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The diffusion of knowledge and behaviours among trainee doctors in an acute medical unit and implications for quality improvement work. A mixed methods social network analysis.

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Title Page

Title: The diffusion of knowledge and behaviours among trainee doctors in an acute medical unit and implications for quality improvement work. A mixed methods social network analysis.

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Abstract

Objectives: The aim of this study is to analyse the social networks that transmit learning and influence relating to three domains of practice (clinical-technical knowledge, patient centred behaviour and and non-patient-facing practices) among trainee doctors acute medical teams, and describe the characteristics of highly influential individuals within those networks.

Design: Mixed methods: i) sociocentric survey consisting of questions about which colleagues are emulated or looked to for advice and ii) interviews regarding sources of influence and the reasons certain people are influential. The study took place over 24 months.
Setting: An acute medical admissions unit, which receives admissions from the emergency department and primary care, in a London teaching hospital.

Participants: Trainee medical doctors working in five consecutive rotational teams. Surveys – 39 trainee doctors; interviews – 20 participants from a maximal diversity sample.
Outcome measures: Social network maps and metrics were derived from surveys and interviews were done and analysed using a grounded theory approach.

Results: Memes in the three domains are transmitted in meaningfully different ways. Clinical-technical behaviours spread in a dense network with rich horizontal peer connections. Patient centred behaviours spread in a sparse network, with prominent vertically hierarchical flow. Approaches to non-patient facing work are seldom copied from colleagues. Influencers for clinical technical memes were identified. There were no individual high influencers for the other domains.

Conclusion: Those aspiring to improve healthcare practices could benefit from applying knowledge of patterns of spread and characteristics of influencers in different ways for different behavioural domains.

Article summary:

Strengths:

This paper is the first to map the social networks of learning and influence among professionals in an acute setting for three major domains of practice.

The findings could be used to tailor the way that change is introduced in acute teams according to domain, and the way that colleagues can behave to influence change.

Limitations:

The research was done in a single hospital, although several different consecutive teams were sampled. The findings may not reflect the situation in all acute units, which may have different local cultures.

The participants may not be aware of all the ways they are influenced, or may not be accustomed to reflecting on and describing their influencers.

3670 words

Introduction

Innovators and leaders who aspire to improve the quality of healthcare care need to influence the practice of multidisciplinary professionals in clinical microsystems. (1) This might be achieved by exploiting the potential for ideas to spread spontaneously between connected individuals. It is known that established links within groups allow behaviours and information to diffuse contagiously in a range of contexts, including the clinical workplace. (2–4) These patterns of connections are termed social networks. The first study of social networks among health professionals was published in 1957 and social network analysis has been applied in a broad range of healthcare settings. (5,6) Most research has described a single network structure, either by analysing the spread of only one category of information, usually the clinical-technical domain, or not differentiating different kinds of information. In a systematic review of studies of networks among health professionals, there were twenty three identified papers; only one of these reported on transfer of more than one kind of knowledge.(5) That study, performed in an emergency department, showed different network topographies for communication regarding medication information and regarding general work related problems. (7)

Healthcare is complex, and its delivery depends on the coming together of different categories, or domains, of behaviour and knowledge. We categorised these as: i) technical/clinical (how to act to produce best clinical results), ii) patient centred (how to create better patient experience), and iii) administrative work-organisation (how to prioritise and conduct non patient-facing work). These domains were intended to map to the elements of quality of healthcare provision that are identified for continuous improvement in the English Health and Social Care Act (2012): The prevention, diagnosis and treatment of illness (technical-clinical); the experience of patients (patient centeredness); effectiveness of the service (work organisation). (8) The aim of this study was to determine whether memes relating to different practice domains spread through different network structures in a team, whether some individuals were more influential in spreading

information in the three domains and what were the personal attributes of highly influential individuals.

We used electronic surveys to map networks, followed by qualitative interviews for more in depth exploration. We conducted this research in six consecutive teams of trainee doctors rotating though in a single 48 bed acute medical admission unit (AMU). This is a ward that provides initial assessment and treatment for emergency general medical patients arriving from the emergency department or directly from primary care in the community.(9,10) We selected this setting because the trainee doctors in AMU have frequent exposure to complex and unfamiliar clinical conditions, as well as challenging communication scenarios (such as breaking bad news, end of life decisions and explaining life changing diagnoses) and so have many opportunities to learn 'on the job' from colleagues. There is a high intensity of non-patient-facing tasks, such as arranging tests and completing documentation, which incentivises trainees to find efficient ways of organizing their daily work. At the same time the trainees have access to a relatively large team of colleagues of different grades on any single day, and are exposed to a broad range of individuals during their rotation within AMU, which is in contrast to the traditional hospital model of small and stable medical firms. This means AMU trainees have a greater than usual opportunity to choose who emulate or to approach for advice.

Ethical Approval

Ethical approval for this study was obtained from Hampshire-B REC; reference 15/SC/0052. All participants gave electronic or written informed consent.

Methods

Participants

Participants were trainee doctors working full time in a single acute admission unit in an NHS university teaching hospital. Teams of approximately 20 doctors, from Foundation year (first two years after qualification) to specialist trainee level (approximately 5-10 years after

qualification), rotate through the unit, the majority at four monthly intervals. The research was conducted in six consecutive teams. We used a mixed methods approach, with teams being invited to take part either in electronic surveys or interviews. All participants gave informed consent.

Interviewers

Two researchers conducted interviews. GS, research fellow, (female) had no prior contact with the teams; PS (male) was a consultant physician and had had some intermittent working contact with the participants. Both had previous experience of qualitative research at postgraduate level. There were no apparent differences between the findings from the interviews of the two researchers that would suggest bias introduced as a result of PS' previous contact and local role. Interviewers knew the results of the surveys that had been conducted previously, in particular, that a small proportion of team members had especially high numbers of connections. Beyond this, neither were aware of conscious preconceptions about the results, or the theories that would emerge.

Surveys

We invited all trainees in two consecutive AMU teams to complete an electronic survey (Qualtrics, Provo, UT) when they had been working together for at least three months. The survey included questions about who they had asked for advice, who they would choose to approach in future, and who have they emulated or been influenced by in the AMU team. The questions were repeated for each of the three domains, clinical-technical, patient-centeredness and organising-work. Explanation was provided with examples to illustrate the domains. The surveys used a sociocentric approach and each question was accompanied by a list of all current trainee doctors in the acute medical team, and multiple selections were possible. Team members were invited to complete electronic surveys at team meetings; those who were not present were approached individually. Teams completed 19 and 20 surveys respectively.

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Interviews

Participants were trainee doctors in the acute unit. They were selected as a diversity sample, to include representatives at different stages of training and from different training schemes, from four separate rotational teams over two years. These were not teams who had completed surveys. Interviews were done in a private room, with only the participant and researcher(s) present. Interviews were recorded and transcribed as the project progressed, and observation notes were made after interviews. Interviews lasted 30-45 minutes.

Method of approach: For surveys, participants were invited at the end of routine team meetings to take part and were given a URL that they could access. Explanation was given, and they were told they could choose not to take part. For interviews, subjects were approached on a 1:1 basis in the workplace when not busy and invited to do a 30 minute interview at a time that was convenient for them. Consent was recorded for surveys and interviews.

The interviews sought insight into the ways respondents were influenced in their behaviour in the three domains, and the perceptions of characteristics of those who influenced them. We explored both advice seeking and emulation.

Interviews began with explanation of the domains, with examples. Participants were asked about times they had been influenced, and why they felt certain people had influenced them. Participants were asked to think about interaction during their time on AMU and also in pervious jobs.

While there is existing literature that could be used to develop a theory regarding attributes of generic networks and of influencers in healthcare teams, there is no prior information that could be used to develop theory about the networks relating to individual information domains. We therefore used an inductive-deductive grounded theory approach, with theories emerging through the course of the research and developing theories were fed back in subsequent interviews for validation.(11) Theoretical analysis was done independently by two coders using

NVivo V11.4.1 software (QSR International Pty Ltd). Interviews continued until it appeared that theoretical saturation was achieved. Initial interview guides are appended.

Non-participation

All those invited agreed to take part, and there were no withdrawals.

Patient and public involvement

Patients/public were not involved in this work, which was conducted entirely with NHS staff as subjects. Staff participants were invited to submit contact details so that they can be sent details of the publication of this research.

Results:

Surveys

Both surveyed teams returned similar network topography maps. Metrics for the first and second teams' networks, respectively, were as follow: For the clinical technical domain, the average number of people each individual influenced (average degree) was 3.7 and 3.5, and the number of connections as a proportion of the maximum possible (density) was 0.3 and 0.2. Equivalent values for the patient centred domain were lower, 0.4 and 0.6 for average degree and 0.03 and 0.02 for density. Values for the communication of memes relating to non-patient facing work practice were 0.05 and 0.00 for average degree and 0.003 and 0.00 for density. Figures 1-3 shows the network graphs for the three domains for one team.

Interviews

We conducted 15 interviews and consider that theoretical saturation was achieved. Participants were representative of the mix of levels of seniority within the team of trainees: 5 Foundation year (HO, US intern equivalent), 7 CT 1-3 (SHO, resident equivalent), 3 ST 4-7 (registrar,

resident or fellow equivalent).

There was consensus among trainees that a significant proportion of their work practice was based on what they had learned from peers after qualifying from medical school, by observation or by seeking advice.

"You learn a lot of theory in med school but actually when you get here things are done differently and you learn by seeing what people more senior do." FY1

Domain 1: Technical-clinical; Diagnosing and treating.

Trainees stated they had largely learned from, and felt they would learn in the future from, only a subset of their peers. Major determinants of whether an individual had been or would be asked for advice or emulated by trainees, were i) their 'track record' of good practice, largely a record of visible successes, ii) conscientiousness and iii) approachability and kindness.

Approachability was described as the expectation of a positive experience for the trainee when asking for help, coupled with the amount of effort and explanation predicted to be provided. There was a strong sense that some seniors would be approachable, and some not, and this was based on knowledge of their past behaviours. The anticipation of approachability was based not only on the way an individual had responded on the past to requests for help and advice, but also on how kind they were in general - to patients and to members of other disciplines. There was also a halo effect. Many participants expressed that they valued kindness toward patients, and therefore held kinder colleagues in higher esteem, and were more likely to trust and copy their technical practices. Absolute consistency in exhibiting kindness was also important.

"Someone who's kind to patients and kind to everyone on the ward …… that's the kind of person I would copy." CT2

"I think, to be honest, the number one thing is kindness, yeh, kindness." CT1

"There's definitely more approachable people who are going to be very helpful and won't give you a hard time if you've forgotten things." CT1

Pre-existing relationships were important. Several interviewees mentioned 'friendship' and 'liking' someone as being a determinant of clinical influence.

Conversely, some people who are seen to be unapproachable, even if known as expert in a topic area, are unlikely to asked for advice. People who were observed to provide a less than ideal patient experience were less likely to be seen as having competent technical skills, whatever their formal credentials.

Individuals who were seen as committed to doing their job well were likely to be emulated.

"Some work hard at being good at their job, you'll walk in on them, like reading things on line just trying to keep on top of research and things, that kind of person I would be more inclined to copy." CT2

"There are certain doctors, I like the way they go about the profession, I feel I could learn a lot by acting like them." CT1

Characteristics of a clinical behaviour itself also determine if it will spread. A great deal of weight was placed on observable success. This might be a diagnostic success, a disease picked up by a test that could otherwise have been missed, or it could be a treatment, especially when a critically ill patient is seen to recover as a result. Higher level strategies, for example a diagnostic work up of a presentation, were widely seen as worth copying when they were comprehensive, or "thorough", meaning that several possible diagnoses were considered, rather than the most likely. Thoroughness was generally perceived as safe practice, casting a wide diagnostic net and

treating aggressively. When a colleague explained the logic behind a clinical approach, the trainees felt considerably more likely to incorporate it into their own practice.

Domain 2: Providing good patient experience.

All trainees expressed that they had never, and did not envisage that they would in future, ask for advice on how to interact with a patient. There was a feeling that this was a behaviour that should be determined by one's own personality and values.

When questioned about the ways that they could be influenced to behave differently toward patients, all trainees talked initially about communication skills. A consistent finding was that trainees regarded that learning occurred through their observation and selective acquisition of detailed approaches to communication: In particular, the detail of the way that conversations were worded and phrased. Trainees were anxious to improve the skills they could use in a number of 'set piece' communication situations, such as giving bad news and discussing end of life. They made conscious appraisals of the communication they observed, identifying good and bad practice, and deliberately copied snippets, to be used in their own practice in the future. They used what they regarded as bad communication as a lesson in what not to do.

We explored what they meant by good and bad communication. A commonly cited criterion for good communication was successful outcome. Examples of success included the patient appearing to understand what they were being told, evidenced by verbal or non-verbal signals. A number cited as an example of success a patient being convinced to change their mind and accept a treatment that the doctor felt they should receive.

In contrast to the clinical domain, personal characteristics of the person who was being observed was not perceived to impact on whether they would be copied.

"If I can see there's progress being made, personality is neither here or there, if goal has been achieved." FY2

Going beyond learning about phrasing, we explored the influencing of values and attitudes Many of the participants stated that they tended to select role models who had similar values to their own. Trainees resonated with the idea that this introduced a degree of circularity, with the role model used to reinforce but not challenge existing beliefs/behaviors.

This led to exploration of: where do these underlying values come from in the first place? Trainees generally felt that the values that drive the way they interact with patients came from outside the profession and pre-dated entry to medical school. Parental influence was mentioned most often; trainees felt they carried the beliefs and behaviors that their parents displayed. Other cited sources were school, social groups, personal development in response to exposure to life in general and, in only one case, religious belief. None of their respondents cited specific ethical or philosophical beliefs.

Some motivators for patient centered behavior that were volunteered were egocentric rather than truly compassionate, even though they led to seemingly altruistic actions: some wanted predominantly to be seen as being kind, or to be respected by people who were similar to themselves; other referred to the professional satisfaction of using good communication skills, or the joy of feeling that one has gone an extra mile for a patient. No respondents referred to a desire to improve the emotional state of the patient.

Trainees were able to describe instances when they had been influenced to behave with kindness after observing others. They particularly noticed small discretionary acts, examples given included such as making tea for a patient, responding to a patient who is calling out for attention, and making an effort to contact a patient's relatives. Several felt that they had behaved differently after seeing somebody else put themselves out to provide good patient experience.

Some trainees discussed the way that observing negative patient centered behaviors could affect them, and felt their behavior was adversely affected when the majority of a team were behaving in a non patient-centred way. However, they felt that they were more strongly influenced by seeing what they felt was good patient centered care, than bad. When local culture was contrary to good care, they could be inspired for the good by the leadership of a single individual.

"If someone said "hang on a minute let's think about what more we can do for the patient", I think definitely I'd stop and take a moment and think 'is there more we can do'" FY1

Domain 3: organization of work

Trainees generally agreed that there were no personal characteristics that made an individual influential in terms of ways of organizing work.

There was a sense of willingness to organize work differently if asked to do so but only by people who worked in the same clinical context and knew about how things worked. There was resistance to adapting practice in response to requests from people seen as outsiders, particularly managers.

…if its someone doing a similar job to you, I'd be inclined to try it, but if it was someone not from this environment, someone in a suit, someone who doesn't do a job like this, my reaction to that would be "actually you don't understand how busy this job is". FY2

There was a widespread sense that trainees could not make a difference to care by the way they organized their work because the system is so inflexible it tends to negate benefits of improving working practices.

Discussion:

Previous research has shown that social networks are key factors for developing practice among trainee doctors. Information from peers can be as important for their learning as advice from consultants, and social network position can be a more powerful predictor of behaviour than formal training. (13,14) Knowledge about the function of networks among trainees offers important intelligence for those who aim to improve the quality of care within frontline clinical

microsystems. Most existing studies of health professionals have mapped generic social networks. In the teams of medical trainees that we investigated, we found that there were different network structures channeling memes relating to different domains of practice. This is the first study to our knowledge that has investigated how information and influence in the three different domains of clinical-technical, patient centeredness and organization of work spread through networks in groups of doctors.

We found that clinical-technical knowledge flowed through dense networks with rich horizontal connections. This configuration can support efficient and spontaneous diffusion of innovations after introduction via a limited number of individuals. In contrast, the network conducting memes relating to patient-centeredness and patient experience was sparse, and where there was person to person transmission, it tended to be among isolated pairs of individuals with very few ongoing chains. Diffusion is likely to be limited and initiatives to improve behaviors in this domain might better be aimed at directly influencing most or all team members. Ways of organizing work were apparently hardly influenced at all by others, which is important information, as quality improvement initiatives frequently target the detail of working routines and practices. If this pattern is typical, then non patient facing practices cannot be relied upon to spread spontaneously.

Interviews provided triangulation for the survey finding of the existence of high clinical-technical influencers. Attributes of clinical-technical influencers included absolutely consistent kindness, and signs of conscientiousness. Trainees were more likely to emulate technical practices of individuals who explained the underlying logic clearly. An interesting finding was that trainees appraised clinical management on the basis of visible diagnostic or therapeutic success. This is important since many diagnostic strategies deliberately aim for low yields, and many treatments have a high 'number needed to treat': Therefore many correct management approaches have visible success only on rare occasions. This makes explanation of underlying logic all the more important in teaching.

In relation to the spread of patient centeredness, trainees did not identify highly influential individuals, and it was actions themselves were seen as more or less worthy of emulation.

Compassion, a concern for the impact of behaviors on the patients internal state was not volunteered as a driver. Instead, communication interactions were judged on the basis of 'getting the job done', for example, getting a message over accurately or getting the patient to agree with the doctor on a decision. The failure to talk about concern for the patient's emotions may be an artefact of the kind of language used in professional lifr and may not reflect an absence of compassion. However, the findings point to a need for leaders to be explicit about behaving to improve patient experience and to demonstrate and teach shared decision making. An interesting finding was that trainees described that they looked to people they felt to be similar to themselves as their role models. Doctors felt they carried their own values from outside their professional life, and looked for validation, rather than looking to adopt new sets of values. If true, this has impactions for those hoping to inculcate values among trainees.

Many of these findings are in keeping with existing literature. The presence of high influencers in healthcare teams is established. In keeping with our own results, the personality characteristics associated with this network influencing roles have been shown to include contentiousness and agreeableness.(15,16) The importance of perception of the utility of a practice, which we found to be key for adoption of ways of organizing work, is recognized in normalization process theory.(17)

We have added an extra dimension to existing knowledge of healthcare professional networks by differentiating and describing social networks that spread different kinds of work related information and influence in medical teams. This information can help change agents to adapt training and communication strategies according to the domain of practice being targeted. Our findings also provide insight into how an individual might adapt their own behavior so as to exert more influence.

This work has a number of limitations. It was conducted in a single center, and may not be representative of all acute settings, although in mitigation, six different consecutive clinical teams were included over a period of 2 years. We limited the research to trainee doctors, and did not include other professions; previous work has described the importance of networks that span professional groups and it would be interesting to go on to perform more inclusive studies. The

categorization of memes into three domains is pragmatic and certainly over simplistic, and there are many more subtle aspects that could have been explored.

Conclusion: The social networks of influence and knowledge transfer among trainee doctors in an acute setting conform to quite different patterns when considering the spread of innovations in three domains, technical clinical, patient centered and self-organization. The attributes of strongly influential individuals and the characteristics of the interventions themselves that impact diffusion also differ for the different domains. Knowing how these coexisting networks are configured and driven is likely to be useful for those leading quality improvement work that requires on the uptake of innovative behaviors across a clinical microsystem.

 DISCLAIMER:

Data sharing statement: Data is not publicly available because a condition consent was that all interview and survey data would be destroyed after analysis.

Figure Legends:

Figure 1: Network graph showing directed connections that conduct clinical-technical knowledge and influence. Square = CT4-7 grades (registrar), Circles = CT 1-3 (SHO), Diamonds = FY 1-2 (house officer).

Figure 2: Graph for network relating to the patient centred behaviours.

Figure 3: Graph for network relating to the non patient-facing practices.

References

1.   Nelson EC, Godfrey MM, Batalden PB, Berry SA, Bothe AE, McKinley KE, et al. Clinical microsystems, part 1. The building blocks of health systems. Jt Comm J Qual Patient Saf Jt Comm Resour. 2008;34:367–78.

2.   Christakis N, Fowler JH. Social contagion theory: examining dynamic social networks and human behavior. Stat Med. 2013 Feb;32:556–77.

3.   Wagter JM, van de Bunt G, Honing M, Eckenhausen M, Scherpbier A. Informal interprofessional learning: Visualizing the clinical workplace. J Interprof Care. 2012;26:173–82.

4.   Rogers E. Diffusion of Innovations. New York: Free Press; 1983.

5.   Chambers D, Wilson P, Thompson C, Harden M. Social network analysis in healthcare settings: A systematic scoping review. PLoS ONE [Internet]. 2012 [cited 2018 Apr 7];7. Available from: http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0041911

6.   Coleman J KE MH. The diffusion of an innovation among physicians. Sociometry. Stud Fam Plann. 1957;20(4):253–70.

7.   Creswick N, Westbrook JI, Braithwaite J. Understanding communication networks in the emergency department. BMC Health Serv Res. 2009;9:1–9.

8.   Elizabeth II. Health and Social Care Act. 2012.

9.   Acute Medicine Taskforce. Acute medical care [Internet]. 2007 [cited 2018 Apr 7]. Report No.: 9781860163210. Available from:
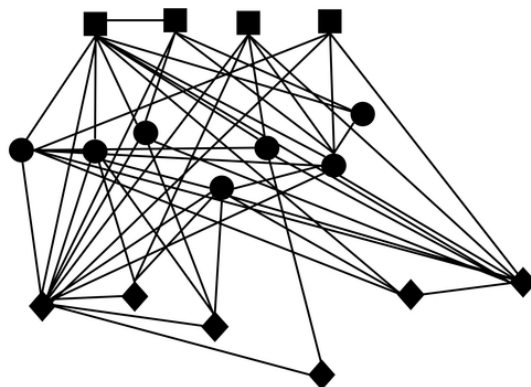
https://www.rcplondon.ac.uk/sites/default/files/documents/acute_medical_care_final_for_web.pdf

10. Bell D, Skene H, Jones M, Vaughan L. A guide to the acute medical unit. Br J Hosp Med Lond Engl 2005. 2008;69:107–9.

11. Heath H, Cowley S. Developing a grounded theory approach: a comparison of Glaser and Strauss. Int J Nurs Stud. 2004;41:141–50.

12. Cornelissen T, Dustmann C, Schönberg U. Peer Effects in the Workplace Peer Effects in the Workplace. 2013;(7617).

13. Jippes E, Achterkamp MC, Brand PLP, Kiewiet DJ, Pols J, van Engelen JML, et al. Disseminating educational innovations in health care practice: training versus social networks. Soc Sci Med. 2010;70:1509–17.

14. Shokoohi M, Nedjat S, Majdzadeh R. A social network analysis on clinical education of diabetic foot. J Diabetes Metab Disord. 2013;12:44–44.

15. Battistoni E, Fronzetti Colladon A. Personality correlates of key roles in informal advice networks. Learn Individ Differ. 2014;34:63–9.

16. Fong A, Clark L, Cheng T, Franklin E, Fernandez N, Ratwani R, et al. Identifying influential individuals on intensive care units: using cluster analysis to explore culture. J Nurs Manag. 2017;25:384–91.

17. Murray E, Treweek S, Pope C, Macfarlane A, Finch T, C. O, et al. Normalisation process theory: A framework for developing, evaluating and implementing complex interventions. BMC Med. 2010;8:2–11.

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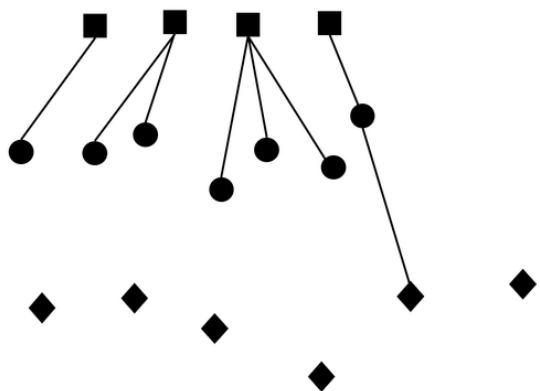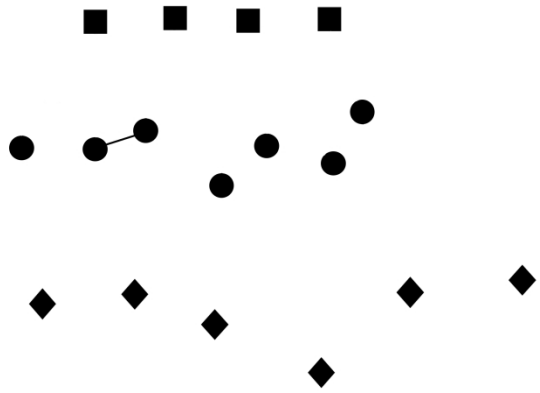
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Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups

Domain 1: Research team and reflexivity

Personal Characteristics

1. Interviewer/facilitator:

a- An external researcher with no connection to the unit studied (GS)   p6
b- A researcher who occasionally works in the unit studied (PS)   p6

    1. Credentials
     a – MSc   p1
     b – MPH MD   p1

2. Occupation

GS– research fellow   p6
PS – hon sen lecturer and consultant physician   p6

3. Gender

GS- female   p6
PS-male   p6

4. Experience and training

GS- experience of qualitative research at Masters level   p6
PS- experience of qualitative research over in several studies   p6

6. Relationship
GS-no previous relationship   p6
PS-some previous contact with some participants; PS works as consultant on the acute unit on an intermittent basis and the participants would know his job role. He would have had some working contact with some of the participants.   p6

7. Participant knowledge of the interviewer

    a- none   p6
    b- knowledge that PS is a consultant; only intermittent contact previously.   p6

8. Interviewer characteristics

Interviewers knew the results of the surveys that had been conducted previously, in particular, that a small proportion of team members had especially high numbers of connections. Beyond this, neither were aware of conscious preconceptions about the results, ot the theories that would emerge.

p6

Domain 2: study design

9. Methodological orientation and Theory : While there is existing literature that could be used to develop a theory regarding attributes of generic networks and of influencers in healthcare teams, there is no prior information that could be used to develop theory about the networks relating to individual information domains. PS had worked in this environment but had no preconception about the attributes of networks or influencers for individual domains. We therefore used a grounded theory approach, with theories emerging through the course of the research. p7

10. Sampling for surveys was socio-centric; all team members were invited to participate. Sampling for interviews took a maximal diversity approach. The goal was to include trainees representing the range of levels, from first year after qualification to end of training (FY1 to ST7). p6

11. Method of approach: For surveys, participants were asked at the end of a team meeting to take part and were given a URL that they could access. Explanation was given, and they were told they could choose to not take part. Consent was collected as the first part of the survey. This was agreed by the ethics committee. For interviews, subjects were approached on a 1:1 basis and asked to do a 30 minute interview. Written consent was obtained. p7

12. Interviews continued until theoretical saturation was apparent; 15 interviews were done. Survey sample sizes were 19 and 20. p6

13. Non – participation: all subjects approached agreed to take part. p7

14. Setting: interviews were conducted in private rooms close to the workplace. p6

15. No one was present other than participant and researcher p6

16. Description of sample

    Interviews: 15 interviewees, all trainee doctors; 5 Foundation year (HO), 7 CT 1-3 (SHO), 3 ST 4-7 (registrar). p8

17. There were no repeat interviews

18. Audio recording followed by transcription was used. p7

19. Field notes were made after each interview p7

20. Interviews lasted 30-45 minutes p7

21. Theoretical saturation was reached. p8

22. Transcripts were not returned to participants

23. Two coders p7

24. Themes/theories were derived during the course of the interviews. p7

25. Software: NVivo 11.4.1   p7

26. Participants did not feed back on findings

27. Quotations are included and identified by level of training

28. We believe the findings are consistent with the data

29. Major themes are discussed pp13-15

30. Minor themes are discussed pp13-15

BMJ Open

The diffusion of knowledge and behaviours among trainee doctors in an acute medical unit and implications for quality improvement work. A mixed methods social network analysis.

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Title Page

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Abstract:

Abstract

Objectives: To describe the social networks that diffuse knowledge, attitudes and behaviours relating to different domains of practice within teams of trainee doctors in an acute hospital medical setting. The domains examined were clinical-technical, patient centeredness and self-organisation of work.

Design: Sequential mixed methods: i) sociocentric survey of trainee consisting of questions about which colleagues are emulated or looked to for advice, with construction of social network maps, followed by ii) semi structured interviews regarding per to peer influence, analysed using a grounded theory approach. The study took place over 24 months.

Setting: An acute medical admissions unit, which receives admissions from the emergency department and primary care, in a UK NHS teaching hospital.

Participants: Trainee medical doctors working in five consecutive rotational teams. Surveys were done by 39 trainee doctors; then 20 different participants from a maximal diversity sample were interviewed.

Results:

Clinical-technical behaviours spread in a dense network with rich horizontal peer to peer connections. Patient centred behaviours spread in a sparse network. Approaches to non-patient facing work are seldom copied from colleagues. Highly influential individuals for clinical technical memes were identified; high influencers were not identified for the other domains.

Conclusion: Information and influence relating to different aspects of practice have different patterns of spread within teams of trainee doctors; highly influential individuals were important only for spread of clinical-technical practice. Influencers have particular characteristics, and this knowledge could guide leaders and teachers.

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Limitations

The research was done in a single hospital and might not be generalisable.

The surveys and interviews could be subject to recall bias, and the interviews might be biased by the fact that one of the interviewers was a senior colleague.

We researched social networks within teams of trainee doctors; links to others outside these bounded groups might be as, or more, important.

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3907 words

Introduction

Doctors in training are important members of the clinical microsystems that deliver acute medical care.[1] The quality of that care is affected by the knowledge, attitudes and behaviours that they bring to bear. Despite long undergraduate training, many elements of real-world care can be under-represented in the formal curriculum, including broader patient centred behaviours, such as expressing compassion, shared decision making and providing good experience, and practical skills such as managing oneself and one's work. [2,3] There is recognition of the existence of an informal, or hidden postgraduate curriculum, which depends on 'on the job' contextual learning during real clinical practice, which has the potential to address gaps between what is taught and what knowledge is needed to do real world work.[4] Team members can be seen as part of a community of practice, negotiating everyday challenges together to developing collaborative competence in a complex social environment. [5,6] Learning from peers is an important and valued part of this experience. A national multispecialty survey of trainee doctors rated learning from other trainees as contributing more to their learning than lectures, tutorials and reading. [7] Attitudes, behaviours and information can spread across a group of individuals contagiously through peer to peer exchanges in a broad range of contexts, including clinical teams.[8-10] Knowledge of the patterns of these linkages, or social networks, could therefore facilitate the spread of best practice across clinical teams.[11]

Trainee doctors require a range of kinds of skills to provide holistic, effective and efficient care. We hypothesis that information relating to different kinds of practice skills might be conducted through different network structures, that coexist in a single team. The aim of this research was to explore how knowledge, attitudes and behaviours diffuse between individuals through different network structures within similar bounded teams of trainee doctors in a particular organisational setting.

The Institute for Healthcare Improvement promotes a widely accepted framework, the "triple aim" which divides healthcare outputs into population health, patient experience and efficiency.[12] We used this as the basis of a conceptual framework for different kinds of

skills of trainee doctors in an acute hospital. We considered population health as mapping to clinical-technical skills, patient experience to patient centred behaviours and efficiency with non patient facing skills such as good prioritisation and self-organisation.

We hypothesised that memes, (using the original meaning of a unit of knowledge, attitude or behaviour that can spread between individuals through communication or imitation) relating to the three domains of work may be conducted in different ways in a single team.[13] If this is the case, it may be necessary to use different approaches to dissemination of memes relating to different domains.

We conducted the research among several different teams of trainee doctors a single acute medical unit (AMU). The AMU provides care for the initial 24-72 hours of an emergency medical hospital admission.[14,15] AMU trainees have access to a relatively large team of colleagues who they can approach for advice, or who's work they can observe. We constrained the research to interactions that occur in real time during work and did not explore use of electronic media. The study used a mixed methods sequential design, with surveys mapping network structures, followed by interviews with members from later teams that added to and triangulated the survey data and explored survey findings.

Ethical Issues

Ethical approval for this study was obtained from Hampshire-B REC; reference 15/SC/0052. All participants gave informed consent.

One researcher (PS) was a consultant who spent some time working in the unit. We believe that the relationship between PS and the trainees was not such that participants would feel coerced. All trainees invited took part, we believe this is because we ensured participation was convenient.

The surveys asked people to name colleagues who were influential for them. We reassured participants that confidentiality would be maintained and survey data would in anonymized format.

Methods

Participants

Participants were trainee doctors working in a single acute admission unit in an NHS hospital. Teams of doctors are allocated to the unit, at four to six monthly intervals. They are training in internal medicine, but they have different experiences and skills that they bring from previous roles. The research was conducted in five consecutive teams, each of approximately 20 trainee doctors, over a total period of 24 months. The first two teams completed electronic surveys, and the members of the following four teams participated in interviews.

Surveys

We invited all trainees in two consecutive AMU teams to complete an electronic survey (Qualtrics, Provo, UT). The sociometric survey (supplementary file 1) included questions about who they had asked for advice, who they would choose to approach in future, and who have they emulated or been influenced by in the AMU team. The questions were repeated for each of the three domains and examples were given to illustrate the intended meaning of domains (supplementary file 2). Teams completed 19 and 20 surveys respectively. Survey responses were converted to unweighted directional edges and entered into SocNetV software to construct network graphs for each of the two teams, one graph for each work domain.

Method of approach: Participants were invited at the end of routine team meetings to take part by accessing the survey on their electronic devices.

Interviews

Participants were selected as a maximum diversity sample, to include representatives at different stages of training to avoid bias. Subjects were approached on a 1:1 basis in the workplace invited to do an interview at a time convenient to them. All those invited agreed to take part.

Two researchers conducted interviews. GS, research fellow, (female) had no prior contact with the teams; PS (male) was a consultant physician and had had some intermittent working contact with the participants. Both had previous experience of qualitative research at postgraduate level. Coders agreed that there were no apparent differences between the findings from the interviews of the two researchers. PS as interviewer had preconception that highly influential individuals would be would be those with less patient centered attitudes. These preconceptions relate to PS's own training in the 1980s. Results were very different from these views, and we believe that these preconceptions did not cause bias. GS is a non clinical researcher and had no previous knowledge of acute medical practice.

Interviews were semi structured, and included vignettes to illustrate the meaning of the domains. Interview guides included questions about which colleagues were particularly influential, and what their characteristics were, in order to explore the finding of the presence of high influencers from the initial survey phase of the study. Interview guides are included (supplementary file 3).

We were not aware of any existing literature on knowledge transfer and influence specifically related to different aspects of practice. We used the domains as a framework to guide interviews, but used an inductive-deductive grounded theory approach to develop novel theories about the ways that diffusion happened and the way that influencers were identified. Developing theories were fed back in subsequent interviews for triangulation.[16]

Theoretical analysis was done independently by two coders using NVivo V11.4.1 (QSR International Pty Ltd). Coding was done after every 2-4 interviews. Themes that developed were incorporated as prompts into subsequent interviews. When items were coded differently the coders discussed these and reached consensus. Interviews continued until it appeared that theoretical saturation was achieved. Initial interview guides are appended.

Patient and public involvement

None.

Results:

Surveys

We found that clinical-technical knowledge flowed through dense networks with rich horizontal connections, (see figures 1-3). In contrast, the network conducting memes relating to patient-centeredness was sparse, and where there was person to person transmission, it tended to be among isolated pairs with no chains. Ways of organizing work were apparently hardly influenced at all by others. For the clinical technical domain, the average number of people each individual influenced (average degree) was 3.7 and 3.5 for team 1 and team 2, and the number of connections as a proportion of the maximum possible (density) was 0.3 and 0.2. Equivalent values for the patient centred domain were lower, 0.4 and 0.6 for average degree and 0.03 and 0.02 for density. Values for the communication of work organisation practice were 0.05 and 0.00 for average degree and 0.003 and 0.00 for density. Figures 1-3 show the network graphs for the three domains for team one; the graphs for team two showed similar topography. Some individuals showed network features of with high influencers. These were high degree centrality (the number of connections that an individual has) and betweeness centrality (the number of bridges an individual completes between others) which is associated with the ability to control information flow.[17]

Interviews

We conducted 15 interviews and consider that theoretical saturation was achieved. Participants were representative of the mix of levels of seniority within the team of trainees: 5 Foundation year (house officer, US intern equivalent), 7 core or specialty trainees in year 1-3 (senior house officer, US resident equivalent), 3 core or specialty trainees 4-7 (registrar, resident or fellow equivalent); 9 were female, all had trained in UK medical schools.

High level theories that emerged were i) there were characteristics of actions that determined if they would be taken on board by a trainee, and ii) there were characteristics of people that

determined if their advice would be used or actions emulated; iii) some values and beliefs that influenced behaviour came from outside of work; iv) patterns of influencing differed between domains.

There was consensus among trainees that a significant proportion of their work practice was based on learning from peers.

"You learn a lot of theory in med school but actually when you get here things are done differently and you learn by seeing what people more senior or experienced do." FY1

Domain 1: Technical-clinical; Diagnosing and treating.

Characteristics of influencers

Chief determinants of individuals who were technical influencers were approachability and kindness, a record of visible successes and conscientiousness.

Approachability was based not only on the way an individual had responded in the past to requests for help and advice, but also on how kind they were in general - to patients and to members of other disciplines; trainees predicted that people who were globally kind would be kind to them if they sought advice.

"my feeling is their empathy toward patients will be similar to their empathy toward me"

"There's definitely people who won't give you a hard time. You can see how they are toward other people, nurse, patents." CT1

Many participants expressed that they valued kindness toward patients for its own sake, and held kind colleagues in higher esteem, and were more likely to trust and copy their technical practices.

"I think, to be honest, the number one thing is kindness."(referring to judging global competence) CT1

"Someone who's kind to patients and kind to everyone on the ward …… that's the kind of person I would copy in other ways." CT2

Conversely,

"even if they're, say, a brilliant diagnostician or surgeon, if I see someone behaving badly with a patient, I struggle to learn from them"

Trainees valued friendship and friendliness

"if they're pally, if you've chatted to them before, consider them friends, you're likely to trust their knowledge and skills"

"I'm much more likely to copy the good bits in the people I'm already on good terms with who might be my friend"

Individuals who were seen as committed to doing their job well were influencers.

"Some work hard at being good at their job, you'll walk in on them, like, reading things on line and things, that kind of person I would be more inclined to copy." CT2

"There are certain doctors, I like the way they go about the profession, I feel I could learn a lot by acting like them." CT1

Characteristics of actions and behaviours themselves could make them more likely to be emulated

A great deal of weight was placed on observable success. This might be an unlikely disease picked up by a test, or a treatment when a patient is seen to recover. Strategies such as diagnostic work up were valued when "thorough", meaning that several possible diagnoses were considered and excluded. When a colleague explained the logic behind a clinical approach, the trainees were more likely to incorporate it.

Domain 2: Providing good patient experience.

All trainees expressed that they had never, and did not envisage that they would in future, ask for advice on interpersonal interaction with a patient. There was a feeling that this was a behaviour that should be determined by one's own values that largely came from outside the profession and often pre-dated medical school.

"I think you come with ideas of how you'd like to be, how you'd like to speak to people"

"you're taught a lot of science but you sort of come before that with an idea of how you want provide people with dignity and being honest and open, that's the values I've had, it's been long term "

"I had that sort of preconceived idea from before I even came to medical school"

As a source of these values, parental influence was mentioned most often; trainees felt they carried the beliefs and behaviors that their parents displayed. Other cited sources were secondary school, social groups, exposure to life in general and, in only one case, religion.

"Probably from parents, encouraging good values, I was just always told that's the way to do it and eventually it becomes part of who you are"

Characteristics of actions and behaviours

When questioned about the ways that they could be influenced at work to behave differently toward patients, all trainees talked about communication skills and learning through

observing ways that conversations were phrased. Trainees wanted to improve skills in 'set piece' situations, such as end-of-life discussion. They copied snippets, to use in the future.

We explored what they meant by good communication that they would emulate. A commonly cited criterion was a successful outcome. Examples of success included the patient appearing to understand what they were being told, evidenced by verbal or non-verbal signals. A number cited as an example of success a patient being convinced to change their mind and accept a treatment that the doctor felt they should receive.

In contrast to the clinical domain, personal characteristics of the person who was being observed was not perceived to impact on whether they would be influential.

"If I can see there's progress being made, personality is neither here or there, if goal has been achieved." FY2

Going beyond learning about phrasing, we explored the influencing of wider values and attitudes

CHARACTERISITICS OF PEOPLE

Many participants tended to select role models who had similar values, with the role model used to reinforce existing beliefs/behaviors.

"I guess I come to it with a kind and caring nature and one of the important things I look for in a role model is, do they have that too?"

"there is a subconscious… why did I get into this and who do I deem also to be in for the right reasons, actually to help people and look after patients"

"I guess, me, personally I've always been an all rounder, I see it's important I have respect for an all rounder like me, that's who I will look to; being kind is part of being an all rounder"

Trainees particularly noticed small discretionary acts, cited examples included making tea for a patient, responding to a patient who is calling out for attention, and making a special effort to contact a patient's relatives. Several felt that they had behaved differently after seeing somebody else put themselves out to provide good patient experience.

"If I see Dr X make someone a cup of tea Ii think I SHOULD try to be more like that, I SHOULD try to be better"

Some trainees discussed the way that observing negative patient centered behaviors could affect them, and felt their behavior was adversely affected when the majority of a team were behaving in a non-patient-centred way. However, they felt that they were more strongly influenced by seeing what they felt was good patient centered care, than bad. When local culture was contrary to good care, they could be inspired for the good by a single individual.

"If someone said "hang on a minute let's think about what more we can do for the patient", I think definitely I'd stop and take a moment and think 'is there more we can do'" FY1

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Domain 3: organization of work

Trainees generally agreed that there were no personal characteristics that made an individual influential in terms of ways of organizing work.

There was a sense of willingness to do work differently if asked to do so but only by people who worked in the same clinical context and knew about how things worked. There was resistance to adapting practice in response to requests from people seen as outsiders, particularly managers.

…if it's someone doing a similar job to you, I'd be inclined to try it, but if it was someone not from this environment, someone in a suit, someone who doesn't do a job like this, my reaction to that would be "actually you don't understand how busy this job is". FY2

If a senior ward nurse asked me to do something this way, because it helped them, I'd be more likely,

There was a strong sense that an approach would have to be tested personally before adoption.

If someone did something, and it seemed to work, I'd try it to see if it worked, it wouldn't matter whether I looked up to that person or not

There was a widespread feeling that trainees could not make a difference to care by the way they organized their work because the system is so inflexible it tends to negate benefits of improving working practices, and so it is not worth trying to improve one's efficiency.

Discussion:

Social network analysis explores the way that individuals interact with social context, and how structures emerge from interpersonal interactions, increasing our understanding of behaviours. associated with leaning and performance in medical learning.17

Previous research has shown that social networks are key for developing practice among trainee doctors.[18,19] Knowledge about the function of networks among trainees offers important intelligence for those who aim to improve the quality of care within frontline clinical microsystems through training and influence. Most existing studies of health professionals have mapped generic social networks, without differentiating or identifying the type of information conducted.[20] In the teams of medical trainees that we investigated, we found that there were different network structures channeling memes relating to different domains of practice. This is the first study to our knowledge that has investigated how information and influence in the three different domains of clinical-technical, patient centeredness and organization of work spread through networks in groups of doctors.

We found that learning and influence in the different domains studied flowed very differently, if at all. Clinical-technical knowledge flowed through dense networks. In

contrast, the team networks relating patient centered items were sparse, with suggestion from interviews that there were important connections that went outside the team. Self orgnaisation appeared not to have any peer to peer spread. This suggests different strategies might be needed for different domains, and passive diffusion is unlikely to achieve change in practice for non-technical practices. This is important information because quality improvement initiatives frequently target patient experience and the detail of working routines and practices.

Interviews provided triangulation for the survey finding of the existence of high clinical-technical influencers. Attributes of clinical-technical influencers included consistent kindness, and signs of conscientiousness. An interesting finding was that trainees appraised clinical management on the basis of visible diagnostic or therapeutic success. This is at odds with the fact that many diagnostic strategies deliberately aim for low yields, and many treatments have a high 'number needed to treat' or delayed outcomes: Therefore many correct management approaches have visible success only on rare occasions. This makes explanation of underlying logic important in teaching.

In relation to the spread of patient centeredness, trainees did not identify highly influential individuals, and it was actions themselves were seen as more or less worthy of emulation. Compassion, a concern for the impact of behaviors on the patients internal psychological state was not volunteered as a driver. Instead, communication interactions were judged on the basis of 'getting the job done', for example, getting a message over accurately or getting the patient to agree with the doctor on a decision. The failure to talk about concern for the patient's emotions may be an artefact of the kind of language used day to day, and may not reflect an absence of compassion. However, the findings point to a need for leaders to be explicit about behaving to improve patient experience and to demonstrate and teach approaches such as shared decision making. An interesting finding was that trainees described that they looked to people they felt to be similar to themselves as their role models. Doctors felt they carried their own values from outside their professional life, and looked for validation, rather than looking to adopt new sets of values. If true, this has impactions for those hoping to inculcate values among trainees, suggesting that amplification of existing mores may be more appropriate.

Many of these findings are in keeping with existing literature. The presence of high influencers in healthcare teams is established. In keeping with our own results, the personality characteristics associated with this network influencing roles have been shown to include contentiousness and agreeableness.[21,22] The importance of perception of the utility of a practice, which we found to be key for adoption of ways of organizing work, is also described elsewhere.[23]

We have added an extra dimension to existing knowledge of healthcare professional networks by differentiating and describing social networks that spread different kinds of work related information and influence in medical teams. This can inform teaching and communication strategies according to the domain of practice being targeted. Our findings also provide insight into how an individual might adapt their own behavior so as to exert more influence.

This work has a number of limitations. It was conducted in a single center, and may not be representative of all acute settings, although in mitigation, six different consecutive clinical teams were included over a period of 2 years. We limited the research to trainee doctors, and did not include other professions; previous work has described the importance of networks that span professional groups and it would be interesting to go on to perform more inclusive studies. Future research could explore how individuals from outside of the core team and from different disciplines exert influence, and how electronic media provides wider peer to peer links. The categorization of memes into three domains is pragmatic and certainly over simplistic, and there are many more subtle aspects that could have been explored.

Conclusion: The social networks of influence and knowledge transfer among trainee doctors in an acute setting conform to quite different patterns when considering the spread of innovations in three domains, technical clinical, patient centered and self-organization The characteristics and prevalence of highly influential individuals also differs between domains. This casts light on the way that practices develop across a team, informs those who wish to enhance their influencing, and emphasizes the importance of making desirable behaviors clearly visible to facilitate their spread. Knowing how these coexisting networks are configured and driven is likely to be useful for those leading quality improvement work that requires on the uptake of innovative behaviors across a clinical microsystem.

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Contributor ship statement: PS conceived the study; PS and GS collected data; PS, GS, MH and IY all contributed to analysis and writing.

Competing interests: no competing interests

Data sharing statement: Data is not publicly available because a condition consent was that all interview and survey data would be destroyed after analysis.

Figure Legends:

Figure 1: Network graph showing directed connections that conduct clinical-technical knowledge and influence. Square = CT4-7 grades (registrar), Circles = CT 1-3 (SHO), Diamonds = FY 1-2 (house officer).

Figure 2: Graph for network relating to the patient centred behaviours.

Figure 3: Graph for network relating to the non patient-facing practices.

References

1. Nelson EC, Godfrey MM, Batalden PB, Berry SA, Bothe AE, McKinley KE, et al. Clinical microsystems, part 1. The building blocks of health systems. Jt Comm J Qual Patient Saf Jt Comm Resour. 2008;34:367–78.

2. Fernandez A, Teherani A, Boscardin CK, Saba GW. Assessment of medical students' shared decision-making in standardized patient encounters. J Gen Intern Med. 2011;26:367-72

3. Burack JH, Irby DM, Carline JD, Root RK, Larson EB. Teaching compassion and cespect; attending pysicians' responses to problematic behaviors. J Gen Intern Med. 1999; 14:49-55

4. Swanwick T. Informal learning in postgraduate medical education: from cognitivism to 'culturism'. Medical Education. 2005; 39:859-865

5. Lingard L, McDougall A, Levstik M, Chandok M, Spafford MM, Schryer. Representing complexity well: a story about teamwork, with implications for how we teach collaboration. Medical Education 2012: 46: 869–877

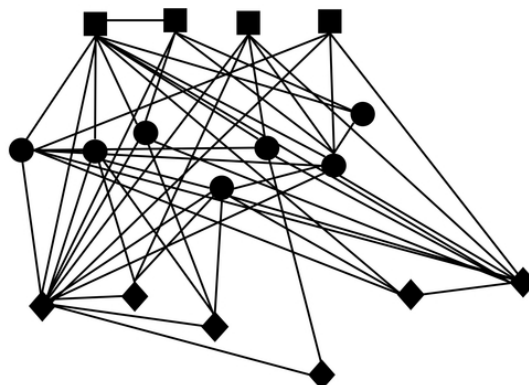6. Wenger, E. Communities of Practice: learning, meaning and identity. 1998 Cambridge, Cambridge University Press

7   DeWitt C. Baldwin DC, Daugherty SR. How Residents Say They Learn: A National, Multi-Specialty Survey of First- and Second-Year Residents. J Grad Med Educ. 2016; 8: 631–639.

8   Christakis N, Fowler JH. Social contagion theory: examining dynamic social networks and human behavior. Stat Med. 2013 Feb;32:556–77.

9   Rogers E. Diffusion of Innovations. New York: Free Press; 1983.

10 Wagter JM, van de Bunt G, Honing M, Eckenhausen M, Scherpbier A. Informal interprofessional learning: Visualizing the clinical workplace. J Interprof Care. 2012;26:173–82.

11 Meltzer D , Chung J, Khalili P, Marlowa E, Arora V , Schumock G, Burt R. Exploring the use of social network methods in designing healthcare quality improvement teams. Soci(al Science & Medicine. 2010; 71: 1119-1130

12 Institute for Healthcare Improvement. The triple aim. http://www.ihi.org/Engage/Initiatives/TripleAim/Pages/default.aspx. (Accessed 18.4.19)

13 Distin, K. 2004. The Selfish Meme: A Critical Reassessment. Cambridge: Cambridge University Press. doi:10.1017/CBO9780511614286

14 Acute Medicine Taskforce. Acute medical care. 2007. https://www.rcplondon.ac.uk/sites/default/files/documents/acute_medical_care_final_for_web.pdf (Accessed 7.4.19)

15 Bell D, Skene H, Jones M, Vaughan L. A guide to the acute medical unit. Br J Hosp Med. 2008; 69:M107-9.

16 Heath H, Cowley S. Developing a grounded theory approach: a comparison of Glaser and Strauss. Int J Nurs Stud. 2004;41:141–50.

17 Isba R, mWoolf K, Hanneman R. Social network analysis in medical education. Medical Education 2017: 51: 81–88

18 Shokoohi M, Nedjat S, Majdzadeh R. A social network analysis on clinical education of diabetic foot. J Diabetes Metab Disord. 2013;12:44–44.

19 Jippes E, Achterkamp MC, Brand PLP, Kiewiet DJ, Pols J, van Engelen JML, et al. Disseminating educational innovations in health care practice: training versus social networks. Soc Sci Med. 2010;70:1509–17.

20 Chambers D, Wilson P, Thompson C, Harden M. Social network analysis in healthcare settings: A systematic scoping review. PLoS ONE. 2012 [cited 2018 Apr 7];7. Available from:http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0041911 (Accessed 10.4.19)

21 Battistoni E, Fronzetti Colladon A. Personality correlates of key roles in informal advice networks. Learn Individ Differ. 2014;34:63–9.

22 Fong A, Clark L, Cheng T, Franklin E, Fernandez N, Ratwani R, et al. Identifying influential individuals on intensive care units: using cluster analysis to explore culture. J Nurs Manag. 2017;25:384–91.

23 Murray E, Treweek S, Pope C, Macfarlane A, Finch T, C. O, et al. Normalisation process theory: A framework for developing, evaluating and implementing complex interventions. BMC Med. 2010;8:2–11.

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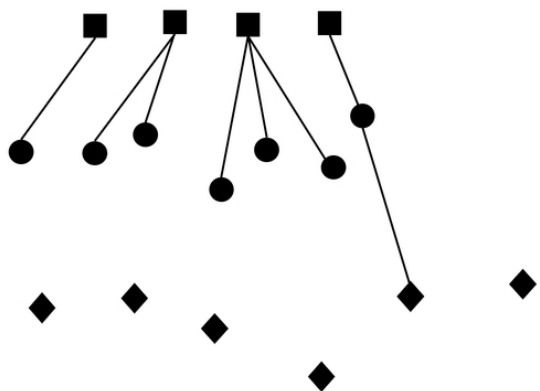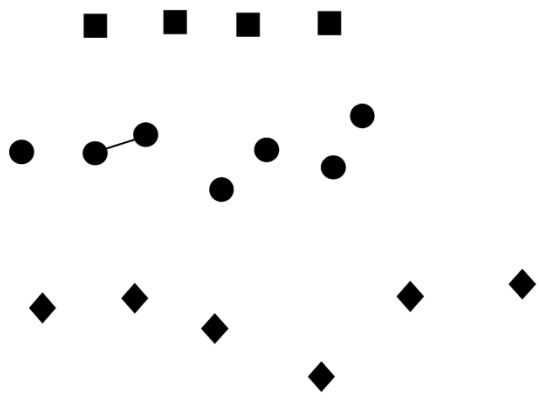
Survey questions: each question is presented with a list of all trainees in the team, with multiple selections permitted.

Have you asked someone what to do in terms of something clinical, e.g. how to diagnose or treat a patient? If so, who?

Have you ever approached a clinical problem a certain way because you had seen some one else do it a certain way? If so, who?

If you had a question about a clinical problem, and everyone was available, are there people you would be likely to choose to ask?

Have you asked someone what to do in terms of something to do with providing good patient experience, If so, who?

Have you ever approached an interation with a patient   patient experience problem a certain way because you had seen some one else do it a certain way, in order to provide good experience? If so, who?

If you wanted to know what to do in terms of an interaction with a patient, is there anybody you would seek out?

Have you asked a team member you you should organise or prioritise a task, such as booking tests or doing paper work?

Have you ever changed the way you organise or prioritise works tasks, for example, when in the day you do discharge documents, because you saw a colleague take a certain approach?

Box:

Examples used to illustrate meaning of domains

Clinical-technical: We mean information or ways of doing things to diagnose or treat disease. An example of influence in this domain would be when you are deciding whether to order a scan for pulmonary embolism, and might think of how a colleague has acted, or you might ask for advice.

Patient centred: This refers to behaviours that affect patient experience, such as communication, reassurance, going 'the extra mile' to do something for a patient. An example might be a nurse asks you to speak to a patient who is anxious; it is not your patient and you are busy. Do you help? Perhaps you might be influenced by what you've seen others do, or perhaps you would ask advice?

Self-organisation: The includes behaviours that impact on the efficiency, such as organising and prioritising your own work. An example would be ensuring all discharge documentation is done early in the day, to ensure that beds are freed. You might see someone else doing things a certain way, or might ask how others organise themselves.

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Initial Interview guide

Sometimes, there are different ways of approaching a clinical problem, for example, should you do a scan, which choice of treatment should you use.

An example would be: Sometimes there is no evidence to support a decision; an example is, at what level of suspicion prompts investigation for pulmonary embolism. Some people are much more likely to order a scan in low risk cases. Others would avoid scanning when there is a very small likelihood of pulmonary embolism.

It might be that you take a certain approach because you've seen somebody else do it that way, or you might approach somebody from the team to ask advice; do you think that can happen?

Do you think there are some people you'd be more likely to copy, or ask?

Are there people who are particularly influential in this way?

Can you think about what it is about those people that makes you see them in that way?

Now thinking about ways you behave so as to produce good patient experience, an example behaviour would be: A nurse asks a doctor to review a patient in pain. The doctor is busy, and is not responsible for that patients. Some people will tell the nurse to call the relevant doctor. Some will take time to assess the patient and prescribe a pain killer.

Same questions

Now, thinking about ways you organise and prioritise the work you do away from patients. An example would be: Many people go through non patient facing tasks in an order that is easiest for them. You observe that one of your colleagues prioritises the tasks that will have the greatest benefit if done early, for example, preparing discharge documents so beds can be freed.

Same questions

Are there any other things you can think of about the way trainees in the team influence each other; and what makes someone especially influential?

Standards for Reporting Qualitative Research (SRQR)

O'Brien B.C., Harris, I.B., Beckman, T.J., Reed, D.A., & Cook, D.A. (2014). Standards for reporting qualitative research: a synthesis of recommendations. *Academic Medicine, 89(9)*, 1245-1251.

No.	Topic	Item
Title and abstract		
S1	Title	TITLE PAGE
S2	Abstract	PAGE 3
Introduction		
S3	Problem formulation	PAGE 4 LINES 11-53
S4	Purpose or research question	PAGE 4 LINES 48-54
Methods		
S5	Qualitative approach and research paradigm	PAGE 6 PAGES 34-51
S6	Researcher characteristics and reflexivity	PAGE 7 LINES 5-15
S7	Context	PAGE 5 LINES 20-26
S8	Sampling strategy	PAGE 6 LINES 53-59
S9	Ethical issues pertaining to human subjects	PAGE 5 LINES 36-56
S10	Data collection methods	PAGE 6 LINES 27-39 AND PAGE 9, 5-51
S11	Data collection instruments and technologies	na
S12	Units of study	PAGE 6 LINES 8-19
S13	Data processing	PAGE 7 LINES 44-51
S14	Data analysis	ditto
S15	Techniques to enhance trustworthiness	PAGE 7 LINES 48-52
Results/Findings		
S16	Synthesis and interpretation	PAGE 8 LINE 11 and ff
S17	Links to empirical data	PAGE 9 LINE 12 and ff
Discussion		
S18	Integration with prior work, implications, transferability, and contribution(s) to the field	PAGE 14 LINE 27 and ff
S19	Limitations	PAGE 16 LINE 29-43

Other		
S20	Conflicts of interest	As per submission web page
S21	Funding	As per submission web page

[a]The rationale should briefly discuss the justification for choosing that theory, approach, method, or technique rather than other options available, the assumptions and limitations implicit in those choices, and how those choices influence study conclusions and transferability. As appropriate, the rationale for several items might be discussed together.

BMJ Open

The diffusion of knowledge and behaviours among trainee doctors in an acute medical unit and implications for quality improvement work. A mixed methods social network analysis.

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Title Page

Title: The diffusion of knowledge and behaviours among trainee doctors in an acute medical unit and implications for quality improvement work. A mixed methods social network analysis.

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Wordcount: 3930

Abstract:

Abstract

Objectives: To describe the social networks that diffuse knowledge, attitudes and behaviours relating to different domains of practice within teams of trainee doctors in an acute hospital medical setting. The domains examined were "clinical-technical", "patient centeredness" and "organisation of work".

Design: Sequential mixed methods: i) sociocentric survey of trainee consisting of questions about which colleagues are emulated or looked to for advice, with construction of social network maps, followed by ii) semi structured interviews regarding per to peer influence, analysed using a grounded theory approach. The study took place over 24 months.

Setting: An acute medical admissions unit, which receives admissions from the emergency department and primary care, in a NHS England teaching hospital.

Participants: Trainee medical doctors working in five consecutive rotational teams. Surveys were done by 39 trainee doctors; then 20 different participants from a maximal diversity sample were interviewed.

Results:
Clinical-technical behaviours spread in a dense network with rich horizontal peer to peer connections. Patient centred behaviours spread in a sparse network. Approaches to non-patient facing work are seldom copied from colleagues. Highly influential individuals for clinical technical memes were identified; high influencers were not identified for the other domains.

Conclusion: Information and influence relating to different aspects of practice have different patterns of spread within teams of trainee doctors; highly influential individuals were important only for spread of clinical-technical practice. Influencers have particular characteristics, and this knowledge could guide leaders and teachers.

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Article summary

Strengths

This is the first research describing several coexisting social networks in the same team in medical practice.

Interviews were used to explore and explain phenomena underlying the social network patterns.

Limitations

The surveys and interviews could be subject to recall bias, which is a recognised issue in sical network research.

Respondents may be subject to influence and learning that they are not conscious of, and so an 'invisible' social network may have been overlooked.

We researched social networks within bounded teams of trainee doctors; links to others doctors outside the core team and links to other disciplines are not included.

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Introduction

Doctors in training are important members of the clinical microsystems that deliver acute medical care.[1] The quality of that care is affected by the knowledge, attitudes and behaviours that they bring to bear. Despite long undergraduate and postgraduate training, many elements of real-world care can be under-represented in the formal curriculum, including broader patient centred behaviours, such as expressing compassion, shared decision making and providing good experience, and practical skills such as managing oneself and one's work. [2,3] Once qualified, trainee doctors form communities of practice and continue to acquire skills and knowledge through 'on the job' contextual learning.[4,5,6] Learning from peers is an important and valued part of this experience. A national multispecialty survey of trainee doctors rated learning from other trainees as contributing more to their learning than lectures, tutorials and reading.[7] Knowledge of the patterns of peer-peer connecations that channel such spread would enable quality improvement leaders and teachers to optimise uptake of new practice across clinical teams.[8]

The aim of this research is to explore how knowledge, attitudes and behaviours diffuse between individuals through different network structures within bounded teams of trainee doctors. Different types of skills and behaviours impact the quality of medical care. Clinical-technical knowledge and skills help trainees reach correct diagnoses, and deliver correct treatments (an example would be knowing which patients should undergo a certain diagnostic test). Patient-centredness skills increase the quality of patient and carer experience (an example would be the ability to reassure an anxious patient). We postulated a third category, that we termed 'organisation of work', by which we refer to the skills that allow clinicians to prioritise and order tasks, particularly non-patient facing tasks, so as to reduce the cost of care (an example would be the ability to prioritise tasks that impact resource use) (supplementary file 1). We hypothesised that memes, (using the original meaning: A unit of knowledge, attitude or behaviour that can spread between individuals through communication or imitation) relating to these different aspects of day to day work may be conducted via different channels within the same clinical team.[9] If this is the case, it may be necessary to use different approaches to disseminate memes associated with the different domains and this knowledge would serve as a guide to clinical leaders and quality improvement agents who aim to change practice across diffuse clinical teams.

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We conducted the research among several different teams of trainee doctors a single acute medical unit (AMU). The AMU provides care for the initial 24-72 hours of an emergency medical hospital admission.[10,11] AMU trainees have access to a relatively large team of colleagues who they can approach for advice, or who's work they can observe. We constrained the research to interactions that occur in real time during work and did not explore use of electronic media. The study used a mixed methods sequential design, with surveys mapping network structures, followed by interviews with members from later teams that added to and triangulated the survey data and explored survey findings.

Ethical Issues

Ethical approval for this study was obtained from Hampshire-B REC; reference 15/SC/0052. All participants gave informed consent.

One researcher (PS) was a consultant who spent some time working in the unit. We believe that the relationship between PS and the trainees was not such that participants would feel coerced. All trainees invited took part, we believe this is because we ensured participation was convenient.

The surveys asked people to name colleagues who were influential for them. We reassured participants that confidentiality would be maintained and survey data would in anonymized format.

Methods

Participants

Participants were doctors in training working in a single acute admission unit in an NHS hospital. Teams of doctors are allocated to the unit, at four to six monthly intervals. They are training in internal medicine, but they have different experiences and skills that they bring from previous roles. The research was conducted in five consecutive teams, each of approximately 20 trainee doctors, over a total period of 24 months. The first two teams

completed electronic surveys, and the members of the following four teams participated in interviews.

Surveys

We invited all trainees in two consecutive AMU teams to complete an electronic survey (Qualtrics, Provo, UT). The sociometric survey (supplementary file 2) included questions about who they had asked for advice, who they would choose to approach in future, and who have they emulated or been influenced by in the AMU team. The questions were repeated for each of the three domains. Teams completed 19 and 20 surveys respectively. Survey responses were converted to unweighted directional edges and entered into SocNetV software to construct network graphs for each of the two teams, one graph for each work domain.

Method of approach: Participants were invited at the end of routine team meetings to take part by accessing the survey on their electronic devices.

Interviews

Participants were selected as a maximum diversity sample, to include representatives at different stages of training to avoid bias. Subjects were approached on a 1:1 basis in the workplace invited to do an interview at a time convenient to them. All those invited agreed to take part.

Two researchers conducted interviews. GS, research fellow, (female) had no prior contact with the teams; PS (male) was a consultant physician and had had some intermittent working contact with the participants. Both had previous experience of qualitative research at postgraduate level. Coders agreed that there were no apparent differences between the findings from the interviews of the two researchers. PS as interviewer had preconception that highly influential individuals would be would be those with less patient centered attitudes. These preconceptions relate to PS's own training in the 1980s. Results were very different

from these views, and we believe that these preconceptions did not cause bias. GS is a non clinical researcher and had no previous knowledge of acute medical practice.

Interviews were semi structured, and included vignettes to illustrate the meaning of the domains. Interview guides included questions about which colleagues were particularly influential, and what their characteristics were, in order to explore the finding of the presence of high influencers from the initial survey phase of the study. Interview guides are included as supplementary file 3.

We were not aware of any existing literature on knowledge transfer and influence specifically related to different aspects of practice. We used the domains as a framework to guide interviews, but used an inductive-deductive grounded theory approach to develop novel theories about the ways that diffusion happened and the way that influencers were identified. Developing theories were fed back in subsequent interviews for triangulation.[12]

Theoretical analysis was done independently by two coders using NVivo V11.4.1 (QSR International Pty Ltd). Coding was done after every 2-4 interviews. Themes that developed were incorporated as prompts into subsequent interviews. When items were coded differently the coders discussed these and reached consensus. Interviews continued until it appeared that theoretical saturation was achieved. Initial interview guides are appended.

Patient and public involvement

None.

Results:

Surveys

We found that clinical-technical knowledge flowed through dense networks with rich horizontal connections, (see figures 1-3). In contrast, the network conducting memes relating to patient-centeredness was sparse, and where there was person to person transmission, it

tended to be among isolated pairs with no chains. Ways of organizing work were apparently hardly influenced at all by others. For the clinical technical domain, the average number of people each individual influenced (average degree) was 3.7 and 3.5 for team 1 and team 2, and the number of connections as a proportion of the maximum possible (density) was 0.3 and 0.2. Equivalent values for the patient centred domain were lower, 0.4 and 0.6 for average degree and 0.03 and 0.02 for density. Values for the communication of memes relating to organisation of work were 0.05 and 0.00 for average degree and 0.003 and 0.00 for density. Figures 1-3 show the network graphs for the three domains for team one; the graphs for team two showed similar topography. Some individuals showed network features of with high influencers. These were high degree centrality (the number of connections that an individual has) and betweeness centrality (the number of bridges an individual completes between others) which is associated with the ability to control information flow.[13]

Interviews

We conducted 15 interviews and consider that theoretical saturation was achieved. Participants were representative of the mix of levels of seniority within the team of trainees: 5 Foundation year (house officer, US intern equivalent), 7 core or specialty trainees in year 1-3 (senior house officer, US resident equivalent), 3 core or specialty trainees 4-7 (registrar, resident or fellow equivalent); 9 were female, all had trained in UK medical schools.

Theories that emerged were i) there were characteristics of actions that determined if they would be taken on board by a trainee, and ii) there were characteristics of people that determined if their advice would be used or actions emulated; iii) some values and beliefs that influenced behaviour came from outside of work; iv) patterns of influencing differed between domains.

There was consensus among trainees that a significant proportion of their work practice was based on learning from peers.

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"You learn a lot of theory in med school but actually when you get here things are done differently and you learn by seeing what people more senior or experienced do." FY1

Domain 1: Technical-clinical; Diagnosing and treating.

Characteristics of influencers

Chief determinants of individuals who were technical influencers were approachability and kindness, a record of visible successes and conscientiousness.

Approachability was based not only on the way an individual had responded in the past to requests for help and advice, but also on how kind they were in general - to patients and to members of other disciplines; trainees predicted that people who were globally kind would be kind to them if they sought advice.

"my feeling is their empathy toward patients will be similar to their empathy toward me"

"There's definitely people who won't give you a hard time. You can see how they are toward other people, nurse, patents." CT1

Many participants expressed that they valued kindness toward patients for its own sake, and held kind colleagues in higher esteem, and were more likely to trust and copy their technical practices.

"I think, to be honest, the number one thing is kindness."(referring to judging global competence) CT1

"Someone who's kind to patients and kind to everyone on the ward …… that's the kind of person I would copy in other ways." CT2

Conversely,

"even if they're, say, a brilliant diagnostician or surgeon, if I see someone behaving badly with a patient, I struggle to learn from them"

Trainees valued friendship and friendliness

"if they're pally, if you've chatted to them before, consider them friends, you're likely to trust their knowledge and skills"

"I'm much more likely to copy the good bits in the people I'm already on good terms with who might be my friend"

Individuals who were seen as committed to doing their job well were influencers.

"Some work hard at being good at their job, you'll walk in on them, like, reading things on line and things, that kind of person I would be more inclined to copy." CT2

"There are certain doctors, I like the way they go about the profession, I feel I could learn a lot by acting like them." CT1

Characteristics of actions and behaviours themselves could make them more likely to be emulated

A great deal of weight was placed on observable success. This might be an unlikely disease picked up by a test, or a treatment when a patient is seen to recover. Strategies such as diagnostic work up were valued when "thorough", meaning that several possible diagnoses were considered and excluded. When a colleague explained the logic behind a clinical approach, the trainees were more likely to incorporate it.

Domain 2: Providing good patient experience.

All trainees expressed that they had never, and did not envisage that they would in future, ask for advice on interpersonal interaction with a patient. There was a feeling that this was a behaviour that should be determined by one's own values that largely came from outside the profession and often pre-dated medical school.

"I think you come with ideas of how you'd like to be, how you'd like to speak to people"

"you're taught a lot of science but you sort of come before that with an idea of how you want provide people with dignity and being honest and open, that's the values I've had, it's been long term "

"I had that sort of preconceived idea from before I even came to medical school"

As a source of these values, parental influence was mentioned most often; trainees felt they carried the beliefs and behaviors that their parents displayed. Other cited sources were secondary school, social groups, exposure to life in general and, in only one case, religion.

"Probably from parents, encouraging good values, I was just always told that's the way to do it and eventually it becomes part of who you are"

Characteristics of actions and behaviours

When questioned about the ways that they could be influenced at work to behave differently toward patients, all trainees talked about communication skills and learning through observing ways that conversations were phrased. Trainees wanted to improve skills in 'set piece' situations, such as end-of-life discussion. They copied snippets, to use in the future.

We explored what they meant by good communication that they would emulate. A commonly cited criterion was a successful outcome. Examples of success included the patient appearing to understand what they were being told, evidenced by verbal or non-verbal signals. A number cited as an example of success a patient being convinced to change their mind and accept a treatment that the doctor felt they should receive.

In contrast to the clinical domain, personal characteristics of the person who was being observed was not perceived to impact on whether they would be influential.

"If I can see there's progress being made, personality is neither here or there, if goal has been achieved." FY2

Going beyond learning about phrasing, we explored the influencing of wider values and attitudes

CHARACTERISITICS OF PEOPLE

Many participants tended to select role models who had similar values, with the role model used to reinforce existing beliefs/behaviors.

"I guess I come to it with a kind and caring nature and one of the important things I look for in a role model is, do they have that too?"

"there is a subconscious… why did I get into this and who do I deem also to be in for the right reasons, actually to help people and look after patients"

"I guess, me, personally I've always been an all rounder, I see it's important I have respect for an all rounder like me, that's who I will look to; being kind is part of being an all rounder"

Trainees particularly noticed small discretionary acts, cited examples included making tea for a patient, responding to a patient who is calling out for attention, and making a special effort to contact a patient's relatives. Several felt that they had behaved differently after seeing somebody else put themselves out to provide good patient experience.

"If I see Dr X make someone a cup of tea Ii think I SHOULD try to be more like that, I SHOULD try to be better"

Some trainees discussed the way that observing negative patient centered behaviors could affect them, and felt their behavior was adversely affected when the majority of a team were

behaving in a non-patient-centred way. However, they felt that they were more strongly influenced by seeing what they felt was good patient centered care, than bad. When local culture was contrary to good care, they could be inspired for the good by a single individual.

"If someone said "hang on a minute let's think about what more we can do for the patient", I think definitely I'd stop and take a moment and think 'is there more we can do'" FY1

'

Domain 3: organization of work

Trainees generally agreed that there were no personal characteristics that made an individual influential in terms of ways of organizing work.

There was a sense of willingness to do work differently if asked to do so but only by people who worked in the same clinical context and knew about how things worked. There was resistance to adapting practice in response to requests from people seen as outsiders, particularly managers.

…if it's someone doing a similar job to you, I'd be inclined to try it, but if it was someone not from this environment, someone in a suit, someone who doesn't do a job like this, my reaction to that would be "actually you don't understand how busy this job is". FY2

If a senior ward nurse asked me to do something this way, because it helped them, I'd be more likely,

There was a strong sense that an approach would have to be tested personally before adoption.

If someone did something, and it seemed to work, I'd try it to see if it worked, it wouldn't matter whether I looked up to that person or not

There was a widespread feeling that trainees could not make a difference to care by the way they organized their work because the system is so inflexible it tends to negate benefits of improving working practices, and so it is not worth trying to improve one's efficiency.

Discussion:

Behaviours and information flow from individual to individual. This leads to dissemination of knowledge and influence across groups through patterns of habitual connections that are termed social networks. This phenomenon has been described in a broad range of social contexts, including clinical teams.[14-16] Social network analysis explores the way that individuals interact with social context, and how structures emerge from interpersonal interactions, increasing our understanding of behaviours. Previous research has shown that social networks are key for developing practice among trainee doctors.[17,18,19] Knowledge about the function of networks among trainees offers important intelligence for those who aim to improve the quality of care within frontline clinical microsystems through training and influence. Most existing studies of health professionals have mapped generic social networks, without differentiating or identifying the type of information conducted.[20] In the teams of medical trainees that we investigated, we found that there were multiple synchronous network structures channeling memes relating to different domains of practice. This is the first study to our knowledge that has mapped coexisting networks that conduct different kinds of information within a single clinical team.

We found that learning and influence in the different domains studied flowed very differently, if at all. Clinical-technical knowledge flowed through densely connected networks. In contrast, the team networks relating patient centeredness were present but were sparse, and there were suggestion from interviews that there were important influences that the team and the profession. "Orgnaisation of work" appeared not to have any direct peer to peer spread. This suggests different strategies might be needed to introduce memes relating to different domains. New clinical technical knowledge is the the most likely to diffuse passively within a team. Patient centred behaviours have a limited degree of peer to peer transfer, and so enthusiasts might best role model these behaviours frequently, to multiple members of a team. Organizing work appears to be devoid of any spread or emulation, and human factor approaches might be more successful than role modelling.

Interviews provided triangulation for the survey finding of the existence of a few high clinical-technical influencers. Attributes of clinical-technical influencers included consistent kindness, and signs of conscientiousness. An interesting finding was that trainees appraised clinical management on the basis of visible diagnostic or therapeutic success. This is at odds with the fact that many diagnostic strategies deliberately aim for low yields, and many treatments have a high 'number needed to treat' or delayed outcomes: Therefore many correct management approaches have visible success only on rare occasions. This makes explanation of underlying logic important in teaching.

In relation to the spread of patient centeredness, trainees did not identify highly influential individuals, and it was actions themselves were seen as more or less worthy of emulation. Compassion, a concern for the impact of behaviors on the patients' internal psychological state was not volunteered as a driver. Instead, communication interactions were judged on the basis of 'getting the job done', for example, getting a message over accurately or getting the patient to agree with the doctor on a decision. The failure to talk about concern for the patient's emotions may be an artefact of the kind of language used day to day, and may not reflect an absence of compassion. However, the findings point to a need for leaders to be explicit about behaving to improve patient experience and to demonstrate and teach approaches such as shared decision making. An interesting finding was that trainees described that they looked to people they felt to be similar to themselves as their role models. Doctors felt they carried their own values from outside their professional life, and looked for validation, rather than looking to adopt new sets of values. If true, this has impactions for those hoping to inculcate values among trainees, suggesting that amplification of existing mores may be more appropriate.

Many of these findings are in keeping with existing literature. The presence of high influencers in healthcare teams is established. In keeping with our own results, the personality characteristics associated with this network influencing roles have been shown to include contentiousness and agreeableness.[21] The importance of perception of the utility of a practice, which we found to be key for adoption of ways of organizing work, is also described elsewhere.[22]

We have added an extra dimension to existing knowledge of healthcare professional networks by differentiating and describing social networks that spread different kinds of

work related information and influence in medical teams. This can inform teaching and communication strategies according to the domain of practice being targeted. Our findings also provide insight into how an individual might adapt their own behavior so as to exert more influence.

This work has a number of limitations. It was conducted in a single center, and may not be representative of all acute settings, although in mitigation, six different consecutive clinical teams were included over a period of 2 years. We limited the research to trainee doctors, and did not include other professions; previous work has described the importance of networks that span professional groups; it would be interesting to go on to perform more inclusive studies. Future research could explore how individuals from outside of the core team and from different disciplines exert influence, and how electronic media provides wider peer to peer links. The categorization of memes into three domains is pragmatic and certainly over simplistic, and there are many more subtle aspects of practice that could be explored in future work.

Conclusion: The social networks of influence and knowledge transfer among trainee doctors in an acute setting conform to quite different patterns when considering the spread of innovations in three domains, technical clinical, patient centered and organization of work. The characteristics and prevalence of highly influential individuals also differs between domains. This casts light on the way that practices develop across a team, informs those who wish to enhance their influencing, and emphasizes the importance of making desirable behaviors clearly visible to facilitate their spread. Knowing how these coexisting networks are configured and driven is likely to be useful for those leading quality improvement work that requires on the uptake of innovative behaviors across a clinical microsystem.

Contributor ship statement: PS conceived the study; PS and GS collected data; PS, GS, MH and IY all contributed to analysis and writing.

Data sharing statement: Data is not publicly available because a condition consent was that all interview and survey data would be destroyed after analysis.

Figure Legends:

Figure 1: Network graph showing directed connections that conduct clinical-technical knowledge and influence. Square = CT4-7 grades (registrar), Circles = CT 1-3 (SHO), Diamonds = FY 1-2 (house officer).

Figure 2: Graph for network relating to the patient centred behaviours.

Figure 3: Graph for network relating to the non patient-facing practices.

References

1.   Nelson EC, Godfrey MM, Batalden PB, Berry SA, Bothe AE, McKinley KE, et al. Clinical microsystems, part 1. The building blocks of health systems. Jt Comm J Qual Patient Saf Jt Comm Resour. 2008;34:367–78.

2.   Fernandez A, Teherani A, Boscardin CK, Saba GW. Assessment of medical
        students' shared decision-making in standardized patient encounters.
        J Gen Intern Med. 2011;26:367-72

3.   Burack JH, Irby DM, Carline JD, Root RK, Larson EB. Teaching compassion
        and respect; attending pysicians' responses to problematic behaviors. J Gen Intern
        Med. 1999; 14:49-55

4.   Swanwick T. Informal learning in postgraduate medical education: from
        cognitivism to 'culturism'. Medical Education. 2005; 39:859-865

5.   Lingard L, McDougall A, Levstik M, Chandok M, Spafford MM,
        Schryer. Representing complexity well: a story about teamwork, with
        implications for how we teach collaboration. Medical Education 2012: 46: 869–
        877

6.   Wenger, E. Communities of Practice: learning, meaning and identity. 1998
        Cambridge, Cambridge University Press

7   DeWitt C. Baldwin DC, Daugherty SR. How Residents Say They Learn: A National,
      Multi-Specialty Survey of First- and Second-Year Residents. J Grad Med Educ. 2016;
      8: 631–639.

8   Meltzer D , Chung J, Khalili P, Marlowa E, Arora V , Schumock G, Burt R. Exploring
      the use of social network methods in designing healthcare quality improvement
      teams. Soci(al Science & Medicine. 2010; 71: 1119-1130

9   Distin, K. 2004. The Selfish Meme: A Critical Reassessment. Cambridge: Cambridge
      University Press. doi:10.1017/CBO9780511614286

10   Acute Medicine Taskforce. Acute medical care. 2007.
      https://www.rcplondon.ac.uk/sites/default/files/documents/acute_medical_care_fi

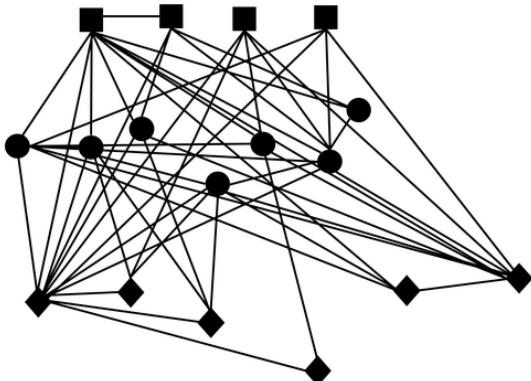nal_for_web.pdf (Accessed 7.4.19)

11 Bell D, Skene H, Jones M, Vaughan L. A guide to the acute medical unit. Br J Hosp
    Med. 2008; 69:M107-9.

12 Heath H, Cowley S. Developing a grounded theory approach: a comparison of Glaser
    and Strauss. Int J Nurs Stud. 2004;41:141–50.

13 Battistoni E, Fronzetti Colladon A. Personality correlates of key roles in informal
    advice networks. Learn Individ Differ. 2014;34:63–9.

14 Christakis N, Fowler JH. Social contagion theory: examining dynamic social networks
    and human behavior. Stat Med. 2013 Feb;32:556–77.

15 Rogers E. Diffusion of Innovations. New York: Free Press; 1983.

16 Wagter JM, van de Bunt G, Honing M, Eckenhausen M, Scherpbier A. Informal
    interprofessional learning: Visualizing the clinical workplace. J Interprof Care.
    2012;26:173–82.

17 Isba R, mWoolf K, Hanneman R. Social network analysis in medical education.
    Medical Education 2017: 51: 81–88

18 Shokoohi M, Nedjat S, Majdzadeh R. A social network analysis on clinical education
    of diabetic foot. J Diabetes Metab Disord. 2013;12:44–44.

19 Jippes E, Achterkamp MC, Brand PLP, Kiewiet DJ, Pols J, van Engelen JML, et al.
    Disseminating educational innovations in health care practice: training versus social
    networks. Soc Sci Med. 2010;70:1509–17.

20 Chambers D, Wilson P, Thompson C, Harden M. Social network analysis in healthcare
    settings: A systematic scoping review. PLoS ONE. 2012 [cited 2018 Apr 7];7. Available

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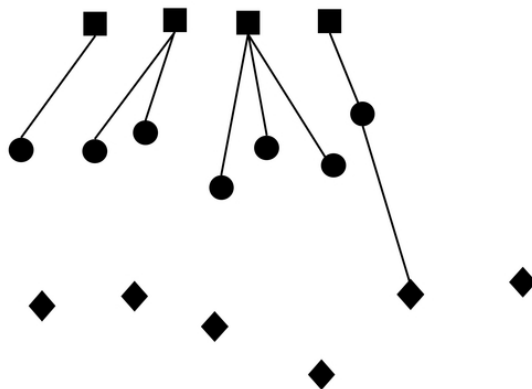from:http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0041911 (Accessed 10.4.19)

21 Fong A, Clark L, Cheng T, Franklin E, Fernandez N, Ratwani R, et al. Identifying influential individuals on intensive care units: using cluster analysis to explore culture. J Nurs Manag. 2017;25:384–91.

22 Murray E, Treweek S, Pope C, Macfarlane A, Finch T, C. O, et al. Normalisation process theory: A framework for developing, evaluating and implementing complex interventions. BMC Med. 2010;8:2–11.

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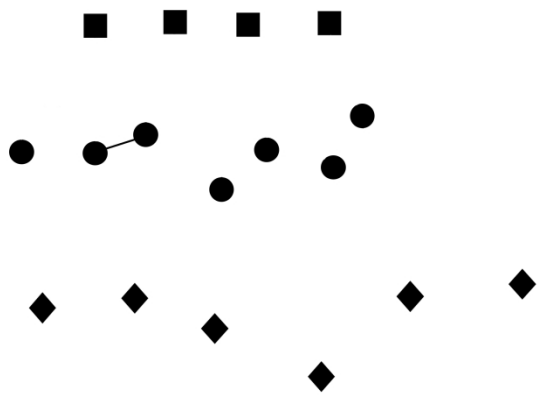47
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Box:

Examples used to illustrate meaning of domains

Clinical-technical: We mean information or ways of doing things to diagnose or treat disease. An example of influence in this domain would be when you are deciding whether to order a scan for pulmonary embolism, and might think of how a colleague has acted, or you might ask for advice.

Patient centred: This refers to behaviours that affect patient experience, such as communication, reassurance, going 'the extra mile' to do something for a patient. An example might be a nurse asks you to speak to a patient who is anxious; it is not your patient and you are busy. Do you help? Perhaps you might be influenced by what you've seen others do, or perhaps you would ask advice?

Self-organisation: The includes behaviours that impact on the efficiency, such as organising and prioritising your own work. An example would be ensuring all discharge documentation is done early in the day, to ensure that beds are freed. You might see someone else doing things a certain way, or might ask how others organise themselves.

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Survey questions: each question is presented with a list of all trainees in the team, with multiple selections permitted.

Have you asked someone what to do in terms of something clinical, e.g. how to diagnose or treat a patient? If so, who?

Have you ever approached a clinical problem a certain way because you had seen some one else do it a certain way? If so, who?

If you had a question about a clinical problem, and everyone was available, are there people you would be likely to choose to ask?

Have you asked someone what to do in terms of something to do with providing good patient experience, If so, who?

Have you ever approached an interation with a patient patient experience problem a certain way because you had seen some one else do it a certain way, in order to provide good experience? If so, who?

If you wanted to know what to do in terms of an interaction with a patient, is there anybody you would seek out?

Have you asked a team member you you should organise or prioritise a task, such as booking tests or doing paper work?

Have you ever changed the way you organise or prioritise works tasks, for example, when in the day you do discharge documents, because you saw a colleague take a certain approach?

Initial Interview guide

Sometimes, there are different ways of approaching a clinical problem, for example, should you do a scan, which choice of treatment should you use.

An example would be: Sometimes there is no evidence to support a decision; an example is, at what level of suspicion prompts investigation for pulmonary embolism. Some people are much more likely to order a scan in low risk cases. Others would avoid scanning when there is a very small likelihood of pulmonary embolism.

It might be that you take a certain approach because you've seen somebody else do it that way, or you might approach somebody from the team to ask advice; do you think that can happen?

Do you think there are some people you'd be more likely to copy, or ask?

Are there people who are particularly influential in this way?

Can you think about what it is about those people that makes you see them in that way?

Now thinking about ways you behave so as to produce good patient experience, an example behaviour would be: A nurse asks a doctor to review a patient in pain. The doctor is busy, and is not responsible for that patients. Some people will tell the nurse to call the relevant doctor. Some will take time to assess the patient and prescribe a pain killer.

Same questions

Now, thinking about ways you organise and prioritise the work you do away from patients. An example would be: Many people go through non patient facing tasks in an order that is easiest for them. You observe that one of your colleagues prioritises the tasks that will have the greatest benefit if done early, for example, preparing discharge documents so beds can be freed.

Same questions

Are there any other things you can think of about the way trainees in the team influence each other; and what makes someone especially influential?

Standards for Reporting Qualitative Research (SRQR)

No.	Topic	Item
Title and abstract		
S1	Title	TITLE PAGE
S2	Abstract	PAGE 3
Introduction		
S3	Problem formulation	PAGE 4 LINES 11-53
S4	Purpose or research question	PAGE 4 LINES 48-54
Methods		
S5	Qualitative approach and research paradigm	PAGE 6 PAGES 34-51
S6	Researcher characteristics and reflexivity	PAGE 7 LINES 5-15
S7	Context	PAGE 5 LINES 20-26
S8	Sampling strategy	PAGE 6 LINES 53-59
S9	Ethical issues pertaining to human subjects	PAGE 5 LINES 36-56
S10	Data collection methods	PAGE 6 LINES 27-39 AND PAGE 9, 5-51
S11	Data collection instruments and technologies	na
S12	Units of study	PAGE 6 LINES 8-19
S13	Data processing	PAGE 7 LINES 44-51
S14	Data analysis	ditto
S15	Techniques to enhance trustworthiness	PAGE 7 LINES 48-52
Results/Findings		
S16	Synthesis and interpretation	PAGE 8 LINE 11 and ff
S17	Links to empirical data	PAGE 9 LINE 12 and ff
Discussion		
S18	Integration with prior work, implications, transferability, and contribution(s) to the field	PAGE 14 LINE 27 and ff
S19	Limitations	PAGE 16 LINE 29-43

Other	
S20 Conflicts of interest	As per submission web page
S21 Funding	As per submission web page

[a]The rationale should briefly discuss the justification for choosing that theory, approach, method, or technique rather than other options available, the assumptions and limitations implicit in those choices, and how those choices influence study conclusions and transferability. As appropriate, the rationale for several items might be discussed together.