

Examining the socialising and problem-solving networks of clinicians on a hospital ward

Stream: Social network research and analysis

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ABSTRACT

Using a social network analysis approach this paper examines the communication and interaction patterns of clinicians on a hospital ward. Good communication and teamwork are important for the provision of good quality health care. We do not understand the complex interaction and communication patterns, particularly between professional groups and between senior and junior clinicians. A social network questionnaire was administered to staff (n=45) in a ward at an Australian metropolitan teaching hospital. This included doctors, nurses, allied health professionals and the ward clerk. This paper focuses on socialising and problem-solving interactions within and between clinician groups. Clinicians were found to interact more within their own profession. Clinicians in certain roles were found to interact across professional groups and acted as brokers. It was concluded that the nature of multidisciplinary healthcare interactions are quite limited in their multidisciplinaryity, despite efforts to encourage interaction and teamwork. The implication of this paper is that information systems that allow or encourage interaction without requiring it to be face-to-face may increase the exchange of information between clinicians. Social network analysis was found to be a useful approach that provided an overview of the complex interactions between groups of health care professionals.

BACKGROUND

Good communication and effective teamwork between clinicians are important in the provision of high quality care to patients (Borrill et al. 2000; Haward et al. 2003).

Poor communication wastes time, threatens patient care and may be one of the chief culprits behind preventable adverse events in clinical practice (Gosbee 1998). Good relationships were also found to be important in the diffusion of innovation amongst clinicians of different professions (Fitzgerald et al. 2002) and within the same profession (Russell et al. 2004). Communication between clinicians is complex and has not been studied to a great extent. We do not fully understand the interaction and communication patterns that occur between clinicians when they carry out their work, particularly the interactions between clinicians from different professional groups and between senior and junior clinicians within professional groups. Social network analysis provides a useful approach by which to examine and measure the communication patterns and interactions of professional groups in hospital wards. Previous studies which have used a social network analysis approach to investigate staff in health care organisations have found that staff in certain positions play important roles in the exchange of information within their networks (Anderson 1991; Aydin et al. 1998; Heng, McGeorge and Loosemore 2005; West et al. 1999). In one social network study of clinicians working in long-term geriatric care wards, staff were found to be dichotomised into two core groups: one made up of doctors, allied health professionals and senior nurses, and the other made up of more junior nurses (Cott 1997).

Much of the health care quality and safety literature points to the important role of multidisciplinary well-functioning clinical teams, yet a recent review of the major health care enquiries investigating significant failures in health systems such as those investigating the King Edward Memorial Hospital in Perth, the Bristol Royal Infirmary in the United Kingdom and the Campbelltown and Camden hospitals in

Sydney has identified several common reasons leading to errors in care (Hindle et al. 2006). In essence these have included systematic breakdowns in communication and information exchange contributing to errors. Nearly all health care enquiries have called for fundamental changes in the ways in which various health care professional groups work together, relate to each other and to their patients. Without a deeper understanding of current communication and networking patterns between clinicians, effective interventions to improve patient care cannot be designed or tested. In this study we applied social network analysis to measure interaction patterns between and within clinician groups in a hospital ward.

METHOD

A ward in an Australian metropolitan teaching hospital was selected for this study in consultation with the clinical sponsors of a planned information technology implementation at the hospital. A social network questionnaire was developed and distributed to all staff who work in the ward. This included doctors, nurses, allied health professionals and the ward clerk. A profile of the ward staff is shown in Table 1. Before the study in this ward, the questionnaire was piloted in another hospital ward, and in a modified format in two research centres.

Table 1: Profile of the ward staff

Setting	Australian metropolitan teaching hospital
Specialty	Renal
Total number of staff on ward	47
<i>Doctors</i>	10
<i>Nurses</i>	30
<i>Allied health</i>	6
<i>Other</i>	1

A whole network approach was used to capture the interactions that occur between staff members of the ward when carrying out their work. This approach allowed the elicitation of patterns of connections that occur between all staff who work in this clinical setting. The social network questionnaire, consisting of a roster design, contained a list of the names of all staff members who regularly work on the ward. The researchers defined the boundary of the network as those staff who regularly worked on the hospital ward. This list of names was produced in consultation with the nursing unit manager and a senior doctor. The questionnaire required the respondents to answer social network questions, demographic questions and attitudinal questions regarding communication. The five social network questions were:

- a. How often do you ask this person to help solve a work related problem?
- b. How often does this person ask you to help solve a work related problem?
- c. How often do you socialise (have lunch or go to coffee) with this person?
- d. How often do you seek advice from this person about medication decisions/tasks?
- e. How often does this person seek advice from you about medication decisions/tasks?

Respondents were required to report the frequency of their interactions with other members on the ward using on an 8-point scale ranging from 0 (Not once in the last year) to 7 (several times a day). The demographics collected in the questionnaire included job title, length of experience in profession, length of time working at the hospital, length of time working on the ward, full- or part-time, age, sex, and usual shift. The attitudinal questions used a 5-point Likert scale to measure the agreement or disagreement with statements regarding communication in the ward, for example “If doctors and nurses talked more frequently, patient care would be improved.”

This paper focuses on the results from two of the social network questions, with visual analysis of nodes according to the attribute of profession. The two social network questions analysed in this paper are:

1. How often do you socialise (have lunch or go to coffee) with this person?
2. How often do you ask this person to help solve a work related problem?

The social network questionnaire was completed by 45 of the staff (n=45), giving a response rate of 95.7%. The number of staff in each position who work in the ward, and the number of staff in each position who completed the questionnaire are shown in Table 2. The initial response rate was about 30%. Those who did not complete the questionnaire in the first round were followed up by letter, telephone and in person by the first researcher in order to increase the response rate. The resulting data consists of multi-relational, valued, directed ties between the 47 staff who work in the hospital ward. Analysis of this data was performed using Netdraw (Borgatti 2002).

Table 2: Positions of ward staff and survey respondents

	Staff who work on ward	Staff who completed questionnaire
Senior doctors	5	5
Junior doctors	5	4
Senior nurses	9	9
Registered nurses	15	14
Enrolled nurses & trainees	6	6
Allied health professionals	6	6
Ward clerk	1	1
Total	47	45

The survey responses were entered into a Microsoft Access database, and reports were exported from Access to allow analysis of the data using Netdraw (Borgatti 2002). Sociograms of the networks were produced in Netdraw (Borgatti 2002) for initial visual analysis of the networks and to display the results of various measures

performed in Netdraw. Substructures of the networks were measured in order to examine the interactions between and within clinician groups. These measures were performed on the data using Netdraw. The measures performed were a weak components analysis, blocks and cut-points analysis, k-cores analysis, hierarchical clustering of geodesic distances, faction analysis and a Newman-Girvan analysis of subgroups, which is a blockmodelling approach. A weak components analysis measures the number of parts of the network in which all nodes are connected (Monge and Contractor 2003: p43). A blocks and cut-points analysis identifies the nodes which if removed, would divide the network into separate unconnected components or blocks (Scott 2000: 107). A k-core analysis measures groups of nodes that are connected to at least k other nodes in the group (Wasserman and Faust 1994: p 266). Hierarchical clustering of geodesic distances groups nodes together according to the similarity of their distances to other nodes (Hanneman and Riddle 2005). Faction analysis groups nodes into substructures consisting of nodes that are more connected to each other than to nodes in other factions (Hanneman and Riddle 2005). A Newman-Girvan analysis of subgroups is a blockmodelling approach that, similar to the faction analysis, divides nodes into groups of nodes that are more connected within the group than between the groups (Hanneman and Riddle 2005).

RESULTS

Analysis of the cliques and subgroups that occur in the interaction patterns between and within clinician groups in the ward is presented for these relations:

1. Socialising (having lunch or going to coffee)
2. Interaction when asking for help to solve a work-related problem

Socialising

The social network diagram in Figure 1 shows the network of the socialising relation between clinicians in the ward. The nodes are colour-coded by the attribute of profession, with nurses in blue, doctors in red, allied health professionals in yellow and the ward clerk in green. The nodes are labelled using categories of staff positions shown in Table 3.

Table 3: Node labels for staff positions

Node label	Staff positions
Senior doctor	Visiting medical officers; Staff specialists
Junior doctor	Registrars; Residents
Senior nurse	Nurse unit manager; Clinical nurse consultant; Clinical nurse educator; Clinical nurse specialist; Discharge planner; Clinical coordinator
Senior RN	Registered nurses years 5+
Junior RN	New graduate nurses; Registered Nurses years 1-4;
EN	Enrolled nurses
TEN	Trainee enrolled nurses
Allied health	Dietician; Occupational therapist; Pharmacist; Physiotherapist; Social worker; Speech pathologist;
Other	Ward clerk

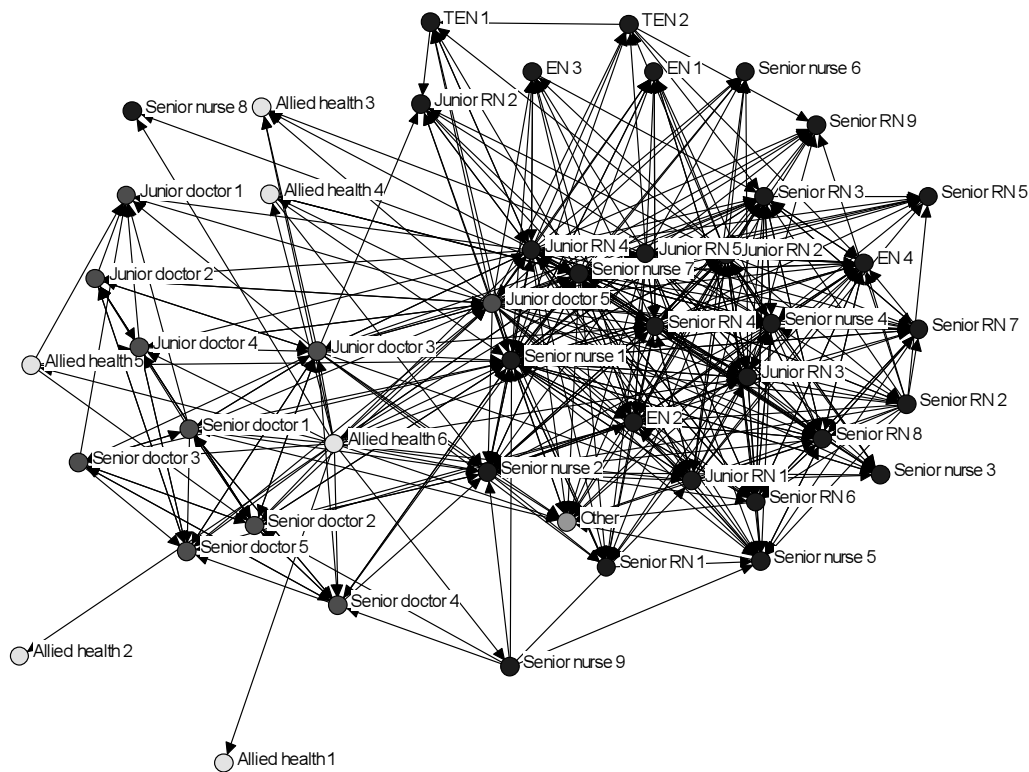


Figure 1: Interaction when socialising colour-coded by profession

The right-hand side of the socialising network in Figure 1 is very dense, whereas staff on the left-hand side appear more sparsely connected. All the nodes are connected with no isolates, which indicates that all staff socialise with each other at work at least once a year. Senior nurses 1 and 7, Senior RN 4 and Junior doctor 5 appear to be at the centre of the socialising network. They socialise (go to lunch or have coffee) with more people and more frequently than the nodes on the periphery of the network. The dense section on the right-hand side of the network is made up mainly of nurses, indicating that the nurses socialise mainly with other nurses. The sparser right side of the network is composed principally of doctors and allied health professionals, with the doctors mainly adjacent to other doctors. This indicates that the doctors socialise mainly amongst themselves. The location of most of the allied health professionals on

the periphery shows that they do not socialise with many other staff members who work in the ward.

What subgroups or cliques are found in the socialising network?

In order to analyse how much interaction there is within and between professions, the existence and composition of subgroups and cliques were studied. Substructures of networks can be detected using a variety of tools for visualising and measuring the arrangement and organisation of groups of nodes.

In a weak components analysis of the socialising network in Figure 1 using Netdraw, all nodes were found to be contained in the one component. Another technique, a blocks and cut-points analysis was run on the same network using Netdraw. “Allied health 6” was found to be a cut-point node, which if it was removed would disconnect “Allied health 1” and “Allied health 2” from the rest of the network.

A K-cores analysis was run on the network in Figure 1. The resulting network diagram is shown in Figure 2. The levels of K of the cliques are presented in Table 4. There are two very clearly defined k-cores shown in the network in Figure 2. The largest clique is shown in blue and is made up mainly of nurses. The only non-nursing members of the blue k-core are “Junior doctor 5” and “Other”(ward clerk). This indicates that nurses tend to socialise with each other. It also highlights that “Junior doctor 5” is the only doctor who socialises more with nurses than with other doctors. The other obvious group of nodes are those coloured red, made up mainly of doctors. This cannot be formally called a clique, as “TEN1” is not connected to the other red nodes. However the red nodes in the left side of the network, still appear to

be grouped, though more loosely than the blue nodes. The one non-medical member of the set of connected red nodes is “Senior nurse 9”. This nurse is not a ward nurse, and mainly comes to the ward in order to attend the weekly multidisciplinary meeting.

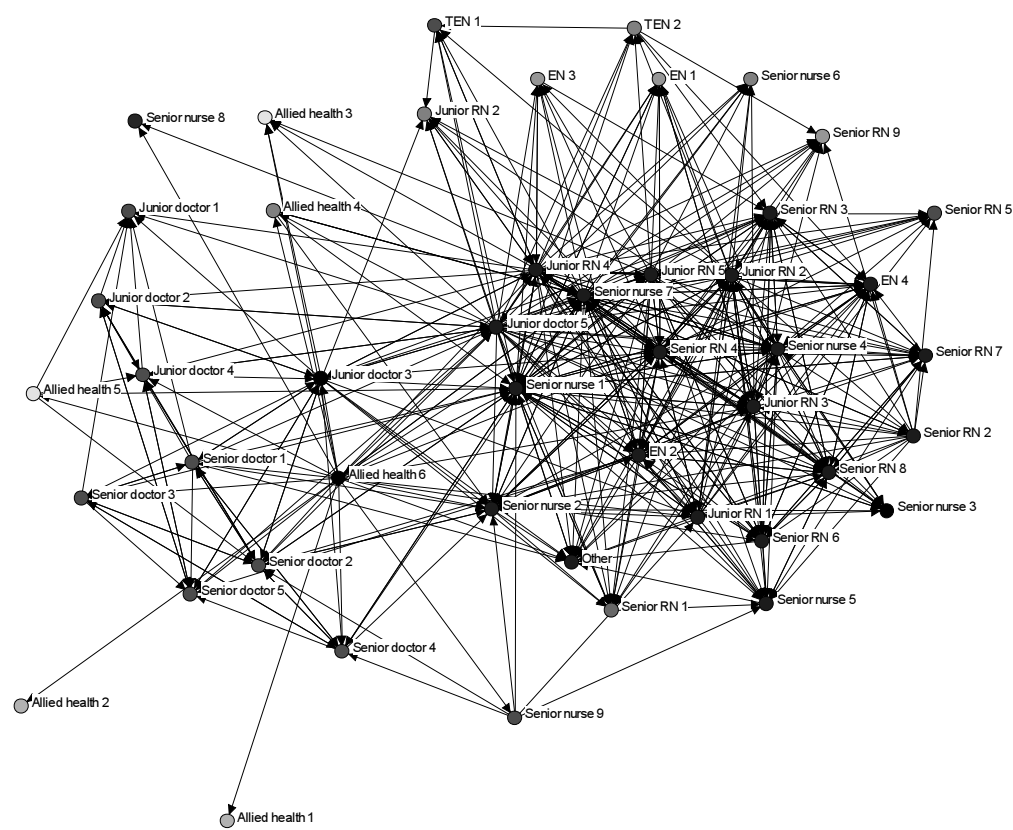


Figure 2: Interaction when socialising colour-coded by k-core

Table 4: K-levels of cliques in the socialising network

K-core in Figure 2	K-level	Number of nodes in K-core	Nodes connected in K-core
Blue	14	20	20
Pink	12	1	N/A
Black	11	3	2
Dark green	10	1	N/A
Light green	9	3	0
Grey	8	3	3
Red	7	10	9
Orange	6	1	N/A
Yellow	5	2	0
Maroon	2	1	N/A
Aqua	1	2	0

A hierarchical clustering of geodesic distances performed on the socialising relation shown in the previous figures, produces 37 different diagrams showing clusters of aggregation of nodes. Geodesic distance is the length of the shortest path between two nodes. In Figure 3, the nodes are colour-coded according to hierarchical geodesic distance clusters. Nodes of the same colour are similar in their distance to all other points in the cluster. This figure shows the hierarchical geodesic distance cluster diagram 34 of 37. Figure 4 shows an earlier hierarchical geodesic distance cluster diagram, number 18 of 37. In Figure 4, nodes of the same colour are more homogenous than the nodes of the same colour in Figure 3. That is, they are more similar in their geodesic distance to other nodes in the same cluster. For example, the Senior doctors are shown in red in both figures, but in the figure showing a higher level of geodesic distance clustering (Figure 4), Junior doctors 1, 2 and 4 are in green, indicating that they have geodesic distances more similar to each other than to the Senior doctors.

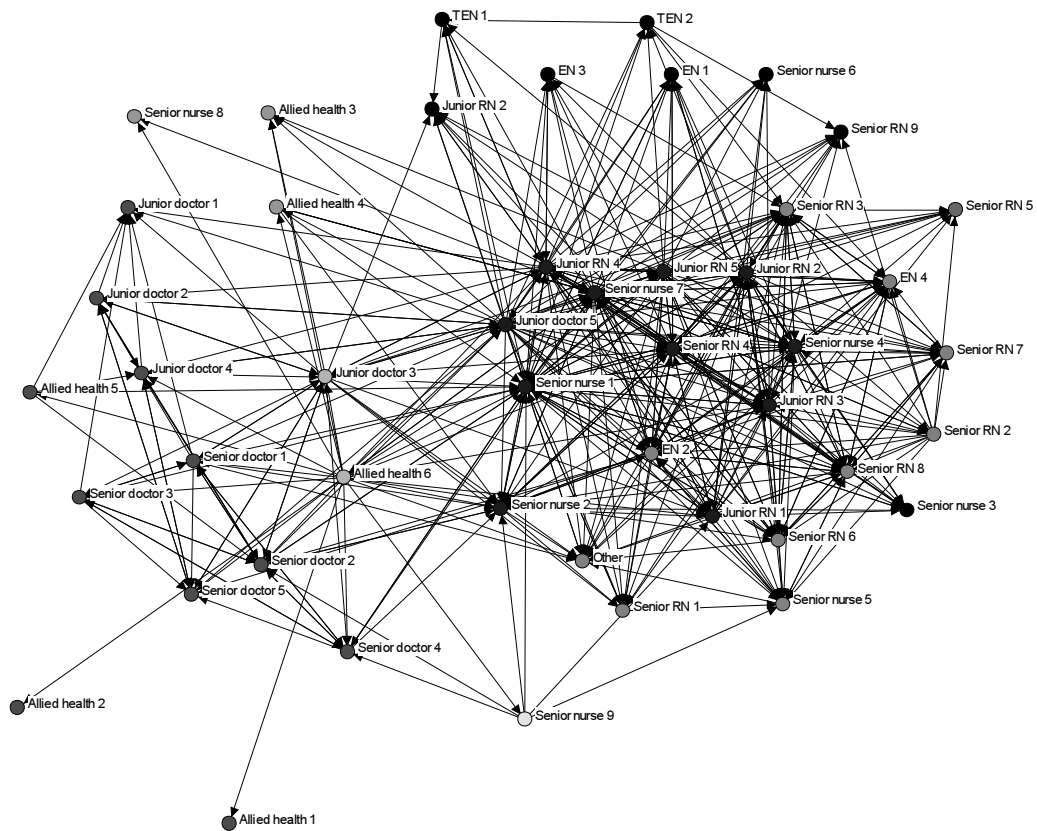


Figure 3: Interaction when socialising colour-coded by hierarchical geodesic distance clusters (34 of 37)

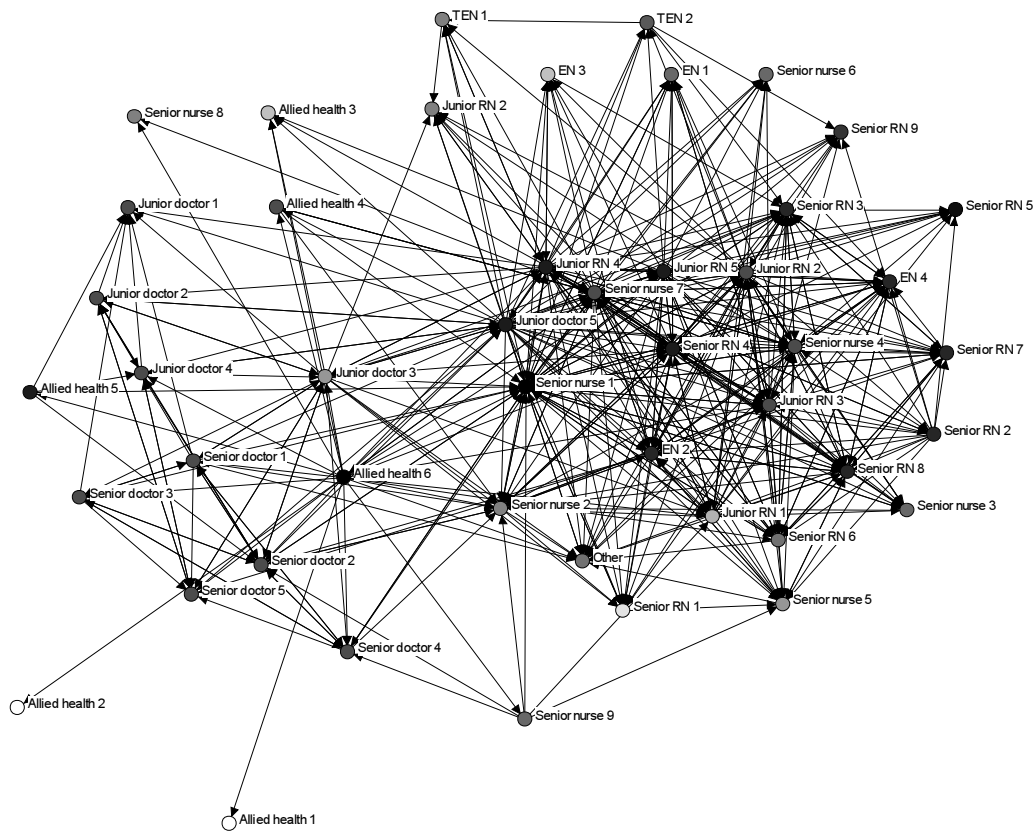


Figure 4: Interaction when socialising colour-coded by hierarchical geodesic distance clusters (18 of 37)

Using Netdraw, a faction analysis was performed on the socialising network. With the number of factions set to two, the social network shown in Figure 5 resulted. Almost all of the nurses belong to the blue faction. The blue faction also includes “Junior doctor 5”, “Allied health 4” and the ward clerk. The red faction is made up of doctors, allied health professionals and two senior nurses.

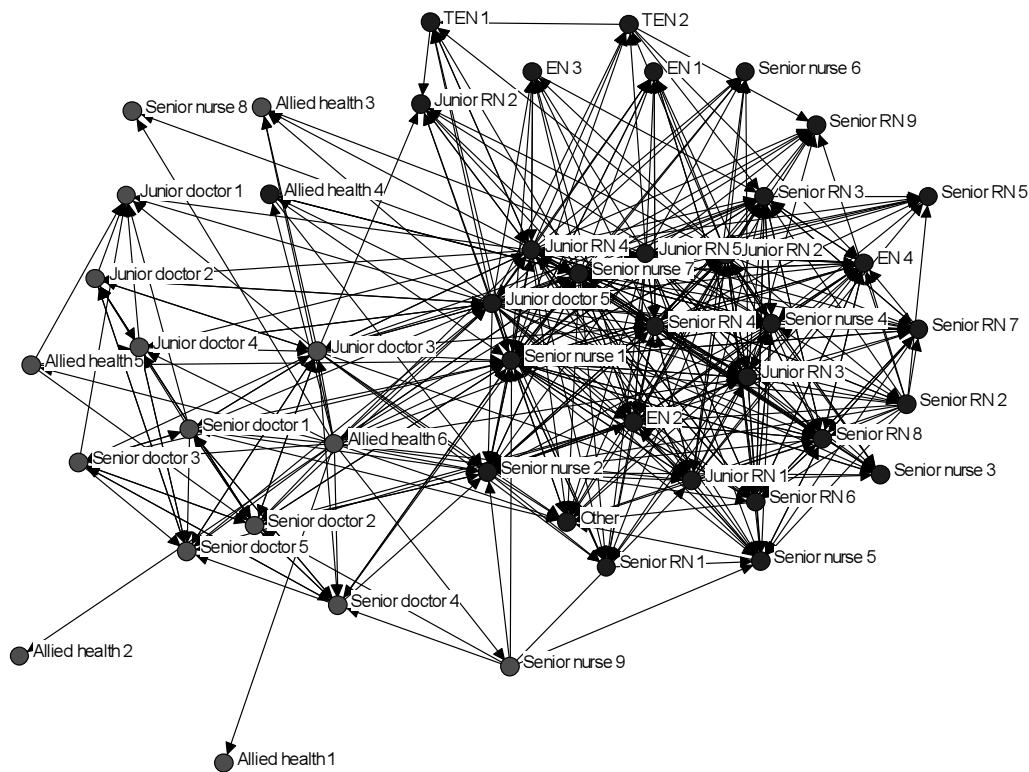


Figure 5: Interaction when socialising colour-coded by faction

A Newman-Girvan analysis of subgroups, a blockmodelling approach, was run on the socialising relation using Netdraw. The nodes split into four Newman-Girvan partitions with a goodness of fit factor of $Q=-0.000$. All but four of the ward staff were in the largest partition, indicating that most staff could be considered one large group. With the nodes split into 27 Newman-Girvan partitions, with a goodness of fit factor of $Q=0.022$ in Figure 6, there is one large partition shown in blue made up mainly of nurses, but also including Junior doctor 5 and the ward clerk. There are other, smaller partitions: the light green partition, which consists of Senior doctor 5, Junior doctor 2, and Junior doctor 4; the red partition consisting of Senior doctors 1 and 2; and the dark green partition made up of Senior nurse 9 and Senior RN1.

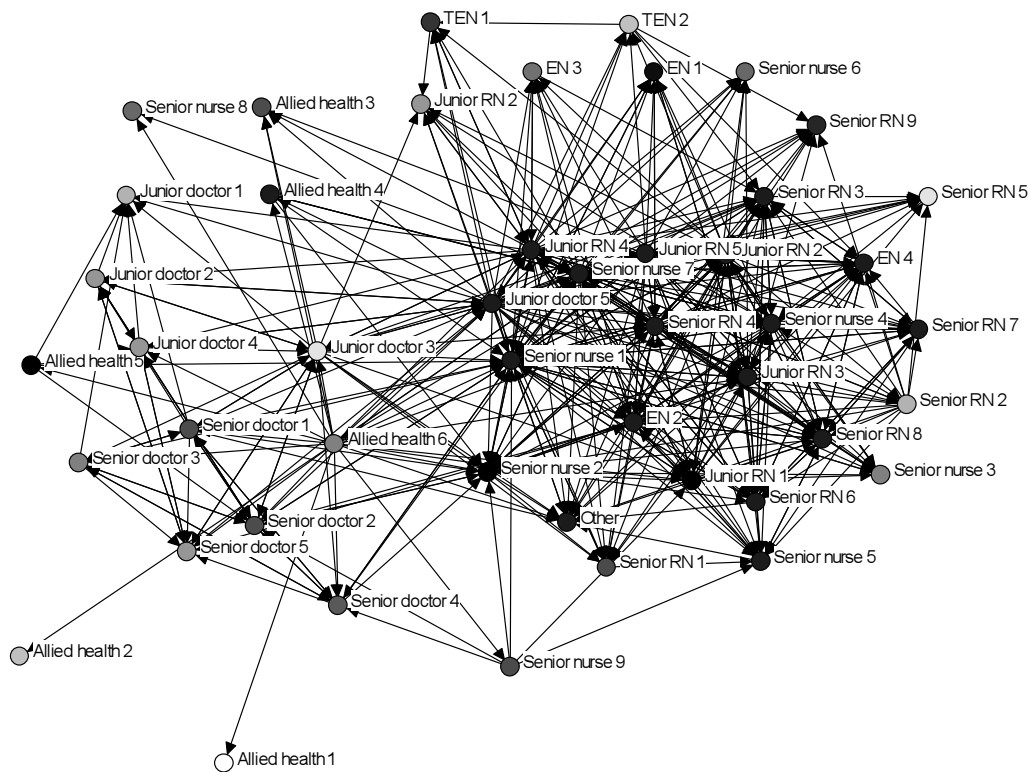


Figure 6: Interaction when socialising colour-coded by 27 Newman-Girvan partitions

Asking for help to solve a work-related problem

The social network diagram in Figure 7 shows the frequency of interaction between clinicians when they are asking for help to solve a work related problem. The nodes are colour-coded by the attribute of profession, with nurses displayed in blue, doctors displayed in red, allied health professionals displayed in yellow and the ward clerk displayed in green. The nodes are labelled using categories of staff positions shown in Table 3.

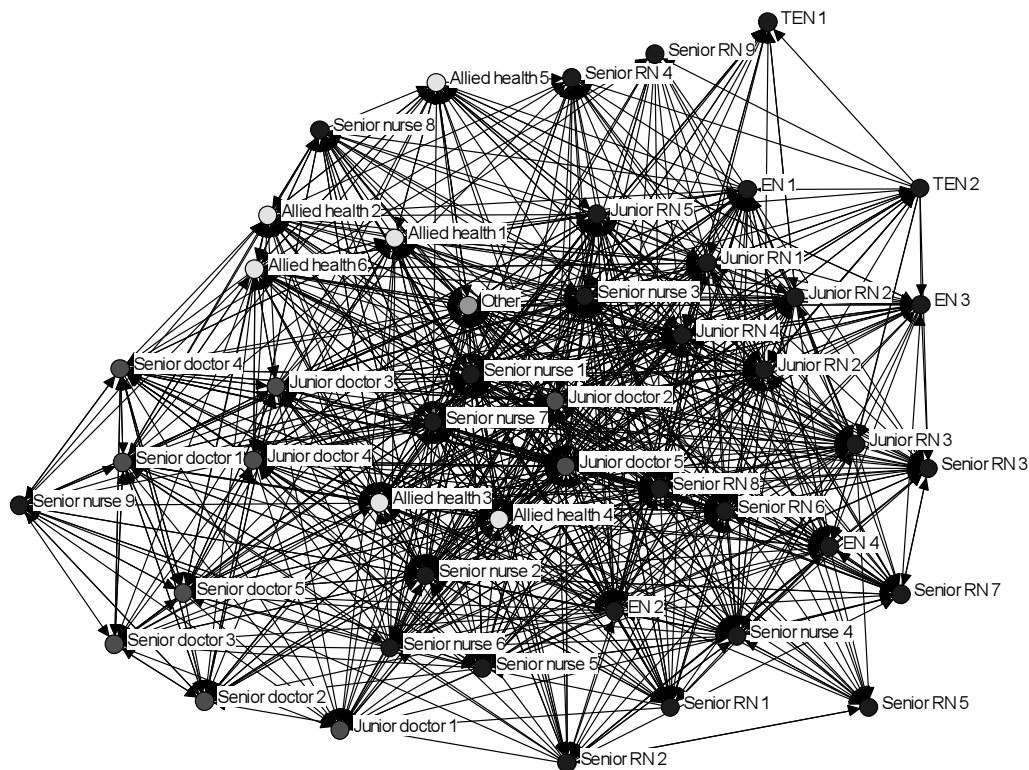


Figure 7: Interaction when asking for help to solve work related problems colour-coded by profession

The colour coding in the network in Figure 7 shows that clinicians are positioned closely to colleagues from their own profession. The nurses are positioned mainly on the right-hand side of the network, the doctors are positioned mainly in the bottom left quarter of the network and the allied health professionals are positioned mainly in the top left quarter of the network. This indicates that when asking for help to solve a work related problem, the members of the ward ask colleagues from within their own profession.

What subgroups or cliques are found in the asking for help to solve a work related problem network?

Like in the weak components analysis of the socialising network, all nodes in Figure 7, were found to be contained in the one component. A blocks and cut-points analysis was run on the network using Netdraw, and all nodes were found to belong to a single block, with no nodes acting as cut-points.

A K-cores analysis was run on the asking for help to solve a work related problem relation. The resulting network diagram is shown in Figure 8. The levels of K of the cliques are presented in Table 5. There is one very large clique shown in this network, the nodes shown in blue, made up of most of the nurses in the ward as well as most of the allied health professionals and four of the five junior doctors. The second largest k-core is made up of the red nodes, though this is not a clique as two of the red nodes are not adjacent to the other red nodes. Three senior doctors belong to this group, as well as the most senior of the junior doctors, Junior doctor 1. Two other senior doctors (Senior doctors 2 and 3) belong to their own k-core of two. These groupings indicate that most nurses, junior doctors and allied health professionals frequently ask each other for help to solve work-related problems. More senior doctors, however, mainly ask other senior doctors for help to solve work-related problems.

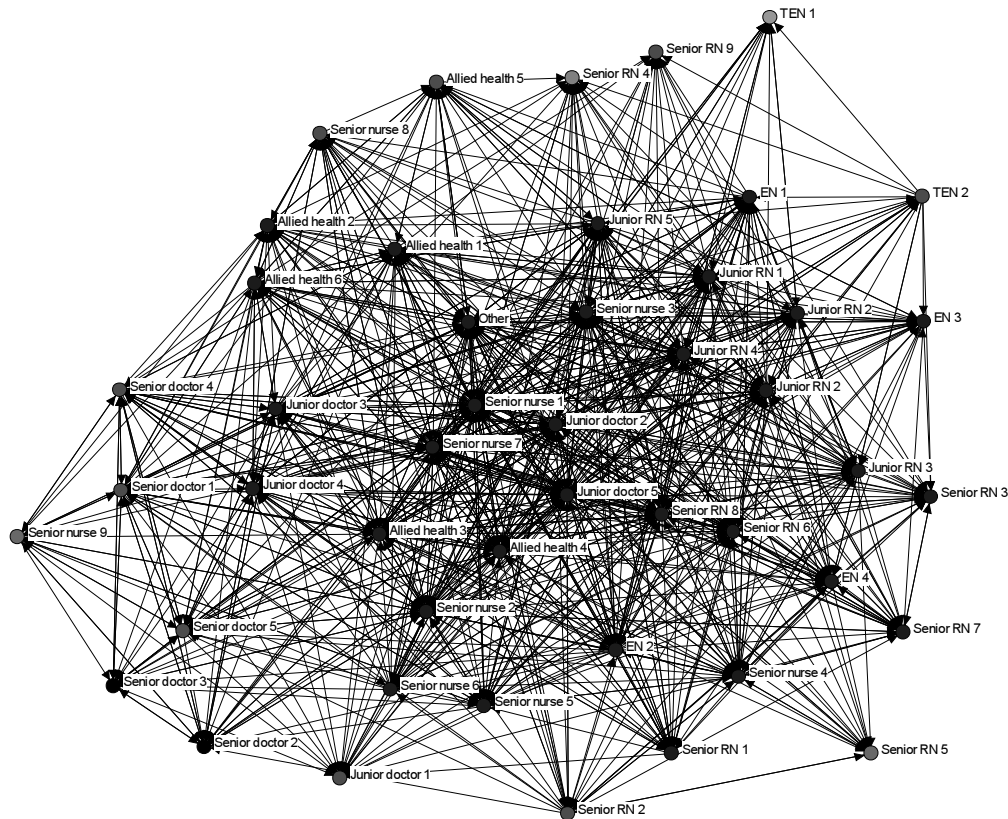


Table 5: K-levels of cliques in asking for help to solve a work related problem relation

A hierarchical clustering of geodesic distances performed on the socialising relation shown in the previous figures produces 40 different diagrams showing clusters of aggregation of nodes. Geodesic distance is the length of the shortest path between two nodes. In Figure 9, the nodes are colour-coded according to hierarchical geodesic

distance clusters. Nodes of the same colour are similar in their distance to all other points in the cluster. This figure shows the hierarchical geodesic distance cluster diagram 33 of 40. Figure 10 shows an earlier hierarchical geodesic distance cluster diagram, number 28 of 40. In Figure 10, nodes of the same colour are more homogenous than the nodes of the same colour in Figure 9. That is, they are more similar in their geodesic distance to other nodes in the same cluster. For example, the Junior doctors 3 and 4 are shown in blue in Figure 9, but in the figure showing a higher level of geodesic distance clustering (Figure 10), Junior doctors 3 and 4 are in purple, indicating that they have geodesic distances more similar to each other than to the large group of blue nurses, allied health and other junior doctors. In both figures, it is clear that the senior doctors share similar geodesic distances to other senior doctors, and there is a large group of nurses, allied health and junior doctors who share similar geodesic distances to each other.

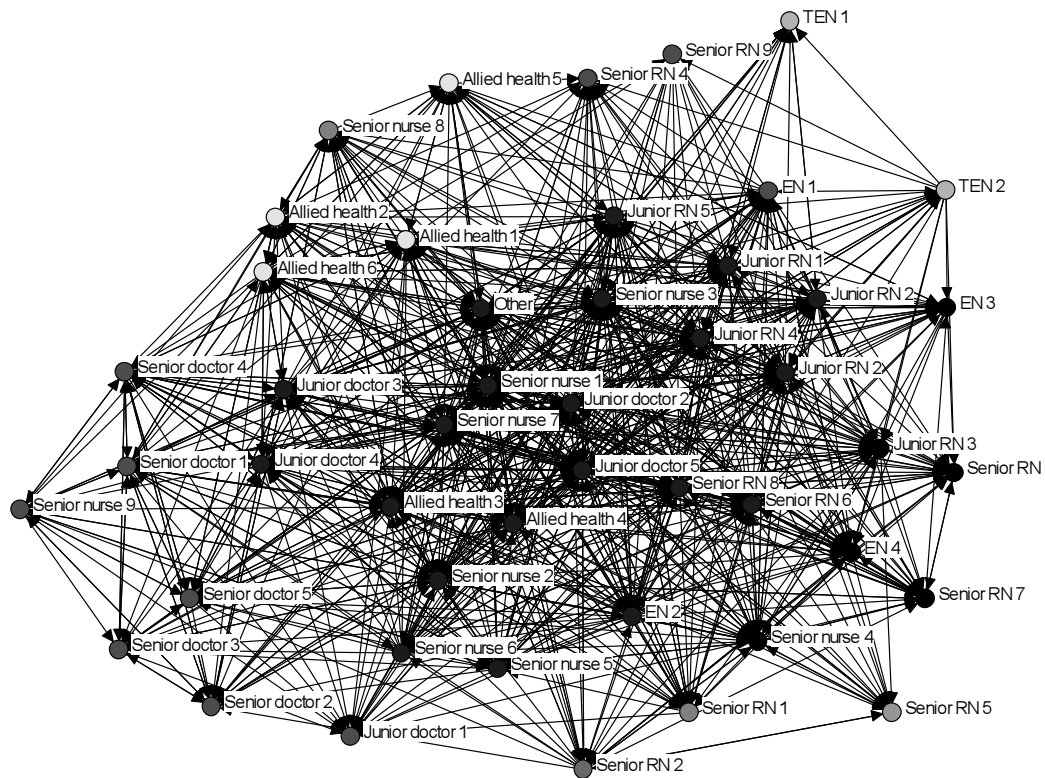


Figure 9: Interaction when asking for help to solve a work related problem colour-coded by hierarchical geodesic distance clusters (33 of 40)

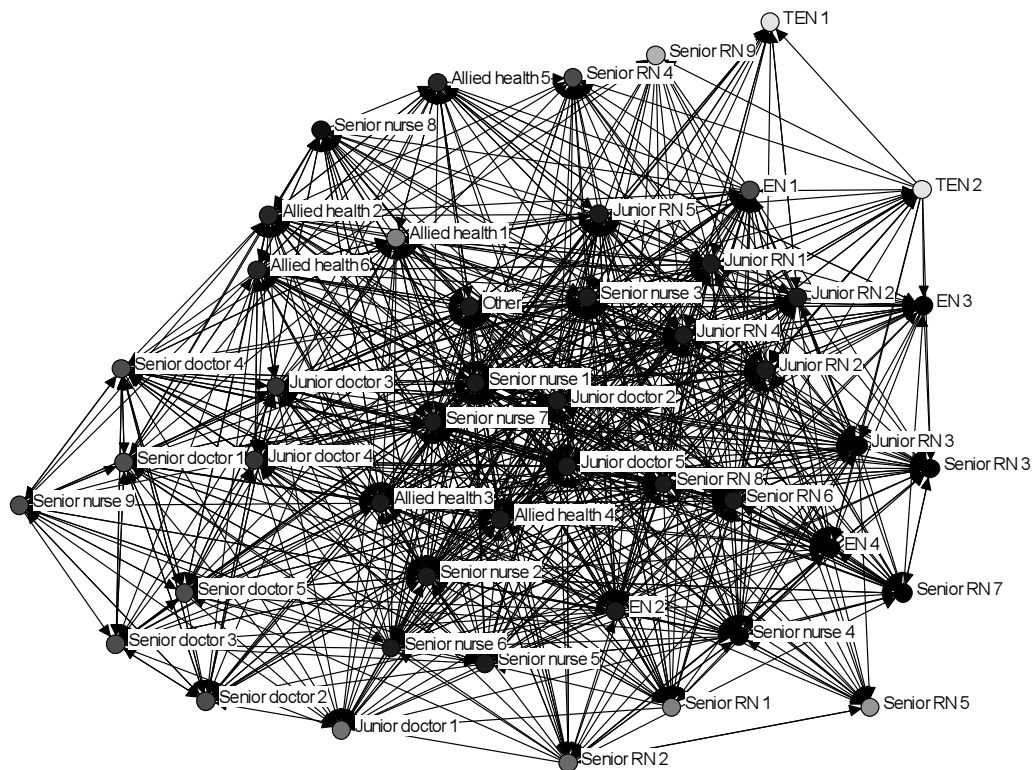


Figure 10: Interaction when asking for help to solve a work related problem colour-coded by hierarchical geodesic distance clusters (28 of 40)

Using Netdraw, a faction analysis was performed on the asking for help to solve a work related problem network. With the number of factions set to three, the social network shown in Figure 11 resulted. The large blue faction is made up mainly of nurses, with two junior doctors, two allied health professionals and the ward clerk also belonging. All doctors except for two junior doctors belong to the red faction. The red faction also contains three allied health professionals and a senior nurse. The black faction is made up mainly of nurses, with one allied health professional also belonging to the black faction.

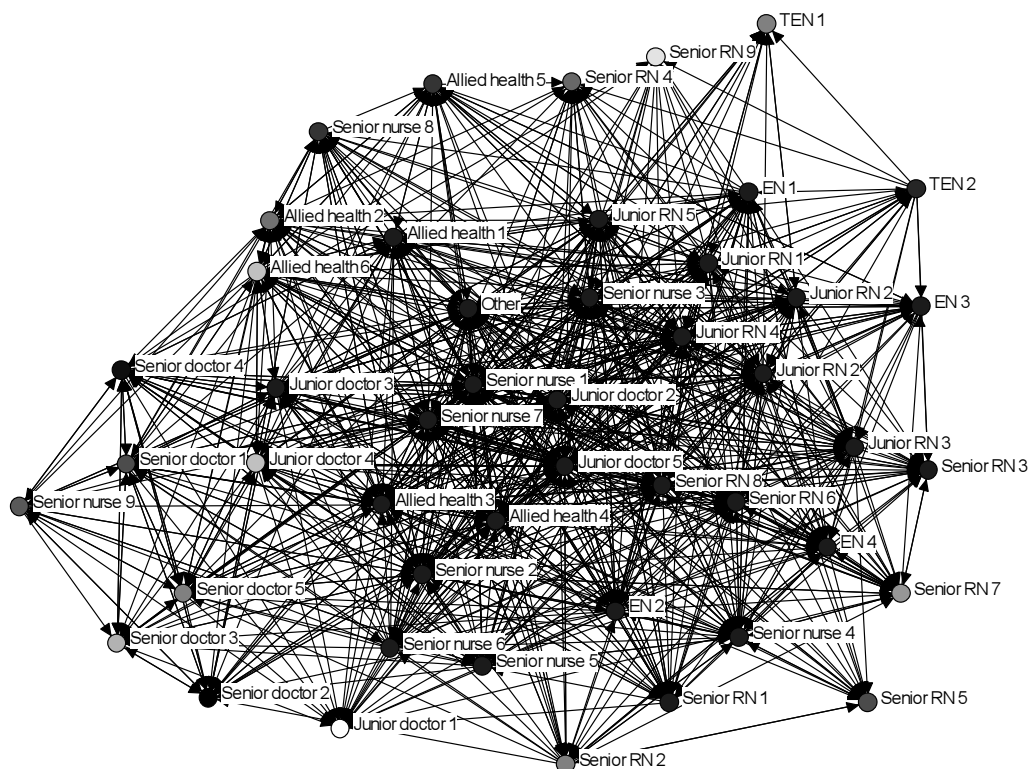


Figure 12: Interaction when asking for help to solve a work related problem colour-coded by 17 Newman-Girvan partitions

DISCUSSION

Subgroups within the ward are made up of mainly one profession. This is particularly evident in the large central group of nurses. This is consistent with the work of Degeling, Kennedy and Hill (2001) showing that health professionals tend to work mainly within their own professional groups. Our results showed that senior doctors tend to ask other senior doctors for help to solve a work related problem (shown in Figure 8). This is similar to the findings in West et al.'s (1999) study of senior doctors and senior nurses, where senior nurses were more likely to consult their junior colleagues than were senior doctors. Like Cott's (1997) finding in her study of long-term geriatric wards, in our study the staff appear to be split into two groups, one

consisting of doctors, senior nurses and allied health professionals, and the other consisting of nurses.

The location of most allied health professionals on the periphery of both socialising (Figure 1) and asking for help to solve a work related problem (Figure 7) networks is explained because they see patients in multiple wards in the hospital. This is unlike most of the nurses who are mainly rostered to work on just this ward, and the doctors, who though they see patients in other wards, have most of their patients staying in this ward. Allied health professionals are located at the periphery of the socialising network (shown in Figure 1), indicating that they do not socialise much with staff members of the ward because they socialise with other members of each of their own particular allied health departments.

Some clinicians in particular roles interact across professional groups. For example, Allied health professional 6 plays an important role as being the cut-point that joins Allied health professionals 1 and 2 to the rest of the socialising network, but also as the most central allied health professional in the socialising network, socialising with a number of doctors and nurses (see Figure 1). Another example of clinicians in particular roles interacting across professional groups are junior doctors and senior nurses. Junior doctors interact more with nurses than do their senior colleagues (particularly illustrated in Figure 8) and some senior nurses interact more with doctors (also shown in Figure 8). The junior doctors interact more with the nurses than do the senior doctors because the junior doctors have more of a role in the every day work carried out in the ward. The senior nurses interact more with the doctors than the ward nurses because the senior nurses are involved in the weekly multidisciplinary meeting,

where as the more junior nurses and other senior nurses are not. These findings correspond to those in Cott's (1997) model of the doctors, senior nurses and allied health professionals making decisions and the junior nurses carrying out the work that is required to put the decisions into action. In our study the junior doctors were found to be grouped more with the ward nurses (shown in Figure 8). The junior doctors are less involved in the decision-making and more involved in the carrying out of work, and therefore interact more with the ward nurses. In fact, the junior doctors are involved in both the decision-making and in carrying out every day work on the ward, and this is why they interact with both senior doctors and ward nurses. The junior doctors could also be considered to be acting in a brokering or bridging role between the senior doctors and the ward nurses, like in Heng, McGeorge and Loosemore's (2005) study where particular hospital staff were found to be the brokers between hospital departments.

Social network analysis provided the researchers with the means to study the complex patterns of relationships, by analysing communication and interaction patterns between ward staff members. Specifically, social network analysis techniques were useful in detecting cliques or subgroups that exist in the work relationships between the ward staff, and in identifying clinicians who play important roles in linking these subgroups.

The results demonstrate support for the view that the level of multidisciplinary teamwork within an average clinical ward, as measured by their work interactions is limited with most interaction occurring within professional groups and not across groups. This professional tribalism is further evidenced by the lack of social

interaction between clinician groups. These results in many ways reinforce the findings made by some of the major health care enquiries (Hindle et al. 2006). The ability to solve system problems, often the source of significant clinical errors in the health system, is difficult when health care professionals are not working within well functioning teams. New interventions which may impact upon communications between and within health professional groups include the introduction of electronic health record systems. These systems are in the process of being introduced into Australian hospitals. When one such system was introduced in a United States hospital, Shu et al. (2001) found that interns spent more time alone and less time talking to other doctors, and in a recent example of the impact of information systems on ward communication, a French study found that once an electronic prescribing system was introduced, doctors and nurses had less chance to interact and discuss prescribing decisions (Beuscart-Zephir et al. 2005). Other studies have found that new computer systems lead to new, increased communication with colleagues (Aydin et al. 1998; Aydin and Rice 1992). These changes in communication patterns following system implementation may impact on the quality of clinical decisions made. Thus it is important to study the impact that new information systems have on the way clinicians interact with each other. Our aim in the next stage of this research is to study the impact of these clinical information systems on social networks within hospital wards to understand the ways in which interactions between and within professional groups change when these systems are introduced.

CONCLUSION

Clinicians interact more within their own profession, than with those from other clinical professions, both in problem-solving and social relationships at work.

However, clinicians in particular roles have a bridging role and interact across professional groups. Yet even individuals in these roles do not interact socially across professional groups to any large extent. This has implications on teamwork and quality and safety where good quality interactions and communications across multidisciplinary teams have been identified as playing a central role in reducing serious clinical errors and improving the overall safety and quality of health care provision (Borrill et al. 2000; Hindle et al. 2006).

Clinician interactions are quite limited in their multidisciplinaryity, despite efforts such as education to encourage collaboration and teamwork. The introduction of information systems that allow or encourage interaction without requiring it to be face-to-face may increase interaction. It may allow exchange of information without clinicians needing to directly interact, thus overcoming the resistance between professional groups to interact, while allowing for the communication of information necessary for the safe delivery of health care.

Social network analysis is a useful approach for providing an overview as well as for detailed analysis of complex interactions between and within groups. Reanalysis of clinician interaction networks would be valuable after the introduction of interventions designed to improve patient care such as electronic health record systems. A comparison of the networks of interactions before and after such systems are introduced will allow assessment of the impact of these systems on the structure of the vital exchanges of information between clinicians.

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