

TriService Nursing Research Program Final Report Cover Page

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Bethesda MD 20814

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Abstract

Purpose: To characterize the typical Operating Room (OR) communication patterns of clinicians at Malcolm Grow Medical Clinics and Surgery Center (MGMSC) and to determine how the interdependent relationships affect individual and group behavior, using the methods of social network analysis (SNA). We developed two Individual Communication Index (ICI) models for each network member based on how well they are perceived to communicate by other network members. The specific aims were:

- 1: Assess the correlation of the ICI with individual centrality within the network
- 2: Investigate the factors that shape interpersonal communication
- 3: Investigate the network factors that shape group-level communication.

Methods/Design: In this exploratory, prospective, cross-sectional, network-centric design, a multilayer network was developed from the survey responses of 45 OR clinicians. We compared 6 networks with communication effectiveness ratings to determine the OR communication structure.

Sample: Total population sampling of all clinicians (45/47) assigned to the OR at MGMSC.

Analysis:

Aims 1 & 3: Bivariate statistics measured the strength of the linear association between the centrality variables and each ICI network model. Linear regression determined predictors of communication effectiveness.

Aim 2: Quadratic Assignment Procedures (QAP) analyzed correlations between the network models and actor attributes.

Findings: Communication effectiveness increased in networks in which OR team members reported interacting frequently, having close working relationships, socializing, and seeking and giving advice from others. Increases in pairwise geodesic distance resulted in increased differences in communication effectiveness. Increases in network density were associated with increases in network communication effectiveness. The networks exhibited low-density and centralization. Centralization was not a significant predictor of communication effectiveness.

Implications: This study supports the DHA high-reliability organization initiative by dissecting the complex safety problems related to OR communication. Optimizing communication among teams of surgical members improves healthcare quality, safety, and military readiness.

TSNRP Research Priorities that Study or Project Addresses**Primary Priority**

Force Health Protection:	<input type="checkbox"/> Fit and ready force <input type="checkbox"/> Deploy with and care for the warrior <input type="checkbox"/> Care for all entrusted to our care
Nursing Competencies and Practice:	<input type="checkbox"/> Patient outcomes <input checked="" type="checkbox"/> Quality and safety <input type="checkbox"/> Translate research into practice/evidence-based practice <input checked="" type="checkbox"/> Clinical excellence <input type="checkbox"/> Knowledge management <input type="checkbox"/> Education and training
Leadership, Ethics, and Mentoring:	<input type="checkbox"/> Health policy <input type="checkbox"/> Recruitment and retention <input type="checkbox"/> Preparing tomorrow's leaders <input type="checkbox"/> Care of the caregiver
Other:	<input type="checkbox"/>

Progress Towards Achievement of Specific Aims of the Study or Project

Findings related to each specific aim, research or study questions, and/or hypothesis:

SUMMARY OF THE STUDY

This study was an exploratory, prospective, cross-sectional, network-centric design that used network analysis, correlational statistics, quadratic assignment procedures, and linear regression to quantify and characterize the operating room (OR) communication network. This study constructed a multilayer network from the survey responses of OR clinicians. Surveys from a closed network of 45 clinicians captured communication perceptions at the end of the surgical day for a three-month period. We compared five networks (advice-giving, advice-seeking, interaction, socialization, close working relationship) with communication effectiveness to characterize the typical OR communication patterns of clinicians at MGMCS and to determine how the interdependent relationships affect individual and group behavior. The study had three specific aims that were examined on three different levels of analysis: egocentric (individual), dyadic (interpersonal), and sociocentric (whole network).

DESCRIPTION OF THE SAMPLE

The sample was 45 multidisciplinary clinicians who are assigned to perform surgeries in the OR at Malcolm Grow Medical Clinics and Surgery Center (MGMCS). The entire population ($n = 47$) of clinicians at MGMCS who met the inclusion criteria were recruited. Because 50 intact surgical teams were surveyed, some study subjects appeared in multiple teams. Two enrolled study subjects were not surveyed due to scheduling conflicts. The mean age in years of all study participants was 35.04 ($SD = 9.06$), with ages ranging from 19 to 55. The mean age in years of the study surgeon group was 40 (range: 32-55), perioperative nursing group 40.83 (range: 32-50), surgical technician reference group 24 (range: 19-33), and the anesthesia provider group 39.09 (range: 30-47). This is in stark contrast to the average age of physicians ($M = 52$),¹ nurses ($M = 50$),² and anesthesia providers ($M = 49$)³ predominantly found in civilian hospitals.

The mean experience from the study sample was generated by the question "How many years of experience do you have in the above clinical field?" The clinical experience of the sample was rather low, but not unusual considering the age of the participants. The mean years of clinical experience for the sample was 5.96 (range: 0.4 -17). The mean experience of the surgeon group was 8 years (range: 1-17), perioperative nursing group 9.08 years (range: 2-13.5), surgical technician reference group 2.85 years (range: 0.4-6), and the anesthesia provider group 5.08 years (range: 3-12). The results for mean experience are as expected due to military demographics, but occur at a rate of about half of the civilian population. A large study of multidisciplinary OR clinicians^{4,5} determined their overall mean years of experience was 13.7 ($SD = 10.47$). Comparing the surgical technician mean years of experience in this study ($M = 2.85$, $SD = 2.13$) to civilian hospitals ($M = 11.2$, $SD = 11.7$),^{4,5} further demonstrates the unique characteristic of the military setting.

Uniquely, the study was comprised of predominately military participants. 91.11% (41/45) of the participants were active duty military, as opposed to civilian (4/45). The study was comprised of four civilians (8.88%), 30 commissioned officers (66.66%), and 13 enlisted

(28.88%) subjects. The subjects were predominately military, as opposed to large military medical center settings where military and civilian nurses and doctors are distributed more evenly.

It is unknown how the demographics of this special population potentially affected the results of the study. Although the sample does vary in gender, race, and role, the subjects do share many commonalities. Being that the sample contains predominately-homogenous military subjects that are closer in age than their civilian counterparts, one can surmise that these factors potentially add to workplace collegiality. Homophily provides a structural explanation for least effort interactions, promotes tie formation, and potentially describes a more positive work environment.^{6,7}

SURVEY RESPONSE RATE

A high response rate in network studies is preferred to increase the accuracy of the results. Therefore, the full network of relationships is preferred to provide a complete depiction of the underlying structural social relations in the setting. As stated in Chapter 3, including all potential individuals in networks in the MGMCS OR, this study targeted an 80% participation rate to generate results that are robust to missing data either by unit or item.⁸ As discussed by Borgatti and colleagues,⁹ networks are robust when the error between true and observed centrality measures is under 10%. When tested, removing 5% of ties from a network resulted in a correlation of more than 90% between true and observed centrality.⁹ The response rate of 96% is extremely high in research using surveys as a data collection method.^{10,11} Baruch and Holtom¹⁰ examined response rates in 490 studies that utilized surveys and determined an average response rate of 52.7% ($SD = 20.4$). Additionally, Zangaro and Johantgen¹² surveyed a U.S. Navy Nursing population via paper and electronic methods with a 42% response rate. There are several possible explanations for the high response rate. Firstly, face-to-face administration of the survey potentially bolstered the response rate and maximized elicitation.¹³ Military surveys administered via the internet are frequently plagued by low response rates.¹⁴ The PI was embedded in the setting for four months of registration and data collection, and this potentially increased the willingness of the participants to volunteer for the study. Furthermore, the response rate was potentially bolstered by a positive work environment at MGMCS. When studied, military nurses feel valued with positive educational opportunities, autonomy, and collegial relationships.¹⁵ These factors result in a positive working environment,¹⁵ and potentially explained the high response rate.

DISCUSSION OF THE SPECIFIC AIMS Network 6 (Voice Network) Discussion

The voice network, question number six from the sociometric survey, was not included in model development or statistical analysis due to all subjects selecting they feel comfortable voicing safety concerns. The voice network question stated, "*I feel comfortable voicing safety concerns and speaking up to the below team member in this surgical case.*" This question was intended to gauge how hierarchical differences in power affect communication effectiveness ratings and contribute to the safety culture. The hierarchical structure of healthcare teams is attributed to communication failure and medical errors.^{16,17} Professional status and personal perceptions of one's own place in the hierarchy can influence the ability to speak up about decision-making¹⁸ or safety concerns.¹⁹ We hypothesized there was a potential for increased

hierarchy in military medicine due to communication barriers created by military status, rank, and job title. However, this was not the instance because all participants selected that they feel comfortable voicing safety concerns to all team members. A possible explanation for this is that the command and/or organization fosters a safety culture that encourages interdisciplinary collaboration and communication. Teamwork and mutual support are part of the fabric of military culture. It is possible that in situations where mostly military clinicians provide care, there is less hierarchical or lateral constriction of voicing safety concerns. This could be due to the training that military members receive or the culture of military medicine. Additionally, the unique demographics of this study could have potentially affected the response to the question. The subjects were predominately military (91%), younger in age ($M = 35$) than their civilian counterparts, and without extensive experience in their respective clinical fields ($M = 5.96$). It can potentially be inferred from subjects selecting they feel comfortable voicing safety concerns to all team members, that the organization is not an overtly toxic work environment.²⁰ Ultimately, determining why all subjects felt comfortable voicing safety concerns was outside of the scope of this study and should be considered for future research.

SPECIFIC AIM 1

ASSESS THE CORRELATION OF THE INDIVIDUAL COMMUNICATION INDEX (ICI) WITH INDIVIDUAL CENTRALITY WITHIN THE NETWORK.

Hypothesis 1: The more central an individual is in the network, the higher their ICI score.

Specific Aim 1 analyzes how the personal network of each clinician affects their communication behavior.

Network centrality had varying effects on the ICI score and is explained as it pertains to each network. The interaction frequency network was developed from the network survey question “*How frequently do you interact in the OR with each of the people on the list below?*” For network 1, there was a non-significant univariate association between centrality and the ICI scores. The non-significance can be explained by differences in demographic characteristics between individuals with high or low ICI scores, or high or low centrality. Once the demographic differences are considered using regression models, the underlying association between ICI and centrality becomes significant. The significance suggests that the more an individual is the target of interactions by other individuals (*indegree*), or the more eager an individual is to interact frequently with others (*outdegree*), the higher their ICI score, which captures their communication effectiveness. This is an important finding that emphasizes the advantages of individuals consistently working together. The association of interaction frequency with increased communication effectiveness ratings has a parallel relationship with research conducted on surgical team consistency. Surgical teams that interact more frequently support speaking up behaviors,²¹ are more likely to accept and request backup help,²² have reduced operative time,^{23,24} improved team performance, and a reduction of surgical morbidity.²⁵ Surgical cases with inconsistent teams result in extended surgical time, lengthier admissions, and higher readmission rates.²⁶ The association of interaction frequency to communication effectiveness is congruent with research in other domains, and could potentially be explained that individuals who interact more frequently have ease of interactions due to the influence of a shared mental model.²² Interaction frequency and familiarity of team members are important

considerations when assigning surgical team members to cases. Therefore, the results for this network should be considered by administrators who determine daily surgical staffing assignments. Additionally, new metrics should be developed that help administrators assign personnel based on team performance and interaction familiarity, instead of assigning members ad hoc.

Close working relationships (Network 2a) had a positive and significant relationship with ICI scores. The close working relationship network was developed from the network survey question “*Would you say that you have a close working relationship with this person?*” The significant results suggest that individual communication effectiveness improves in team members who report or are targeted as having a close working relationship with others. Close working relationships have a direct connection to interaction frequency, as studied in network 1. Close working relationships are an indicator of strong network ties, which enable individuals to accomplish complex tasks by reducing the need for elaborate communication.²⁷⁻²⁹ Strong ties are developed through a linear pattern of interaction frequency, emotional intensity, intimacy (mutual confiding), and by exchanging resources and knowledge.^{13,30,31} Team building initiatives such as TeamSTEPPS[®] foster close working relationships with competency outcomes of mutual trust and maintaining a shared mental model.³² Close working relationships can be fostered by administrators through team building exercises and by fostering a work environment that encourages engagement of staff. Maintaining close working relationships is often difficult in a military medical setting, with transient clinicians. However, administrators should consider methods to encourage close working relationships among staff, based on the association to increased communication effectiveness ratings.

The socialization network (network 2b) had a positive and significant relationship with ICI scores. The results suggest that individual communication effectiveness improves when team members socialize outside of work, considering the other network factors. The socialization network was developed from the network survey question “*Have you socialized with this person outside of work?*” Socialization was not common in this setting and was potentially inhibited by the unique military subjects. When socialization did occur, team members that reported socializing with others (*outdegree*), and team members that were targeted as someone that another team member had socialized with (*indegree*), were associated with higher communication effectiveness rating. Socialization in this setting is sometimes prohibited under the Uniform Code of Military Justice (UCMJ), which discourages fraternization among military officers and enlisted. However, socialization outside of work can be encouraged in a military context through participation in military balls, formal military dinners (dining out/in), and through military branch and corps birthday celebrations. Although the socialization network was only 3.9% dense, it has the largest effect of all networks in multivariate analysis. The advice-seeking network (network 5a) *indegree* had a positive and significant correlation with communication effectiveness. The advice-seeking network was developed from the network survey question “*Have you gone to this person for advice?*” Overall, communication effectiveness is higher in networks in which OR team members report seeking advice from others, but this association is partially explained by differences in demographic variables and is no longer significant in multivariate analysis. Although not significant at $p < 0.05$, Model 20 (ICI Task) *indegree* ($p = 0.051$) and Model 24 (ICI Average) *indegree* ($p = 0.083$) were marginally

significant. Even though communication effectiveness is higher in advice-seeking networks, further research is recommended on this topic.

The advice-giving network was developed from the network survey question “*Has this person come to you for advice on his or her ideas?*” For network 5b (advice-giving), there was a non-significant univariate association between centrality and the ICI scores. The nonsignificance can be explained by differences in demographic characteristics between individuals with high or low ICI scores, or high or low centrality. Once the demographic differences are considered using regression models, the underlying association between ICI and *indegree* becomes significant. Overall, communication effectiveness is higher in networks in which OR team members report giving advice to others.

A workplace environment in which members can freely seek and give advice plays a central role in safety.³³ Creswick and Westbrook determined that clinical staff most often seek advice from those in their profession, but the results of this study do not support this.³⁴ This is due to the design of this study in which the small surgical teams interviewed often only contained one member from each surgical profession.

An interesting descriptive revelation of this study is that the surgeon and anesthesia provider groups seek advice from others at half the frequency as the perioperative nurse and surgical technician groups. Additionally, the surgeon and anesthesia provider were the most frequent target of advice by other members. This highlights the underlying power structure and measures of prestige that are present in the setting. Prestige in network science is a measure of prominence and is defined as an actor that receives many directed ties but initiates few relations.³⁵ In this setting, the surgeon is a prestigious actor that others seek for advice, but infrequently initiates advice from others. This is an expected finding, due to the level of expertise and education of the surgeon.

Supplemental Findings for Specific Aim 1

Military rank was a significant predictor in the regression models of ICI Average and was determined to be highly collinear with clinical group. Military officers had a higher mean ICI Average (4.570) than civilians (4.350) and enlisted (4.184). The two ranks with the lowest ICI Averages were Airman and Airman First Class. This is potentially due to their military and clinical inexperience. Junior enlisted members are frequently honing their job skills and learning to work in a professional environment. Additionally, rank affects perceptions of clinical competency, with lower ranking members perceived as less competent by those that higher in rank.³⁶

Clinical groups also differed in their communication effectiveness. In the regression models, clinical group had a significant effect on ICI Average. After controlling for other network factors, the predicted ICI Average score is higher for perioperative nurses, anesthesia providers, and surgeons, compared to the surgical technician reference group. Surgical technicians had the lowest mean ICI Average (4.184), followed by surgeons (4.375), perioperative nurses (4.406), and anesthesia providers (4.530). Anesthesia providers having the highest communication effectiveness rating is an interesting finding. In observational communication studies, anesthesia providers initiate and receive very little communication, compared to the rest of the team.³⁷ Future work should consider if communication frequency affects communication effectiveness ratings.

SPECIFIC AIM 2**INVESTIGATE THE FACTORS THAT SHAPE INTERPERSONAL COMMUNICATION.**

Hypothesis 2: The greater the network distance between two individuals, the greater the difference between their ICI scores.

Geodesic distance depicts how actors are embedded in networks and is an important macro representation of information flow throughout the network. Actors that are adjacent from one another have a distance of one, while actors that have intermediate actors between them have a higher geodesic number. In this aim, we compared and contrasted pairwise geodesic distance difference with communication effectiveness (ICI) difference among 522 dyadic relationships that were present in the network. We postulated that nodes that have similar geodesic distances would have similar ICI scores. Therefore, our hypothesis is the greater the network distance between two individuals, the greater the difference between their ICI scores.

The hypothesis was confirmed in all networks. The dyadic geodesic difference for Networks 1-5 had a very strong positive correlation with the ICI difference models. This suggests that as pairwise geodesic distance increases in interaction frequency, close working relationships, socialization, advice-seeking, and advice-giving networks, then the communication effectiveness differences also increase. The results highlight that the more different actors are in the aforementioned networks, then the more dissimilar their communication effectiveness is. The demographic variables provided interesting, but somewhat conflicting results. As two people become more different in age and experience, they will also have increased communication effectiveness differences. Additionally, two people of either the same race, gender, rank, or work frequency are associated with increases in ICI Task differences. When put into a regression model with other variables, the coefficients for race and gender are significant but have very small effect sizes.

The results emphasize how actor homophily in networks influences communication effectiveness. Homophily is the extent to which two or more individuals who interact are similar in particular characteristics. Homophilous actors share common beliefs, meanings, and mutual understandings, which lead to more effective communication.^{38,39} Actors typically prefer homophilous communication and are often frustrated with the ineffective communication that heterophilous relationships breed.³⁹ Furthermore, the more time that two actors spend communicating together, the more they become homophilous and the more likely they will have effective communication.³⁹ This is congruent with the results from network 1, interaction frequency. As pairwise geodesic distance increases in interaction frequency, the communication effectiveness differences also increase. The results from this specific aim suggest that by creating strong pairwise bonds in interaction frequency, close working relationships, socialization, advice networks, communication effectiveness improves.

The demographic variables did not neatly follow the rules of homophily, in relation to communication effectiveness. As compared to the other variables, work frequency and rank produced the largest effects. If two people shared the same rank (civilian, enlisted, officer) or the same work frequency, then their ICI score difference was higher. The tenets of homophily would suggest that those with the same rank or work frequency would have lower ICI score differences, based on ease of communication. The extent to which rank and work frequency affects communication effectiveness should be explored in future studies.

SPECIFIC AIM 3**EXPLAIN HOW NETWORK STRUCTURE AFFECTS GROUP COMMUNICATION.**

Hypothesis 3A: The higher the network density, the higher the Network Communication Index (NCI), or the mean of the network ICI scores.

For this specific aim, a network level communication index was developed to investigate the network factors that shape group level communication. The network communication index (NCI) was created from the mean of the network ICI scores. The NCI was used to compare network level communication effectiveness with density (specific aim 3a) and centralization (specific aim 3b). Centralization and density measures enable the deduction of unequal distribution of positional advantages across the network.

Network density describes the number of actual ties in a network as a percentage of all possible relationship ties. Network density is a measure of cohesion and represents ease of interaction among network members.¹³ Dense networks are more close-knit which can facilitate information exchange and decision making.⁴⁰ We hypothesized that dense networks would exhibit higher NCI scores. The hypothesis was confirmed in all of the networks. Overall, increases in network communication effectiveness are associated with increases in network density in the interaction, close working relationships, socialization, advice-seeking, and advice-giving networks.

Overall, the networks were not very dense. The networks exhibited ample room for improvement in density, with the most dense network (close working relationship) reporting 45.9% possible ties existing. The socialization network was only 3.9% dense, but had the largest effect of all networks in multivariate analysis. The results are analogous with the findings of specific aims 1 and 2. Administrators will likely see an improvement in network communication effectiveness by fostering interaction, close working relationships, socialization, and advice among clinicians. Increasing density and fostering cohesion in these networks will potentially affect the ability of clinicians to communicate clinical information, which, in turn, greatly affects patient safety.

Hypothesis 3B: The lower the network centralization, the higher the Network Communication Index (NCI), or the mean of the network ICI scores.

Similar to density, centralization is a network level concept that enables the deduction of unequal distribution of positional advantages across the network. Network centralization is characterized by one node that possesses particularly high centrality, while other network nodes exhibit low centrality scores.⁴¹ Nodes that are highly central create potential points of failure in a network when removed.^{13,42} Conversely, networks that are less centralized have no single points of failure and are more resilient because nodes can continue to function when other nodes are removed.^{13,42} Centralization ranges from 100%, where one node is maximally central, and all other nodes are minimal, to 0% where every actor holds the same centrality.

It is common and advantageous for one person to be highly central in crisis situations such as a patient cardiac arrest or an emergent surgical procedure. It is common in healthcare and disaster management for the most trained, educated, and experienced person to dominate the network in emergencies. Centralization in crises can be advantageous, but in non-emergent situations, a more even distribution of centrality through the network is preferred. This specific aim determined how centralization in the five networks (interaction, close working relationship,

socialization, and advice) affected network communication effectiveness scores. For this specific aim, *indegree* and *outdegree* centralization was used to characterize the structural patterns of communication in the networks. We hypothesized that networks that are not dominated by a single node will have lower network centralization, thus increasing the network mean NCI.

The hypothesis was not confirmed for the interaction network (1), the advice networks (5a, 5b), and socialization (2b). Networks 5a, and 5b had small correlations with NCI Task but became non-significant in multivariate analysis. For network 1, the results suggest that the OR team's communication effectiveness improves when there is a central individual who makes an effort to interact with every other team member. This is an instance when inequality in the distribution of individual positional advantage is actually beneficial to the group. Additionally, the results for network 2b indicated that communication effectiveness improves when there is one central team member that reported socializing with others or is a targeted for socialization by others. However, due to very low density in network 2b, further exploration is suggested before more robust conclusions are made.

The hypothesis was confirmed in the close working relationship network (2a). For network 2a, the findings suggest that communication effectiveness worsens when a focal recipient is targeted for a close working relationship with other team members.

Overall, the networks were not highly centralized or had low to moderate levels of centralization. The highest *indegree* network centralization was 35% (5a), while the lowest *indegree* centralization was 6.4% (1-interaction). The results suggest that the power of individual actors in the network varies substantially.

The negative and positive regression coefficients depict how concentrations of prestige and influence affect network communication effectiveness. The negative *indegree* coefficients in network 1, and network 2a signify that when prestige is highly concentrated in the network (*indegree* centralization), it is associated with lower NCI or group communication effectiveness. Conversely, the positive *outdegree* coefficients in network 1 and network 2a signify that when influence is highly concentrated in the network (*outdegree* centralization), it is associated with higher NCI or group communication effectiveness. The interplay between prestige and influence in the interaction and socialization networks is an interesting finding and should be explored in future studies.

Our hypothesis was not confirmed in four of the five networks. This is possibly due to low network centralization, or the small group sizes that were included in the design of this study. It is possible that certain amounts of centralization might be beneficial in a high paced, task-oriented setting. Nevertheless, the extent to which centralization affects communication effectiveness in this setting should be explored in future studies.

RECOMMENDATIONS FOR FUTURE WORK

The results of the study have led to additional questions about OR team dynamics, network science, and standardized communication. Future work should be considered in the areas of:

Surgical Team Consistency

The results of this study suggest that there is an association between interaction frequency and the ICI score, which captures communication effectiveness. The association of interaction frequency to communication effectiveness is congruent with research in other domains, and could potentially be explained that individuals who interact more frequently have ease of interactions due to the influence of a shared mental model.²² Recent research has shown that surgical teams that interact more frequently have reduced operative time,^{23,24} improved team performance, and a reduction of surgical morbidity.²⁵ Interaction frequency, team familiarity, and team performance are measures that administrators should consider when assigning surgical team members to cases.

There is considerable research in the healthcare field suggesting that interaction frequency and team familiarity affect team performance and communication. However, from an administrative standpoint, little has been done with this information. Therefore, the first recommendation is not for future research. The first recommendation is for the development of new metrics or tools that help administrators assign personnel based on team performance and interaction familiarity, instead of assigning members ad hoc. MEDCOM (U.S. Army Medical Command) Surgical Services Service Line (3SL) currently computes metrics such as surgical workload, OR caseload, OR performance, turnover time, surgical return on investment, and surgical recapture rate.⁴³ Incorporating staffing decision metrics should be a priority for the 3SL, and can potentially be built into their current system. Administrators will use the metrics as a decision tool to assign staff by team familiarity, and previous team performance. Maintaining surgical team consistency is difficult in a transient population such as the military. However, a concerted effort should be made to have the same people consistently work together. Strategic methods that increase interaction and ensure surgical team consistency are likely to have the greatest immediate impact on patient safety.

Perioperative Network Analysis Research

Social Network Analysis in healthcare settings is in its infancy. This network study provided a unique framework to study communication and should be adapted as a method in future studies. In this study, increased density in interaction frequency, close working relationships, socialization, and advice networks was associated with increased ICI scores, which capture communication effectiveness. Future research should determine the overall affect that each of these networks has on communication effectiveness, possibly with an intervention (pretest-posttest design).

In this study, the surgeon and anesthesia provider groups seek advice from others at half the frequency as other groups, while being the most frequent target of advice by other members. Overall, communication effectiveness is higher in networks in which OR team members report seeking advice from others, but this association is partially explained by differences in demographic variables and was no longer significant in multivariate analysis. The group with the lowest ICI Average, surgical technician, had the highest *outdegree* for advice-seeking. Future research is recommended to determine if advice-seeking behaviors create negative perceptions of communication effectiveness.

For the pairwise network, work frequency and rank produced the largest effects. If two people shared the same rank (civilian, enlisted, officer) or the same work frequency, then their ICI score difference was higher. This finding does not neatly follow the rules of homophily.

Therefore, the extent to which rank and work frequency affects communication effectiveness should be explored in future studies.

Centralization in the OR should be studied in more detail. High concentrations of prestige were associated with lower network communication effectiveness while high concentrations of influence were associated with higher group communication effectiveness. The interplay between prestige and influence in the interaction and socialization networks is an interesting finding and should be explored in future studies. Additionally, centralization increased communication effectiveness in the interaction and socialization networks. It is possible that varying amounts of centralization might be beneficial in a high paced, task-oriented setting. Nevertheless, the extent to which centralization affects communication effectiveness in this setting should be explored in future studies.

Standardized Communication

All high-risk communication events in the perioperative setting should be standardized. The aviation industry has standardized their high-risk communication, and the same principles should be applied to healthcare. MEDCOM developed an excellent example of standardized communication with their Universal Protocol: Procedure Verification Policy (MEDCOM 4053) that standardizes the surgical time-out procedure. Much like the surgical time-out, there are other critical periods in the perioperative setting that could benefit from standardized communication and reductions in distractions and interruptions.⁴⁴ These same principles should be applied to communication in other high-risk events such as handoffs and surgical counts. MEDCOM currently uses SBAR (Situation, Background, Assessment, and Recommendation) from the TeamSTEPPS[®] toolkit as a general guide for handoffs. A more rigorous tool that is specific for the OR needs to be developed. Additionally, the surgical count procedure should be standardized with the same treatment as the surgical time-out. The standardized protocol should include a cessation of talking and other distractions so that effective communication can occur. Implementing and determining the standardized approach to other high-risk perioperative communication events would necessitate multiple research studies and input by multidisciplinary clinicians.

Relationship of current findings to previous findings

The association of interaction frequency to increased communication effectiveness has a parallel relationship with research conducted on surgical team consistency. Previous researchers have demonstrated that consistent surgical teams are safer and have better performance. This research strengthens the surgical team consistency literature, while adding a richer understanding of the factors that influence communication such as advice, socialization, and close working relationships.

Effect of problems or obstacles on the results:

The only obstacles that were present in the research was that 2 enrolled subjects were not available to submit surveys during the time period. This did not affect the data analysis or interpretation of results.

Limitations:

This study used predominately-military subjects in a military medical setting to satisfy the specific aims. The researcher deliberately selected a military population to study with the intent of generating knowledge that contributes to increasing military nursing practice, clinical excellence, quality, and safety. The results of this study should transfer and apply to similar settings including other DOD healthcare facilities. However, the generalizability of the findings is potentially weakened due to the special characteristics and demographics present in a military population. The results could potentially be applied to a civilian setting, being there are many similarities between military and civilian health care.^{45,46}

The responses exhibited by question 2b of the sociometric survey (*Have you socialized with this person outside of work?*) are potentially influenced by military culture. Military fraternization between officers and enlisted is discouraged and prohibited under the Uniform Code of Military Justice (UCMJ). The results presented for the socialization network are potentially affected by these policies.

Sampling is a common issue in studies involving self-report procedures. This study used total population sampling to enroll the entire population of clinicians at MGMCS. However, two participants enrolled did not participate due to scheduling conflicts. Additionally, because of the inclusion/exclusion criteria, not all subjects in the network were enrolled in the study. It is possible that the clinicians excluded from the study were highly central members of the setting (positive or negative influence) and their presence could have skewed results. However, this study attempted to mitigate this by having a high response rate (96%), thereby providing an accurate of a description of the network as possible.

Conclusion:

This study was the first multilevel comprehensive investigation of OR communication using social network analysis, with the results revealing the underlying factors that shape clinician communication in this high-risk setting. This study demonstrated that social network analysis has utility in the perioperative setting. Future researchers can build on the findings of this study to develop future interventions targeted at optimizing communication and decreasing risk.

Significance of Study or Project Results to Military Nursing

This study is significant to military nursing by focusing on clinical excellence, quality, and safety by researching communication errors, which are largely responsible for most adverse events in hospitals. Adverse events decrease the quality and safety of care provided to beneficiaries and negatively affect military readiness. Furthermore, this study assists military medicine by supporting the 2016 Joint Commission National Patient Safety Goals by researching Goal 2: Improving the effectiveness of communication among caregivers.⁴⁷

The military OR contains a unique and complex culture of multidisciplinary clinicians with different levels of education, rank, military status, and experience. These differences result in an uneven power dichotomy and authority gradients among clinicians, potentially causing communication barriers that contribute to errors and patient harm. To understand OR communication, it is crucial to study the relationships among individuals who communicate in this setting. This study used social network analysis to explore the culture and multilevel relations of individuals and teams in the OR. A clear understanding of the dynamics that affect the complex interdependent relational states among individuals in the OR is necessary to improve clinical excellence and patient safety. This research produced new knowledge on individual and multidisciplinary team communication in the OR setting, potentially enabling future interventions targeted at optimizing communication and decreasing risk. Additionally, the results potentially apply to other areas where multidisciplinary military teams provide health care, including austere deployment situations and Forward Surgical Teams (FST).

The Military Health System (MHS) oversees a large surgical network that provides high quality health care for 9.6 million beneficiaries while providing support to military operations worldwide.⁴⁸ As of 2016, the MHS surgical services line contains 274 surgical suites at 60 sites and performs almost 200,000 surgeries annually. With high-volumes of surgical cases, the results from understanding and optimizing dyadic and network communication among military OR clinicians could potentially have an immediate impact on policy development that focuses on safe and reliable performance. The MHS recently faced media scrutiny for the safety and quality of healthcare provided.⁴⁹⁻⁵¹ Media outlets reported problems with surgical complications,⁵² infection control,⁵³ and patient safety.⁵² DHA leaders emphasized improving communication and building a safety culture with an initiative to become a High-Reliability Organization (HRO).⁵⁴ This research assists the DHA initiative to become an HRO by helping to dissect the complex safety problems related to OR communication.^{54,55} Optimizing communication among teams of surgical members including nurses, surgeons, anesthesiologists, and surgical technicians at the organization and microsystem level will improve healthcare quality and safety, decrease adverse events, improve military readiness, and is a crucial step to becoming an HRO.

Changes in Clinical Practice, Leadership, Management, Education, Policy, and/or Military Doctrine that Resulted from Study or Project

This was an exploratory study, so no policy changes have been initiated. However, recent research has shown that teams that work together frequently have reduced operative time and improved team performance, possibly due to a shared mental model. Interaction frequency,

team familiarity, and team performance are measures that administrators should consider when assigning surgical team members to cases.

Summary of Dissemination

Type of Dissemination	Citation	Date and Source of Approval for Public Release
Publications	Preparing for publication	
Podium Presentations	Stucky, C.H., <i>A Network Analysis of Perioperative Communication in a Military Medical Setting</i> , Podium presentation at USU Research Days 2018, Graduate School of Nursing (GSN) Research Colloquium, May 17th, 2018, Uniformed Services University	Approved for public release 26 March 2018. Department of Clinical Investigation, Womack Army Medical Center, Fort Bragg, NC.
Podium Presentations	Stucky, C.H., <i>A Network Analysis of Perioperative Communication in a Military Medical Setting</i> , Podium presentation at the TriService Nursing Research Program (TSNRP) Dissemination Course, May 2 nd , 2018, TriService Nursing Research Program	Approved for public release 26 March 2018. Department of Clinical Investigation, Womack Army Medical Center, Fort Bragg, NC.
Poster Presentations	Stucky, C.H., <i>A Network Analysis of Perioperative Communication in a Military Medical Setting</i> , Poster session at the TriService Nursing Research Program (TSNRP) Dissemination Course, May 2 nd , 2018, TriService Nursing Research Program	Approved for public release 26 March 2018. Department of Clinical Investigation, Womack Army Medical Center, Fort Bragg, NC.
Poster Presentation	Stucky, C.H., <i>A Network Analysis of Perioperative Communication in a Military Medical Setting</i> , Poster session presented at the USU Research Days 2018 Graduate School of Nursing (GSN) Research Colloquium, May	Approved for public release 26 March 2018. Department of Clinical Investigation, Womack Army Medical Center, Fort Bragg, NC.

	17th, 2018, Uniformed Services University	
Poster Presentation	Stucky, C.H., <i>A Network Analysis of Perioperative Communication in a Military Medical Setting</i> , Poster session presented at the Womack Army Medical Center Research Symposium, May 4th, 2018, Womack Army Medical Center	Approved for public release 26 March 2018. Department of Clinical Investigation, Womack Army Medical Center, Fort Bragg, NC.

Reportable Outcomes

Reportable Outcome	Detailed Description
Applied for Patent	None
Issued a Patent	None
Developed a cell line	None
Developed a tissue or serum repository	None
Developed a data registry	None

Recruitment and Retention Table

Recruitment and Retention Aspect	Number
Subjects Projected in Grant Application	47
Subjects Available	47
Subjects Contacted or Reached by Approved Recruitment Method	47
Subjects Screened	47
Subjects Ineligible	0
Subjects Refused	0
Human Subjects Consented	47
Subjects Who Withdrew	0
Subjects Who Completed Study	47
Subjects With Complete Data	45
Subjects with Incomplete Data	2

Summary regarding recruitment and retention: Forty-three study subjects were recruited in the first month, during the recruitment phase. The additional four subjects were recruited during the data collection phase. Four subjects were not available during the recruitment phase due to military leave or duty. Two enrolled subjects did not fill out surveys. This was due to military and personal reasons, and was not caused by the study.

Demographic Characteristics of the Sample

Characteristic	
Age (yrs)	35.04 ± 9.06
Gender	
Male	28 (59.57%)
Female	19 (40.43)
Race	
White/Caucasian	30 (63.83%)
Black or African American	6 (12.77%)
Hispanic or Latino	5 (10.64%)
Asian or Pacific Islander	4 (8.51%)
Multiple Ethnicity	2 (4.26%)
Military Service or Civilian	
Air Force	43 (91.49%)
Army	0 (0%)
Marine	0 (0%)
Navy	0 (0%)
Civilian	4 (8.51%)
Military Status	
Civilian	4 (8.51%)
Officer	30 (63.83%)
Enlisted	13 (27.66%)
Service Component	
Active Duty	43 (91.49%)
Reserve	0
National Guard	0
Retired Military	0
Prior Military but not Retired	0
Military Dependent	0
Civilian	4 (8.51%)

TASK BUDGET SUMMARY

Current as of: MAR2018

Organization: HJF-Henry M. Jackson Foundation

Award #/Name: 65136 - A NETWORK ANALYSIS I



HENRY M. JACKSON FOUNDATION
FOR THE ADVANCEMENT OF MILITARY MEDICINE

Advancing Military Medical Research

Award Manager: STUCKY, CHRISTOPHER **Award Period:**

08/01/2016 to 01/31/2018

Project #/Name: 308898 - A NETWORK ANALYSIS PRJCT 1

Project Manager: WALLACE, PEARL SHANGE

Project Period: 08/01/2016 to 01/31/2018

Task # / Name: 1.00 - A NETWORK

ANALYSIS I **Task Period:**

08/01/2016 to 01/31/2018 **Task**

Manager: NUNEZ, MELANIE B.

Task Desc: GSN-N16-P13

Award UNIFORMED SERVICES UNIVERSITY
OF

Sponsor: THE HEALTH SCIENCES

Billing

LI,

MING YIN **Analyst:**

Primary

LIVAN, REYHAN

Analyst:

Current As of	Award/Project/Task Number	Task Budgetary Control	Category Group	Expenditure Category	Budgetary Control	Current Month Expenses	Budget	Open Commitment	Task-To-Date Expenses	Total Funds Used	Balance Available	Percentage Available
03/19/2018	65136 - 308898 - 1.00	Absolute	DIRECT	SUPPLIES	Absolute	0.00	5,466.86	0.00	5,466.86	5,466.86	0.00	0.00
				DOMESTIC TRAVEL	Absolute	0.00	8,628.00	0.00	2,647.86	2,647.86	5,980.14	69.31
				OTHER DIRECT COSTS	Absolute	0.00	486.21	0.00	40.00	40.00	446.21	91.77
TOTAL DIRECT :						0.00	14,581.07	0.00	8,154.72	8,154.72	6,426.35	44.07
			INDIRECT	ON-SITE OVERHEAD	Advisory	0.00	5,065.47	0.00	2,585.18	2,585.18	2,480.29	48.96
				COMPANY-WIDE G & A	Advisory	0.00	2,809.46	0.00	1,471.35	1,471.35	1,338.11	47.63
TOTAL INDIRECT :						0.00	7,874.93	0.00	4,056.53	4,056.53	3,818.40	48.49
TOTAL TASK :						0.00	22,456.00	0.00	12,211.25	12,211.25	10,244.75	45.62

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Ref Award#: HU0001-16-1-TS15

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