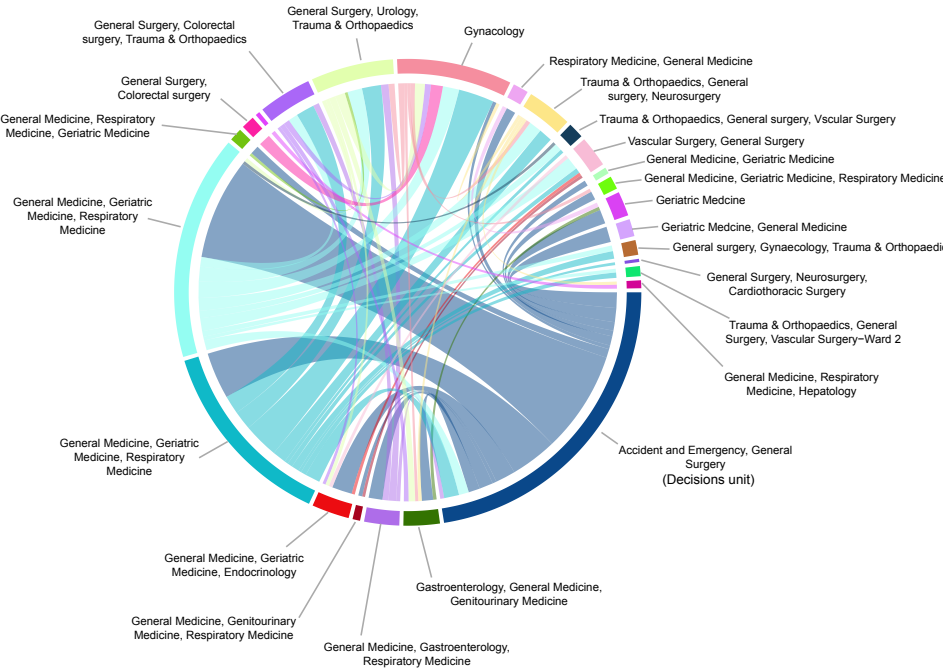
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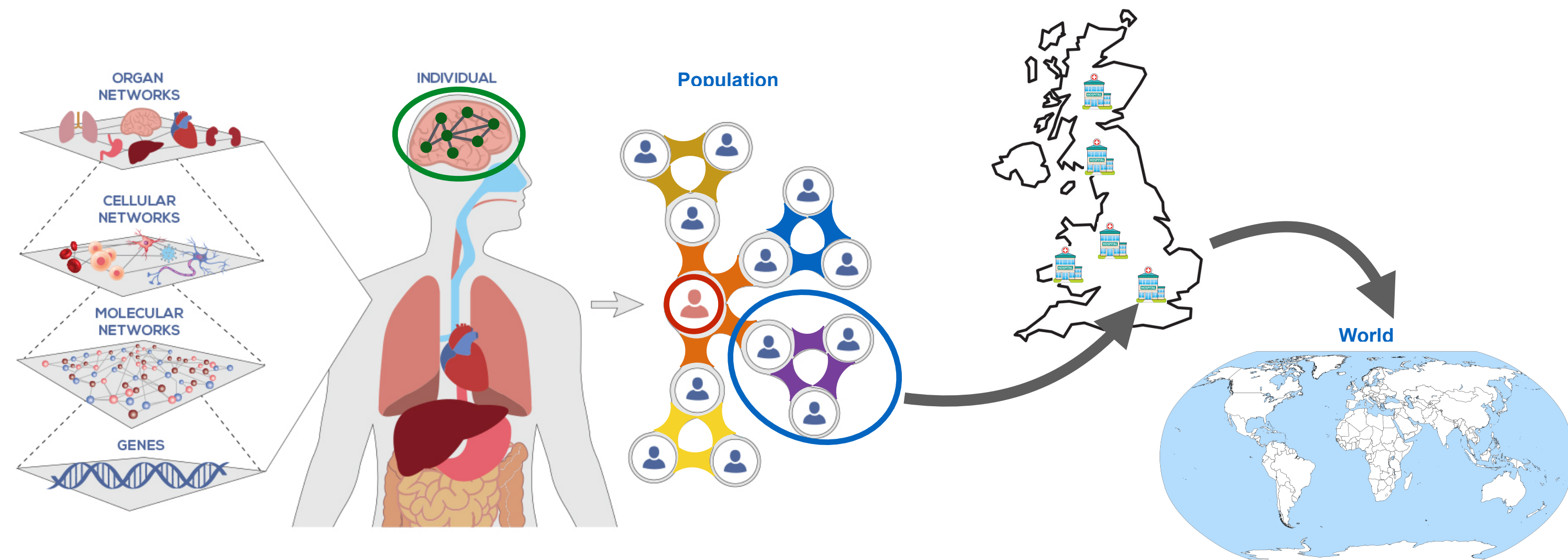


Mendelsohn et al., Sci Rep

Healthcare sub-systems are interconnected

Many sub-systems co-exist:

- Community and social care,
- Primary care,
- Secondary care,
- Mental health
- Diagnoses and treatments,
- Medication,
- Material procurement,
- Healthcare workforce,
- Drug development,
- ...



They all interact between and within themselves.

COMMENTARY

Healthcare’s earthquake: Lessons from complex adaptive systems to develop Covid-19-responsive measures and models

New metrics and forecasting models are key to understanding and anticipating the challenges of the Covid-19 pandemic.

Burton et al. BMC Medicine (2018) 16:138
<https://doi.org/10.1186/s12916-018-1132-5>

BMC Medicine

RESEARCH ARTICLE

Open Access

Do healthcare services behave as complex systems? Analysis of patterns of attendance and implications for service delivery

Christopher Burton^{1*}, Alison Elliott^{2,4}, Amanda Cochran² and Tom Love³

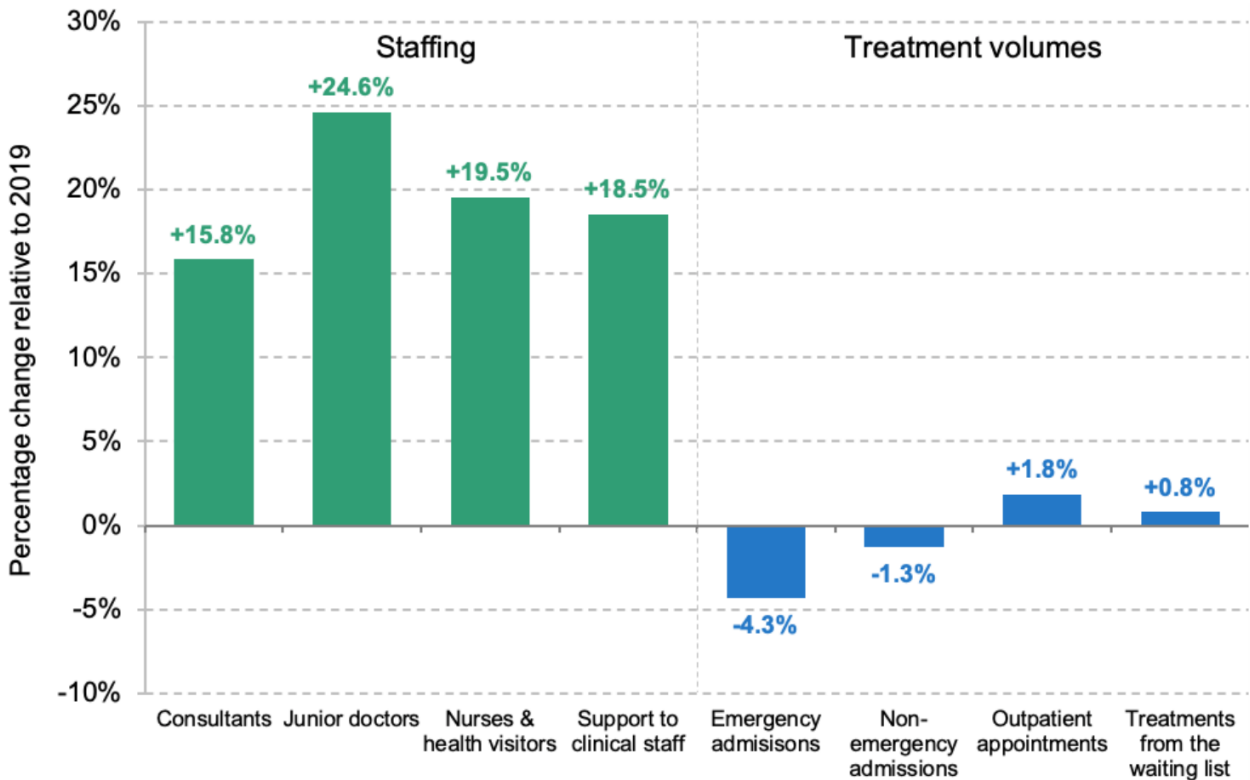


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The NHS productivity puzzle



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Understanding health care delivery as a complex system

Achieving best possible health outcomes for individuals and communities by focusing on interdependencies

Joachim Sturmberg¹ and Holly J. Lanham^{2,3}

¹Associate Professor, Departments of General Practice, Newcastle University-Newcastle, Newcastle, NSW, Australia

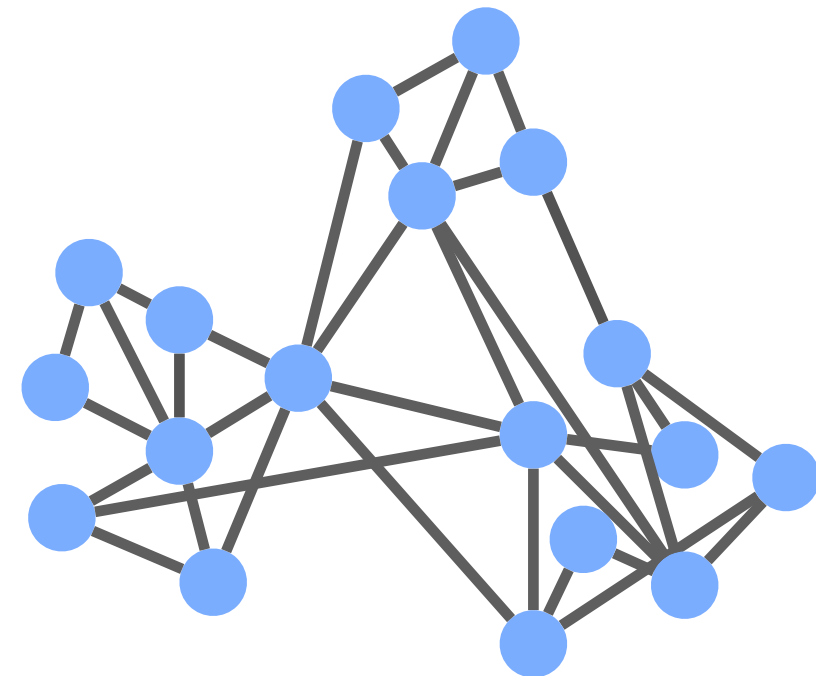
²Assistant Professor, Medicine and Family & Community Medicine, University of Texas Health Science Center at San Antonio, San Antonio, TX, USA

³Investigator, South Texas Veterans Health Care System, San Antonio, TX, USA

Networks in the health care context

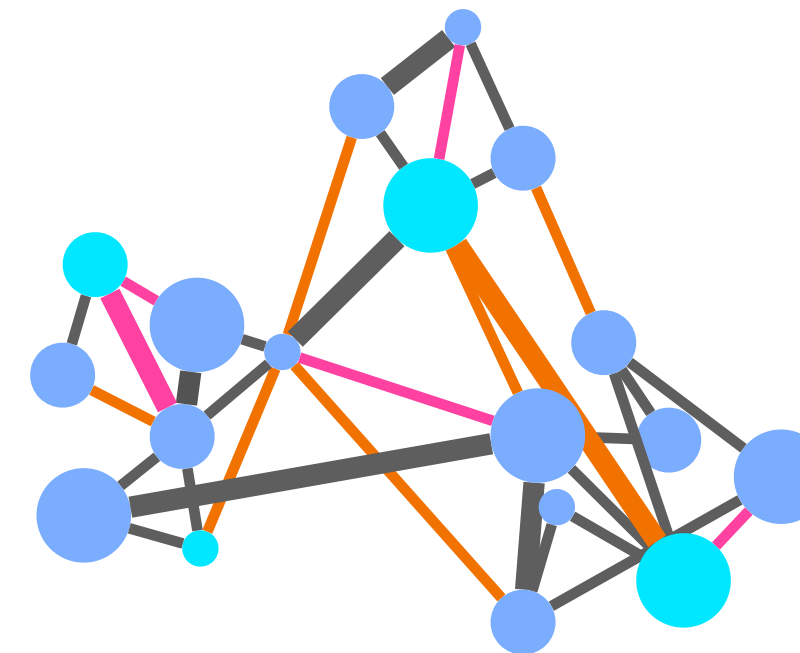
Nodes can be any type of entities:

- genes,
- patients,
- GP practices,
- hospital wards,
- hospitals,
- ...



Edges can be observed or deduced interactions:

- metabolic pathways,
- co-morbidities,
- antibiotics stewardship,
- patient movements,
- infections,
- ...



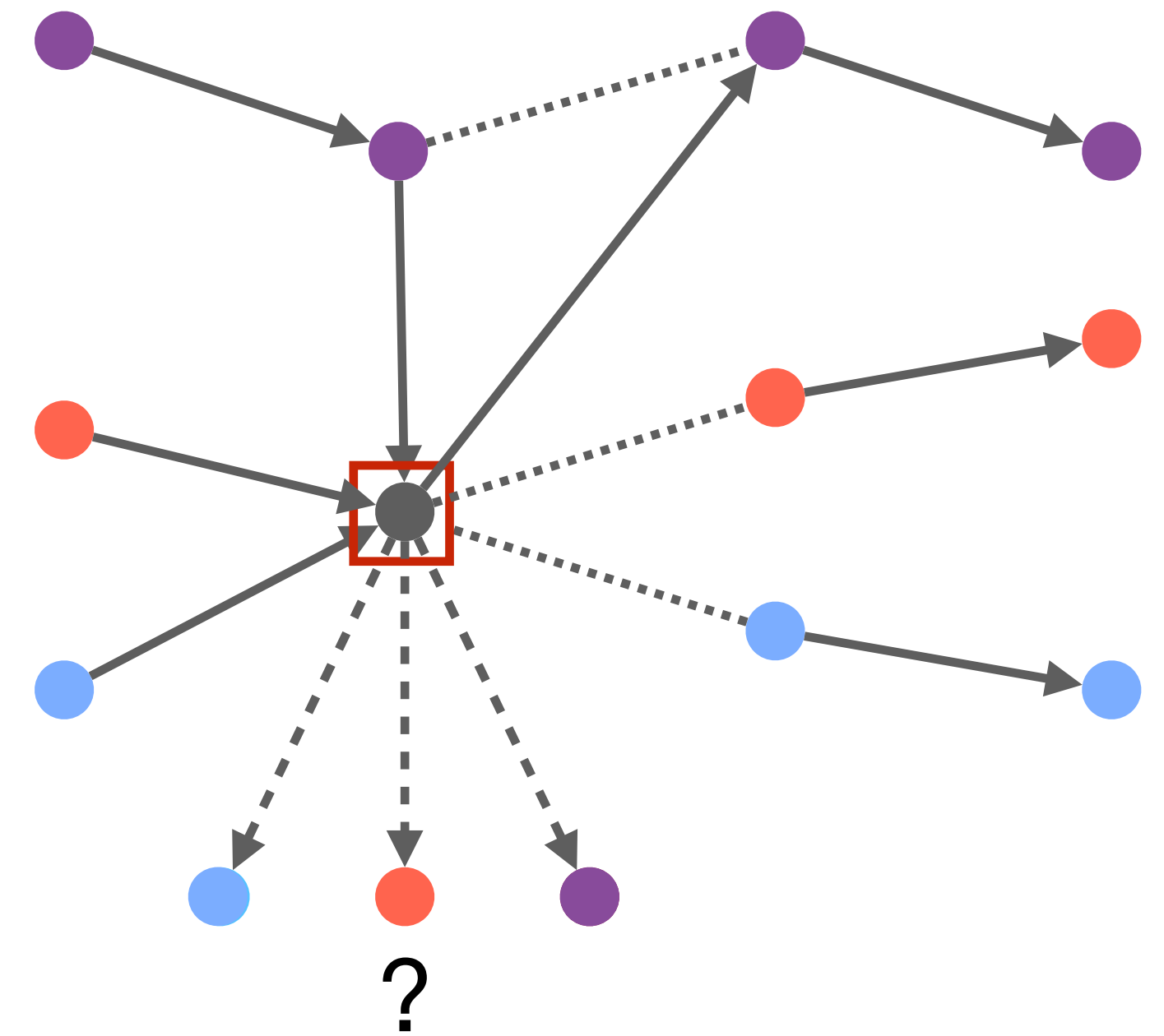
Meta-data can add layers of depth to the representation, e.g. patient types, medications, etc ...

Hospitals as complex systems - environment

Wards depend from a speciality.

Patients evolve in the hospital as an environment.

Different parts of the system and pathways interact.



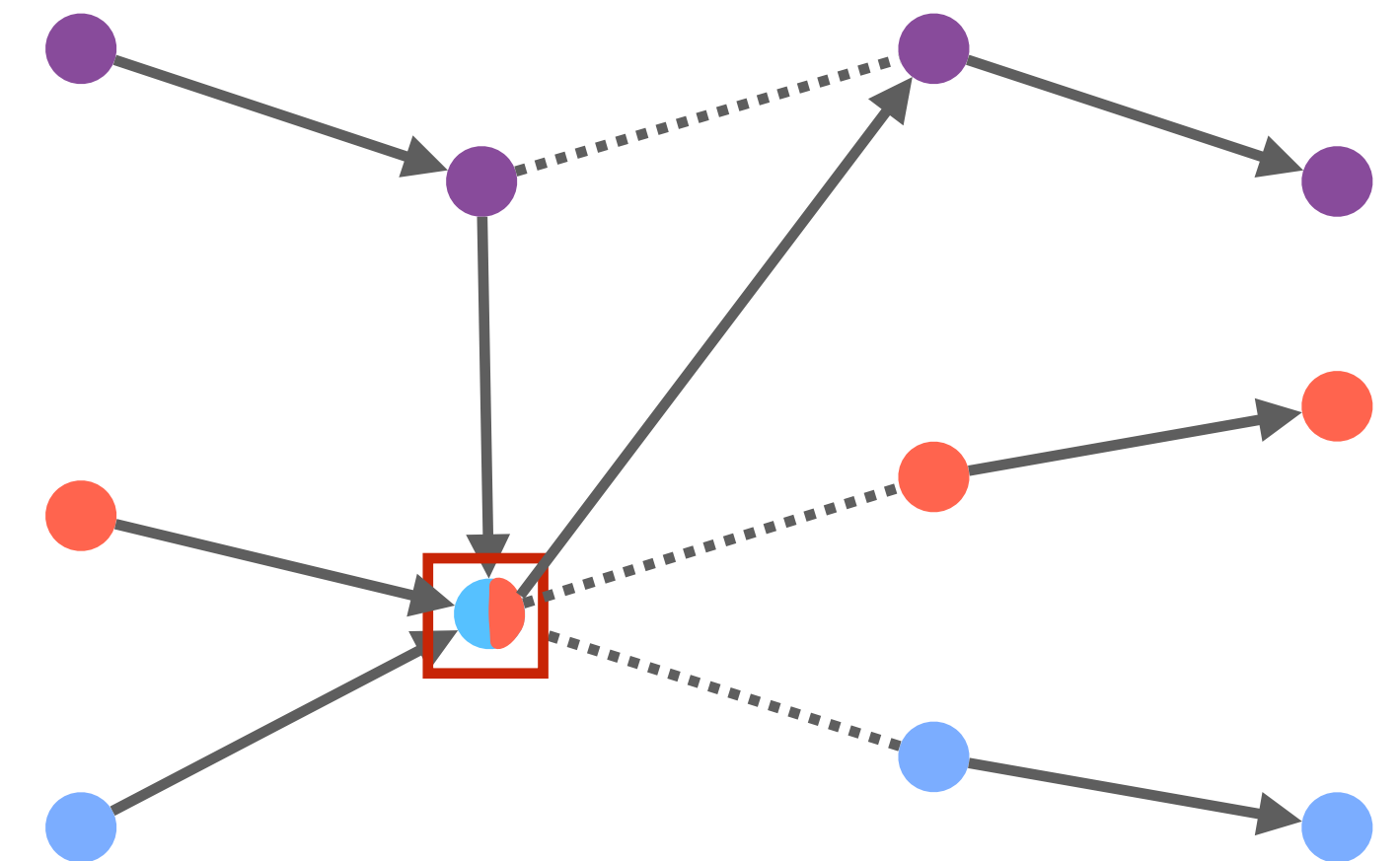
Hospitals as complex systems - environment

Wards depend from a speciality.

Hospital usage by patients determines their environment.

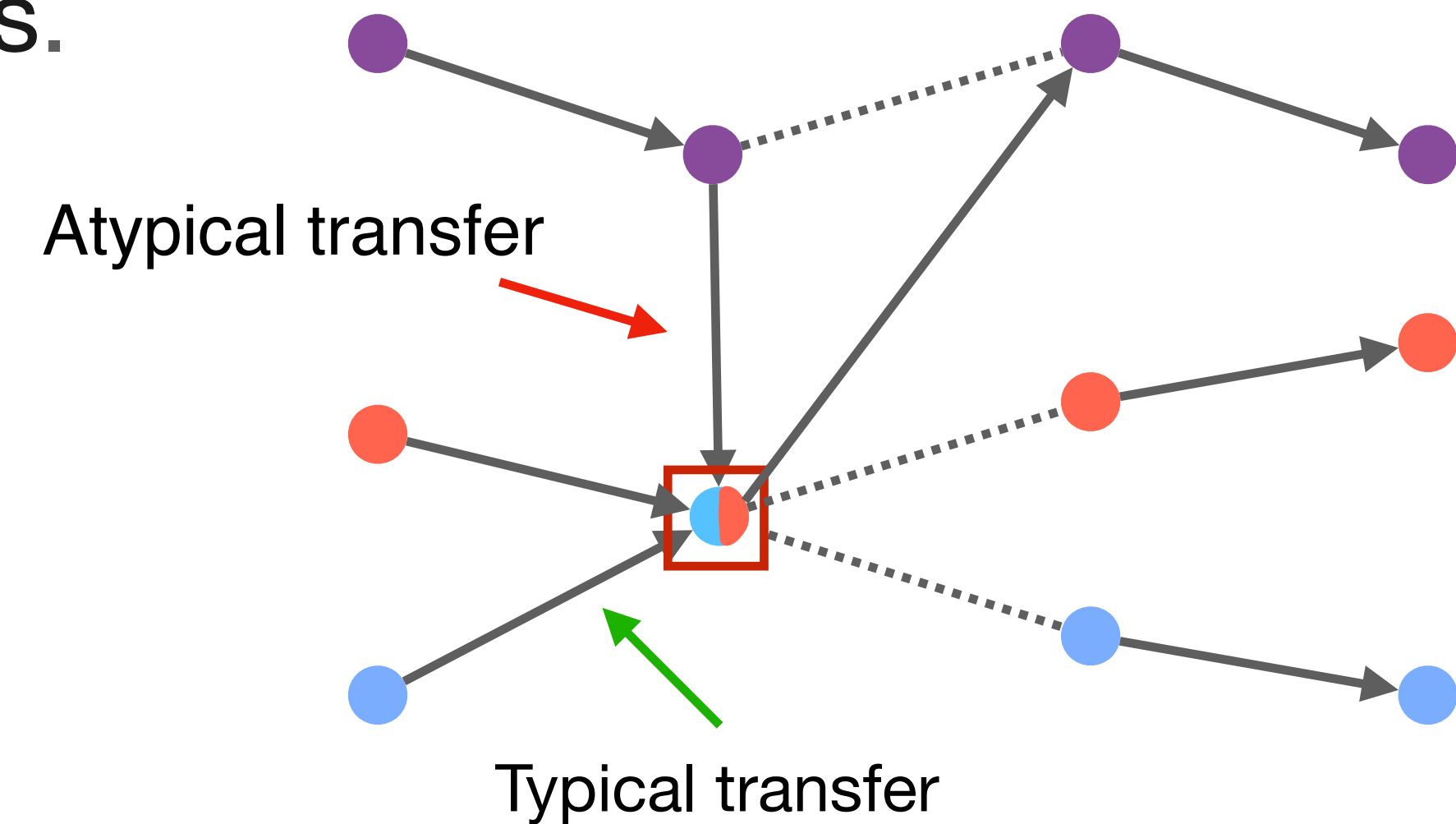
Patients evolve in the hospital as an environment.

Different parts of the system and pathways interact.



Outcome: Length of stay

A rare (12.9%) perturbation has significant consequences.



- 1 atypical transfer is associated with an increase of Length of Stay by 2.84 days (95%CI: 2.56,3.12)
- 1 regular transfer is associated with an increase of Length of Stay by 1.92 days (95%CI: 1.82,2.03)

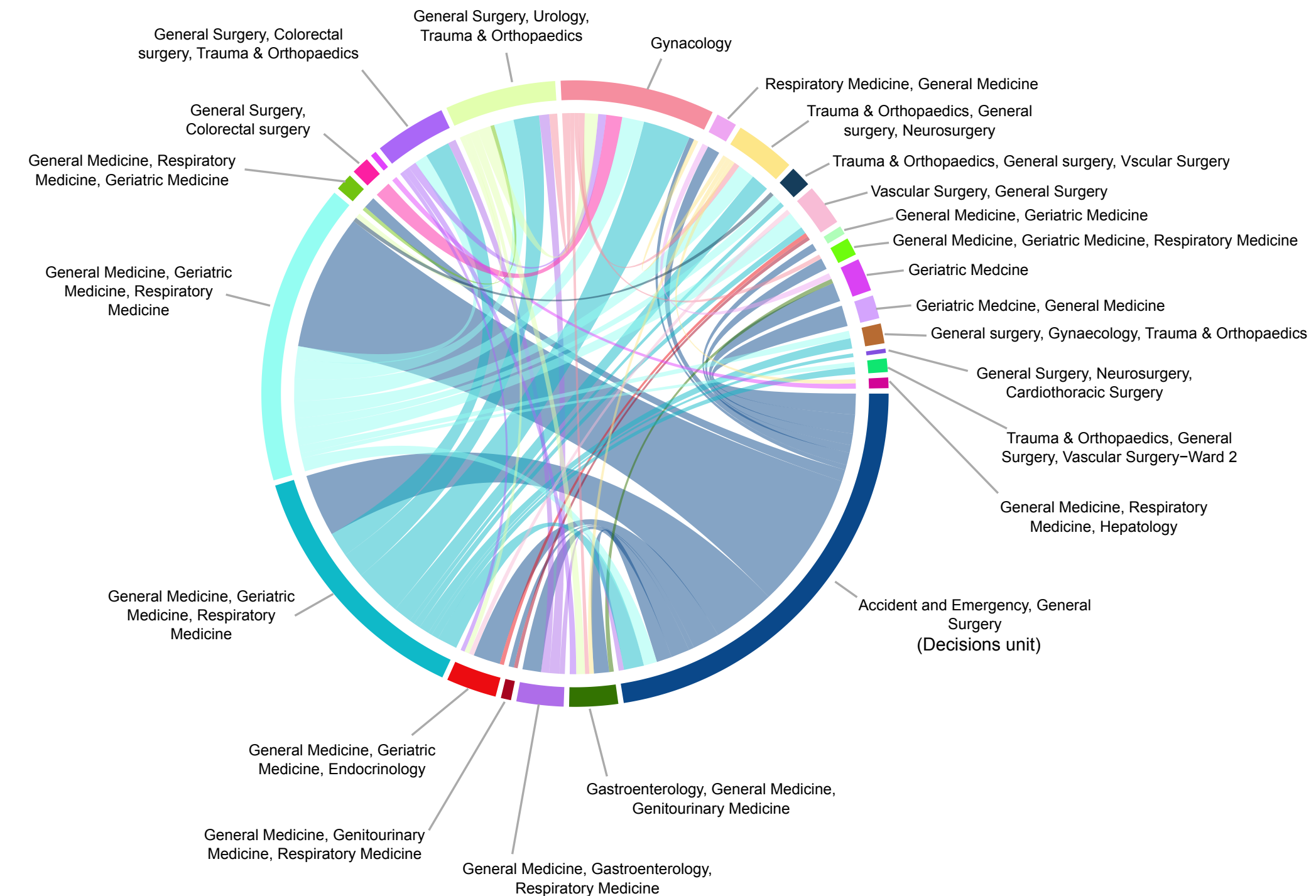
Hospitals as complex systems - feedback

Qualitative research

Reasons for transfer: unknown from data

New data source: those who generate the data

e.g. bed managers, clinicians, nurses



Reasons for atypical transfers

Qualitative research

- Gang members

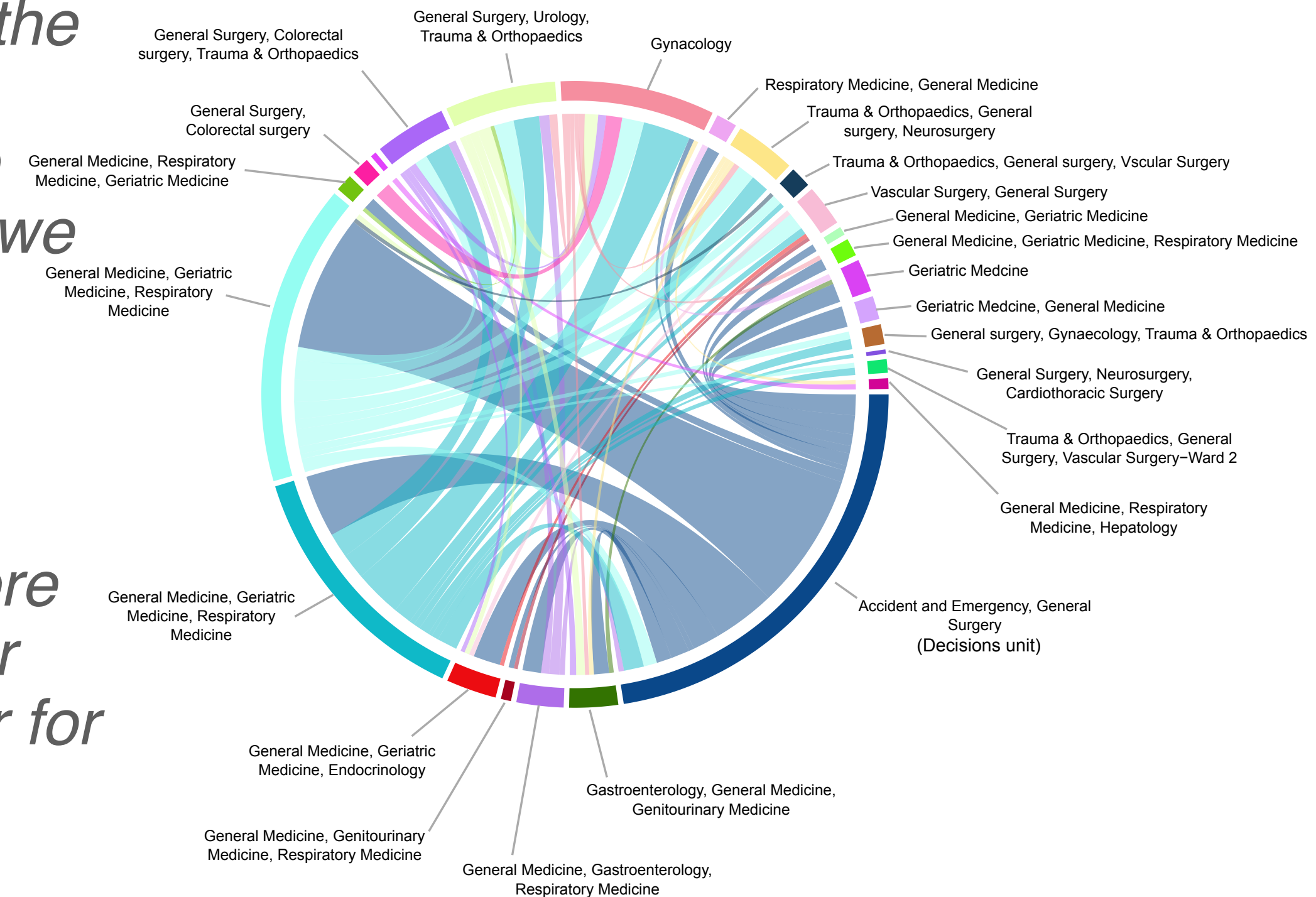
“Another transfer or move of patient...operational wise is the trauma patients that involves police escort and so it's basically not clinical but we move them to separate all the trauma patients, due to, I don't know, gang members. So we can't put them in one ward”

- Specialised equipment

“We don't have monitoring, cardiac monitoring facilities in most...wards there apart from Ward J and ITU, so therefore if they become unwell, if they're needing a cardiac monitor then... maybe to be fair, that would be an atypical transfer for them”

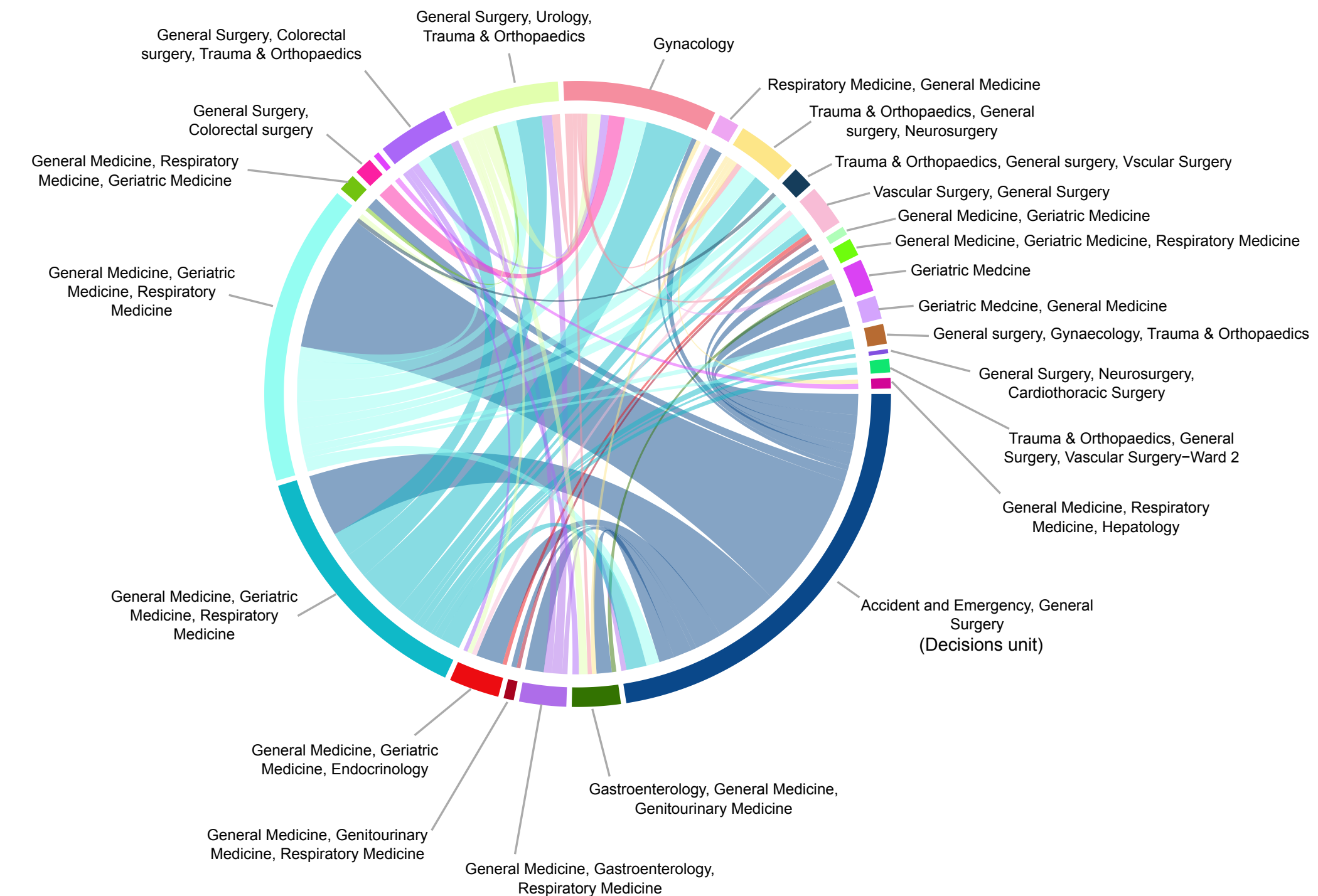
- Late night or weekend admissions

“Out of hours...for example, oncology, neurology, they don't admit patients. The patient is admitted under acute medicine and the speciality will take them over [the] next day”



Data+experiences >> data

- Atypical transfers are associated with a larger increase to LOS than normal transfers.
- They are rare but must understood.
- They are due to lack of bed space and multiple conditions.
- They must be minimised.
- **But**, they can also be beneficial.



Feedback

“I have trouble seeing how this can help us improve the quality and safety of care... from a health systems perspective, it is unclear what the results from the present study mean” – Reviewer for BMJ Quality and Safety journal

“It is a fascinating piece of work and considering the complexity it written in a really helpful and compelling way... I am going to give some more thought to the applicability of your findings to how we run things across the organisation and wider system” – Consultant Paediatrician and hospital director

Thank you for listening



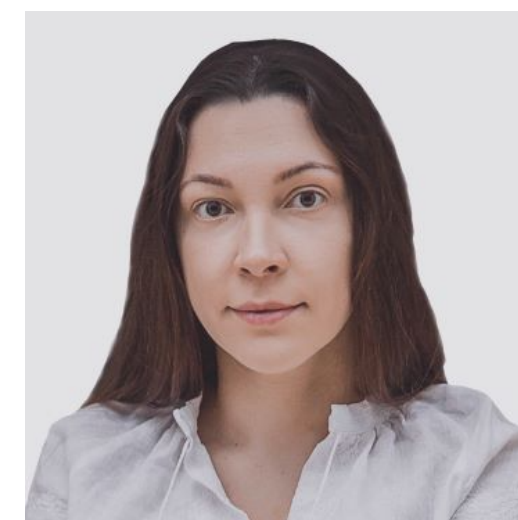
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