



**The effect of social network structure on
the spread and existence of burnout in medical residents**

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Abstract

This study explored the relationship between physician well-being and characteristics of their social network. However, due to an extremely low-response rate, no conclusions were made. The survey was sent out to 323 surgical residents at the University of Michigan and had an 8% completion rate, with only 28% of the residents opening the survey link. We were able to note survey fatigue, survey format, the study's context, the nature of network data, and a generally short timeline as main sources of failure. Despite this low response rate, researchers were still able to explore reasons as to why understanding residency experiences through a more holistic lens is important. The literature review also revealed theories such as network convergence that could prove useful in the future of studying residencies as social networks. Despite these faults, this thesis still explores the potential advantages of using network analysis to study the deeply social nature of burnout.

Introduction

Growing focus on Physician Well-Being

The United States has seen a significant rise in the level of burnout among the country's healthcare professionals. As of 2018, over one-half of physicians and one third of nurses exhibited symptoms of burnout (Reith, 2018). Reith also explained that, comparatively, physicians see a higher rate of burnout (51%) than the general population (40%). This rate was found in a Medscape survey from 2017 and indicated a 25% increase in burnout rates over the course of four years. Additionally, Medscape surveys from 2013-2018 consistently found physicians citing levels of bureaucratic tasks, hours at work, and increased computerized practices as sources of burnouts (Reith 2018).

Studies have also found that burnout rates tend to be higher among residents in surgical/urgency specialties as compared to their clinical counterparts (Rodrigues et al, 2018). More specifically, burnout rates can range from “31% to 32% in pediatric and orthopedic surgery to highs of 43% and 52% in urologic, vascular, and trauma surgery” (Kuerer and Holleman, 2012). In 2011, it was also found that burnout is more common among female surgeons (43%) than men (39%) and that conflicts between work and home life are a significant contributor to surgeon burnout (Dybye et al, 2011). Burnout has also been shown to coexist with depression, but there have been few attempts to try and establish a causal relationship (Thomas, 2004).

Burnout has also been studied within the context of individual characteristics. As it is obviously a large problem, many researchers wondered if there were specific qualities in a person that could either mitigate the effects of burnout or exacerbate them (Cortez et al, 2020). In February 2020, one study found a negative linear relationship between grit (“a psychological term which is defined as perseverance and passion for long-term goals”), emotional exhaustion,

and depersonalization. In contrast, the study found a positive relationship between grit and personal achievement. This close relationship between a personal characteristic such as grit and experienced burnout, then, suggests that understanding burnout on an individual level may provide insight into how best to address the negative effects of the phenomenon.

Consequences of Physician Well-Being

The consequences of physician burnout are far-reaching; patient outcomes suffer, and healthcare institutions can suffer financially as a result of tired healthcare professionals. Consider, first, physician work hours, a source of burnout often cited by physicians; physicians that work more than 16 hours see more failures to attention and more severe medical errors than those who work less than 24-hour shifts (Wallace et al, 2009). As described by Shanafelt et al, physician burnout has been observed to increase rates of “reported errors, turnover, and higher mortality ratios in hospitalized patients” (Shanafelt et al, 2017). There are also significant financial consequences to unmitigated burnout within a program; one study found that, in the United States, \$4.6 billion in costs could be attributed to burnout. At an organizational level, this same study found that these costs can range from \$4100 to \$10,200 per physician (Han et al, 2019).

Factors that have been associated with burnout (more specifically work-home conflict) have also been cited as a trigger for a resident’s desire to leave a program (Gifford et al, 2014). In a 2016 survey, the researchers found that 44% of residents in the sample thought about dropping out of the program. They also noted that residents who met the criteria for burnout were more likely to consider dropping out than their peers who didn’t suffer from this

psychological burden. Addressing attrition and thoughts of leaving a program become important (Shanafelt et al, 2019) for institutions because residency positions are often difficult to fill and pose a financial burden. Resources and time have been spent training these residents and if their environment or experience pushes them to leave the program this ultimately wastes the assets of the institution (Chen et al, 2019).

Current Interventions

Despite these negative consequences, however, there seems to be little consensus on how best to address the existence of burnout within a surgical residency. In 2003 and 2011, resident work-hour restrictions were put in place and some residency programs did see improvement in burnout levels (Busireddy et al, 2017). But there is a trade-off; while work hour restriction can reduce the risk of burnout, they also reduce the chances for adequate levels of training. The same study that found the positive effects of the duty hour restrictions also surveyed residents and found that trainees reported “a decreased sense of readiness for more senior roles” (Busireddy et al, 2017). Other studies also found that there haven’t been consistent positive improvements for resident well-being as a result of these regulations and may even affect patient care negatively (Alobuia et al, 2018).

Other interventions call for considering institutional and program environment specifics as a means of addressing burnout, rather than relying on generic regulations such as duty-hour restrictions. In 2018, Appelbaum et al explored the relationship between perceived organizational support and resident burnout. The research suggested a need to develop systems in which residents are relieved of non-physician-oriented tasks as well as the creation of potential “wellness programs.” Though the nature of these wellness programs wasn’t detailed within the

study, it stands to reason that medical professionals would benefit from similar initiatives implemented in the corporate world. These include physical wellness initiatives (e.g providing a gym membership) as well as subsidizing wellness through healthcare discounts. Overall, institutions tend to be left to their own devices when it comes to creating methods of addressing burnout beyond the minimal adherence to duty hour restrictions.

Why medical trainees?

One key point of this thesis is its focus on medical residents. While burnout has been shown to start as early as medical school, these training periods are often when the issue becomes exacerbated (Pulcrano, 2016). Though attendings and faculty have also been known to show issues with work-life balance (a large factor in the onset of burnout), residency has a distinct set of circumstances that make it rife for burnout as well as an interesting source for research. Residents are at a turning point in their career — many are learning how to do certain procedures, trying to learn the ins and outs of a hospital, all while potentially under the financial and social stress posed by hard hours and lower salaries. Many studies have pointed out that the learning environment for residents is stressful; these trainees have spent years in the high-stress environment of medical school and those educational demands only increase in residency. At the same time, they may see higher imbalances in their work versus home life and though they have completed four years of medical school, many are still relatively new to their field and see little to no autonomy in the early days of their career (Pulcrano, 2016). By studying medical trainees, we can address systemic issues in the early stages of a medical career and hopefully create an improved experience that would lead to healthier and better trained medical professionals.

Introducing Social Network Analysis

Another important facet of this thesis is its use of social network analysis. The popularity of social network analysis (SNA) has grown in tandem with an increasing interest in social psychology. The '50s and the '70s, as well as today with the advent of social media, were pivotal points in the history of social network analysis. During these decades, new ways to make connections, and track them, grew on an unprecedented scale (Burt et al, 2013). Sites like Facebook and Instagram most notably highlight friendship networks, but social networks can consist of all kinds of ties (Davis and White, 2015) — collaboration, advice, and professional ties being some of the ones measured in this thesis. Generally, network analysis works to “understand individual action in the context of structured relationships or studies structures directly” (Wasserman and Faust, 1994) as a means to consider the potential regularities or patterns that may develop into the actual structures themselves. These structures, after having been identified, can then be studied to see if they have an impact on the group’s functioning or how the structure influences individuals within the group (Wasserman and Faust, 1994).

To understand the network data presented in this thesis, a few key terms are necessary to define. Network structure is characterized by specific sets of individuals (referred to as “actors” or “nodes”) linked together through various kinds of ties, such as those listed above (Borgatti and Halgin, 2011). One of the most useful tools of network analysis is the ability to both map and measure the networks in question. First, data in which everyone fills out the same questionnaire aims to create a global network within the workplace. And while surveying only residencies that are surgical in nature is far from a global view of the hospital, it is still a largely representative group of medical professionals that are at higher risk of burnout. Additionally, data can be

directed or undirected in a network; network questions in which both nodes would give roughly the same answer result in undirected, symmetric data (in the case of this thesis, we'd hope to see the personal friendship networks and research networks be undirected). Conversely, directed data would be seen in the mentorship and work advice networks generated for this thesis; this data has identified a specific person in the relationship that likely would not have the same answer for the same question.

Quantifying the data in social network surveys, however, relies heavily on measures of centrality. Measures which are derived from what is known as "degree." Degree is defined as how many people a node is connected to; ties coming into a node are deemed "in-degree" while ties going out are called "out-degree." Further definitions include "closeness:" how easily can a node reach everyone else; "betweenness:" how often is a node on the shortest path to other people; and the "eigenvector" measure: how well connected are the connections of a particular node (Davis and White, 2015). This thesis is going to consider in-degree and out-degree more closely as well as the general structure of the network in a more global sense.

Networks were chosen as the analytical tool for this thesis for a variety of reasons. First consider that current interventions regarding resident burnout are mainly reactionary, rather than preventative. While implementations of work hour interventions showed some improvement, they also reduced the chances for adequate training with many residents reporting "a decreased sense of readiness for more senior roles" (Rodrigues, 2018). Consequently, there's a need for more active and individualistic initiatives that social network analysis can guide us towards. Network analysis also provides an interesting viewpoint from which we can consider a resident's experience in a hospital. And while these networks are used heavily throughout the corporate world, little research has been done to put residencies into a similar context.

LITERATURE REVIEW

An empirical national assessment of the learning environment and factors associated with program culture

In order to fully understand the implications of the relationship between a resident's social network and their burnout experience, it's important to recognize that there are a variety of reasons why residents suffer from burnout. In this study, researchers looked to "characterize residency program culture as measured by duty hour violations, resident mistreatment, resident wellness, and career satisfaction" (Ellis, 2019).

Following the January 2018 American Board of Surgery In-Training Examination, the researchers administered a study to a total of 7387 clinically active trainees across 260 programs. The survey covered topics such as "resident wellness, duty hour adherence, experience with workplace gender discrimination, verbal and physical abuse, and sexual harassment." Resident wellness was measured with the Maslach Burnout Inventory Human Services Survey for Medical Personnel and data regarding specific program characteristics such as program size, the number of female residents, location, and institution type (academic versus community/military) was also collected.

The study found high levels of program variation. Researchers reported medians on a variety of characteristics; 11.9% of residents reported frequent duty hour violations and 30% reported program-level verbal/physical abuse. 66.7% of female residents reported program-level gender discrimination and 16.7% reported sexual harassment. They also noted that program level rates of severe stress were around 13.3%, dissatisfaction with surgical career was reported at a

median level of 22.9%, burnout at a rate of 36.6%, thoughts of attrition at 11.3%. These statistics can be broken down into two categories: program-level stress, career satisfaction, burnout, and thoughts of attrition define “Program Wellness” while program-level verbal/physical abuse, gender discrimination, and sexual harassment define “Negative Exposures.”

Overall, the study found that “the only significant structural factors associated with program culture were percentage of female residents, program size, and percentage of non-White faculty.” The researchers also noted that while some programs may have had low scores across the board for the measured factors, it wasn’t likely that we would see overall “good” programs versus “bad” ones. In fact, the study found that having good outcomes in 1 variable didn’t necessarily mean an overall “good” culture. As such, the study concluded that “uniform strategies to help improve the learning environment may have inconsistent results.”

This empirical assessment highlighted the need for a nuanced understanding of each institution and their programs. While the study had little focus on social networks, it created the basis for other potential sources of burnout that could be addressed when looking at a resident’s mentor relationships or personal relationships. Social networks underpin many of the interactions found in both components of this study’s analysis and will likely prove helpful in understanding their nature.

Surgical Resident Burnout and Job Satisfaction: The role of workplace climate and perceived support

Other studies have done similar work to try and contextualize burnout. And while the empirical assessment concluded that there were no characteristics of a residency that would

automatically lead to a “good” experience, others have taken a more specific approach to try and identify potential areas of improvement. In this study, researchers utilized organizational science to test a model that shows “how workplace climate positively predicts job satisfaction directly and indirectly through perceived organizational support and burnout for general surgery trainees” (Applebaum et al, 2018).

The study relied on the Job-Demands Resource model as its theoretical framework. The model suggests that pressures (such as workload and physical environment) are associated with exhaustion while resources (e.g., feedback and autonomy) are tied to engagement. The study used the Maslach Burnout Inventory to measure well-being in residents; additionally, they also collected demographic data such as program, gender, training year, etc. After collecting this survey data, the researchers conducted mediation analysis. As described by the study “Mediation analysis is a technique that allows investigation in how variable X (workplace climate) affects variable Y (job satisfaction) through one or more mediating variables M (perceived organizational support and burnout).” From this kind of analysis, the study can try to better understand “the strength of relationships between measured constructs and how study variables relate to one another in a given population.”

Results included group comparisons for relationship status and found that there were no meaningful differences between general surgery residents with and without a significant other. However, researchers did find that general surgery residents with children reported less burnout, better work climates, and higher job satisfaction compared to those without children. The study also went on to report that male general surgery residents often perceived greater levels of organizational support as compared to female residents. Other findings include that workplace climate significantly and directly predicted job satisfaction and that perceived organizational

support and burnout significantly and indirectly predicted job satisfaction. Workplace climate had a positive prediction relationship with perceived organizational support.

The results of the surveys and the mediation model suggest that autonomy, workload, and collegiality all have a strong effect on job satisfaction and can be affected by perceived organizational support and subsequent burnout. For the purposes of this thesis, there are a few important takeaways: first, the fact that collegiality has an effect on job satisfaction and perceived burnout indicates that looking at the relationships between residents in a program is an important topic. And second, contextual factors such as perceived organizational support and other program specific factors have an effect on the levels of burnout within a program that need to be acknowledged in trying to understand resident social networks.

Residency as a Social Network: Burnout, Loneliness, and Social Network Centrality

Studying residency as a social network, and the subsequent implications this has for the study of burnout, is a relatively new area of study. Though the effects of social networks, and our place within them, is not. Social networks represent a unique opportunity to explore the emotional exhaustion, depersonalization, and decreased sense of personal accomplishment that often define burnout. The goal of this study was to “investigate the relationship between burnout and loneliness” (Shapiro et al, 2015).

The study used the REDCap survey platform in December of 2013 to collect data on resident “sex, relationship status, program type, and year in training” (Shapiro et al, 2015). The study used the 22-question Maslach Burnout Inventory (MBI), a common survey tool for studying burnout. In order to measure loneliness, Shapiro et al used the UCLA Loneliness Scale.

The study noted that “the loneliness scales measure a lack of perceived connection to others, but this may be influenced by those outside the workplace” (Shapiro et al, 2015). The program as a social network was studied by asking residents to rate their “connectivity to all other residents” (Shapiro et al, 2015). This survey created data that highlighted both degree and centrality. Shapiro’s research focused on residents in categorical internal medicine, preliminary year internal medicine, and internal medicine pediatrics.

The primary outcome studied in this research was the relationship between burnout and loneliness. The study also worked to understand relationships between burnout and social network degree and centrality. Residents that displayed significant burnout based on emotional exhaustion or depersonalization scores often rated themselves as lonely. Personal accomplishment scores were not associated with loneliness and once results were adjusted for year of training or program, no association was found between burnout and loneliness.

Secondary outcomes for this study are the closest to what this thesis also hopes to accomplish. Overall, researchers found that none of the measures of degree or centrality were associated with burnout as defined by emotional exhaustion or depersonalization scores. However, the study did find that higher personal accomplishment scores were associated with measures such as In Degree, Out Degree, Closeness Centrality, and Eigenvector Centrality. With this relationship, we may be seeing the progression of a resident’s career — as they gain responsibility and confidence, the trainee is becoming more connected they’re “moving to more central roles within their network” (Shapiro et al, 2015).

This data, taken into consideration with what was found regarding burnout, belonging, and loneliness in the following two studies, serves to create a foundation of understanding for building residencies as a social network. At the time of this publication (2015), no other studies

investigating residency as a social network had been done. For the purposes of this thesis, it's important to note that the study found no significant association between emotional exhaustion and depersonalization, as these are the main measure by which the research will be measuring burnout. Both this thesis and the study outlined above utilize the strategies of network theory proper (as defined in the "Theoretical Framework" section of this thesis). The conclusions of Shapiro and his team focused on similar structural network characteristics that this thesis hopes to obtain, however network structure and theory is often unique to the specific institutions. As such, while we may have similar findings, it's always good to have the understanding of the network and see how residents may be connected in order to see the larger picture of how a residency is organized.

Social Belonging as a Predictor of Surgical Resident Well-being and Attrition

As we continue to think about residency as a social network, it's important to address the consequences of unmitigated resident burnout and loneliness and how they might be estimated through the use of network analysis. In 2018, Salles et al surveyed general surgery residents in a variety of specialties as well "nondesignated preliminary residents." In doing so, the team hoped to determine the connection between a resident's social network and their well-being in addition to their risk of attrition.

The study spent three years (2011, 2014, and 2015) collecting survey data from their first institution and gathered the second data set in 2017. The surveys assessed belonging, well-being, and attrition. Belonging was measured "using a 10-item scale adapted from prior rigorous work on social belonging." Well-being was quantified through the 22-item Dupuy General

Psychological Well-Being Scale, the 13-item Beck Depression Inventory, and the 22-item Maslach Burnout Inventory. The study noted that in their analysis they focused mostly on the emotional exhaustion and depersonalization characteristics of the Maslach Burnout inventory “as these are the most clinically relevant” (Salles et al, 2018).

In a series of analyses, the researchers first determined that there were significant differences between the three survey groups as it related to their social belonging. One of the first sets of analysis considered if different types of residents could be grouped together based on level of belonging, general psychological well-being, depression, emotional exhaustion, depersonalization, and frequency of thoughts of leaving by type of resident. Of the categories listed, there were statistically significant differences in level of belonging; preliminary residents had lower levels of belonging than categorical general surgery residents and designated preliminary residents. The study found no significant differences by gender in belonging, psychological well-being, depression, depersonalization, or thoughts of leaving residency.

After this preliminary analysis, the study found a positive correlation between belonging and well-being as measured by general psychological well-being. Belonging was negatively associated with depression, emotional exhaustion, and depersonalization. Similarly, measured by frequency of thoughts of leaving residency, belonging was negatively correlated with risk of attrition.

This research serves to highlight the importance of social networks within a residency and the necessary steps to making sure that programs are connecting with their residents. The researchers conclude that “efforts should focus specifically at improving residents’ sense of belonging within their program” (Salles et al, 2018). Salles, et al essentially described why we

need to study social networks and the ways in which they can be used to note potential at-risk residents within a program.

Getting By with a little help from friends and colleagues: Testing how residents' social support networks affect loneliness and burnout

Similar to the above research, “Getting by with a little help from friends and colleagues” studies the significance of resident social networks on their experience with burnout. While Salles et al looked at a more quantitative result of burnout (attrition rates), this paper explored burnout’s relationship with different sources of social support, comparing the effects of personal and collegial ties on resident well-being. However, the two studies do reach a similar conclusion, both note the importance of having strong network ties. Salles notes that “belonging” has an important effect on resident well-being while the following research describes the effect of “loneliness,” both of which are factors that describe the social phenomenon of connection.

At the University of British Columbia, researchers studied residents in the Faculty of Medicine’s Postgraduate Medical Education Program. They measured burnout levels using the Copenhagen Burnout Inventory to gather information regarding personal and work-related fatigue and exhaustion. In order to measure loneliness, the study used a 3-item loneliness scale developed by Hughes et al in 2004. This scale is meant to assess the degree to which a subject “felt that he or she lacked companionship, felt left out, and felt isolated from others” (Rogers et al, 2016). Finally, the study also assessed both actual social support and perceived social support using the Lubben Social Network Scale.

The study's sample was "predominantly female, white, married or partnered, born in Canada and training in family practice and non-surgical specialties." The study found statistically significant support for their first hypothesis, suggesting that greater social support is associated with lower burnout as well as a significant association between higher levels of friend-based support and lower work-related burnout scores. However, after controlling for loneliness, this friend-based support is no longer significant. The study's second model found loneliness to be positively associated with burnout and that "a higher level of loneliness was significantly associated with both higher personal and work-related burnout scores." Finally, the third model connected both of the themes in the first two hypotheses and concluded that "higher friend and colleague support are both indirectly associated with lower personal and work-related burnout scores via lower loneliness."

These results can be summarized into three major conclusions: first, there was little evidence for an association between burnout and social support from friends outside the workplace. Second, they found that levels of loneliness correlated with personal and work-related burnout. Third, they found that "more friend and colleague support was associated with lower levels of loneliness" (Rogers et al, 2016). The goal of the study was to explore the relationship between a resident's social support network (like family, friends, and colleagues) and their levels of burnout and loneliness. Their findings are important in understanding the different sources of social support and looking at the quality nature of different individual relations.

And so, while we know now that support from friends and colleagues seem to reduce levels of burnout by keeping loneliness at bay, this thesis hopes to explore social networks on a more macro-level scale. Building the actual structure of a resident's social network has the

potential to generate a visual that may reveal which residents are at risk for loneliness by depicting who is less central than others. As such, we can use this past research as well as the findings from this thesis to hopefully create proactive strategies against burnout, rather than reactive.

Theoretical Framework

This thesis is based in general network analysis principles and uses quantitative centrality measures to contextualize a surgical resident's wellness experience.

Network analysis is a relatively new field of study, having gained recognition in the 1950s and popularity in the 1970s (Burt et al, 2013). In the forty years between 1970 and 2010, the field has seen an exponential growth in publications that reference "social networks." In defining network theory, there are two distinct areas of research, as defined by Borgatti and Halgin (2011): "network theory" proper and "theory of networks." The theory of networks looks at how the antecedents of networks to better understand how networks are developed (Borgatti and Halgin, 2011). In contrast, network theory studies "the consequences of network variables" — the goal is to understand the effects of being centrally located or having many ties. That said, this thesis will look at resident networks through the lens of network theory proper, with an aim of understanding the potential relationship between resident burnout and social networks at the University of Michigan.

For the purposes of studying burnout in residents, centrality measures are the most relevant. To recap, there are four kinds of centrality that are important to any social network study: degree centrality, closeness centrality, betweenness centrality, and eigenvector centrality.

These four measures can reveal how information and attitudes travel throughout a network as well as point out specific nodes of interest (i.e., those that are particularly connected or disconnected).

Another important aspect of SNA is the kind of ties that are formed between nodes on a network. There are two categories of ties (Borgatti and Halgin, 2011): states and events. States are more open-ended and continuous overtime; examples include kinship ties, knowing someone, liking someone, etc. These kinds of ties can be broken down further and measured in terms of strength, intensity, and duration. Event ties are more quantitative in nature; they're discrete and may include e-mail exchanges, phone conversations, or transactions. Both kinds of ties can help facilitate information and other exchanges throughout a network. Additionally, analysis of the strength of state ties (i.e strong versus weak ties) may prove useful in that the presence of both strong and weak ties has been shown to be important in the spread of information throughout a network (Friedkin, 1982). Whether or not the strength of ties within a resident's social network has an effect on their experienced burnout, may be an important avenue to consider in the development of this research.

Though there are a variety of theories that explain specific outcomes of network structure, the most relevant for this research is the convergence theory. This theory relies on "structural equivalence" (Borgatti and Halgin, 2011) and puts forward the idea that actors adjust to their environment and those in similar network structures will demonstrate similarities in attitudes and behaviors. With this in mind, this thesis will apply the convergence theory to the networks found in surgical residencies at the University of Michigan in order to further our understanding of the resident burnout experience on a more structural scale.

In addition to working within the social network theory, this research will also utilize the widely accepted Maslach Burnout Inventory (MBI) to try and measure the experienced burnout within a program and match it with the social network that we've created. Christina Maslach and Susan E. Jackson originally developed the survey in 1981 and have since published updated versions of the inventory in decades past. In 2009, Poghosyan et al conducted an analysis of the inventory that highlighted the inventory's ability to provide consistent results across countries (Poghosyan, 2009). The inventory consists of 22 items divided into three subcategories and is designed to measure emotional exhaustion, depersonalization, and reduced personal accomplishment (the three main components of burnout). More specific characteristics of the survey will be discussed in the "Methods" section of this proposal.

In all, this theoretical framework creates an interesting context in which we can study the proliferation of burnout. It's often hard to remember that those experiencing burnout are not alone, especially given the individual nature of many of burnout's characteristics. In fact, as research has shown, burnout is an incredibly common phenomenon throughout programs and institutions. Medical students enter their residencies in cohorts — they're not alone in the recruitment process and many often see each other multiple times as they interview for similar positions. Analyzing the structure of the networks formed in and across residencies has the potential to reveal new insights on how burnout comes about and spreads at an institution. Network analysis focuses on the relationships among individuals within a study in the hopes of trying to understand individual experiences (in this case, burnout) in the context of an identified structure (Wasserman and Faust, 1994)

Also, in studying the rate of career choice regret in a series of residents, one study found that while burnout rates were varied between specialties, these levels of burnout also tended to

mirror those of the practicing physicians within that specialty (Dyrbye, 2018). Though this may be a result of contextual, institutional issues (as discussed in the literature review of this proposal), the mirrored nature of resident burnout shows that these residents are in a unique position within a hospital's social structure. As such, network analysis will likely reveal interesting details about a resident's relationship to their superiors and how these mirrored characteristics come about.

Methods

Setting and Participants

Researchers piloted the study with integrated Cardio/Thoracic residents at the University of Michigan. Residents from programs considered surgical in nature and across a spectrum of PGY levels were included in a subsequent distribution. Specifically, the survey was sent to Urology, Obstetrics and Gynecology, Neurosurgery, General Surgery, Orthopedic Surgery, Anesthesiology, Integrated Plastic Surgery, Otolaryngology, Integrated Vascular Surgery residents at the University of Michigan.

Survey Design

Data collection focused on demographics, burnout, and network data. The survey used the Qualtrics system and was collected at a single point in time (March 2021). Demographics included information on sex, race, program type, and training level. The survey used an

abbreviated version of the Maslach Burnout Inventory (MBI), measuring Emotional Exhaustion and Depersonalization.

This decision was made for a variety of reasons; first, the full MBI is limited in its utility in larger settings of medical professionals. Additionally, one of the key components of effectively administering the MBI is not telling participants that they are being surveyed about burnout. However, given the prevalence of the survey and the increased studies of burnout since the MBI's first publication in the '80s, this is less feasible. Thus, other studies have been done to measure the efficacy of smaller versions of the MBI. In 2009, West et al found that the "single item measures of emotional exhaustion and depersonalization stratified risk of high burnout in the relevant domain on the full MBI."

Network data was collected using a free recall, free choice method (see Fig. 1 for a summary of the statements presented to residents). In this manner, residents are asked to nominate certain actors in their network that meet specific criteria (e.g., "I consider this person a personal friend.") As there was no required number of choices, though a suggestion of nominating 2-3 people was made, the survey was free choice. Surveying with free choice data is also known as administering a "relationship-centered survey" and asks respondents about their specific relationships with others in the network. In 2009, Thaden and Rotolo found that this kind of survey saw differences in responses only when studying "weak tie" relationships. Given the nature of this study's survey and residency in general, this was of little concern.

Area of Interest	Criteria
Personal Network	“I see this person as a personal friend.”
Professional Network	“I would go to this person for work advice.” “I have done research with this person.”
Mentorship Network	“I see this person as a mentor.”
Burnout Experience	“I feel burned out from my work.” “I have become more callous towards people since I took this job.”

Figure 1: Residents were presented with the above statements and asked to either identify all the actors that fit the given criteria (network areas of interest) or note how frequently they thought the statements on the right (burnout experience).

The survey was then distributed to all of the residencies listed above, with unique links for each residency. A reminder email was sent out a week after the original distribution. Researchers then went through and de-identified the data by assigning random labels in Excel to each participant.

Data Analysis

After collection, residents were de-identified, and researchers tried to develop social networks. However, as is discussed later, there was not enough data to create these networks nor draw any meaningful conclusions.

Assumptions and Limitations

Moving forward, there are a few limitations and assumptions that we have to consider. First and foremost, network analysis is assuming that there are no other confounding factors. Much of the conclusions made based on network data also have to be considered in the context of the institution itself. As we saw in the literature review, there are a variety of institutional and program related factors that have an effect on burnout within a residency. In past network studies, these complications have either been addressed through a control group or statistical analysis is able to account for these components. In conducting network analysis, it is also important that we consider the induction, homophily, and shared environment hypotheses. The *induction hypothesis*, “posits that the loneliness in one person contributes to or causes the loneliness in others” The homophily hypothesis states that lonely people tend to connect with lonely people while those who aren’t lonely tend to congregate together. Finally, the *shared environment* hypothesis suggests “that connected individuals jointly experience contemporaneous exposures that contribute to loneliness” (Cacioppo et al, 2009).

Another limitation is that the study was only conducted at one institution. Though this makes generalization of the data harder to generalize, the study adds another institution to existing literature and allows us to compare findings with other studies that also only used one institution. In this comparison, we may find useful similarities or differences. Also, social networks tend to be unique from institution to institution, suggesting that the value of network data is not diminished when focused only on one institution. Additionally, the sample size at the actual institution is a potential concern. Though there are a variety of residency programs at the University of Michigan, with the ongoing pandemic and general nature of medicine, it proved

difficult to the large number of residents necessary to make satisfactory and generalizable conclusions.

Finally, the Maslach Burnout Inventory notes that respondents must be unaware of the survey's intent to measure burnout in order to minimize the effects of personal beliefs regarding burnout on survey responses. However, given the widespread nature of this survey as well as the increased focus of research on the prevalence of burnout, it's entirely possible that the subjects will be familiar with the survey and complicate the effectiveness of the results of the survey. In order to combat this, this thesis simply identified the questions that measured wellness and relied on previous literature that proved the efficacy of the elements of the MBI used.

RESULTS

Once data collection had been stopped, researchers found high levels of non-response. Figure 2 summarizes these findings for the overall population. Overall, while the survey was sent out to 323 residents in total, only 28% (92) opened the link sent, 17% (55) started the survey, and 8% (27) completed the survey.

On a per residency basis, there was a significant amount of variation, both in residency size and response rates. As can be seen in Figure 3, response rates ranged from 2.5% to 30.77% of a residency completing the survey. However, an important discrepancy to note is the size of each residency. For example, while the Cardio-Thoracic residency had the highest completion rate, they were also one of the smaller residencies. Comparatively, the Anesthesiology residency had one of the lower completion rates (3.45%) but was also the largest residency "surveyed." In fact, both residencies only had 4 residents complete the survey. See Table 1 for a count of responses within each residency.

Residency Survey Counts, n = 323						
Residency	Completed	Started	Opened	Never Opened	Total, Opened	Total
General Surgery	4	7	15	28	26	54
Anesthesiology	4	10	10	92	24	116
OBGYN	5	4	2	12	11	23
Cardio Thoracic	4	0	3	6	7	13
Urology	1	0	1	19	2	21
Orthopedic	1	0	1	38	2	40
Plastics	3	5	2	23	10	33
Otolaryngology	5	2	3	13	10	23
Total	27	28	37	231	92	323

Table 1: Residency Survey Counts. A count of the residents that either completed, started, or opened the survey.

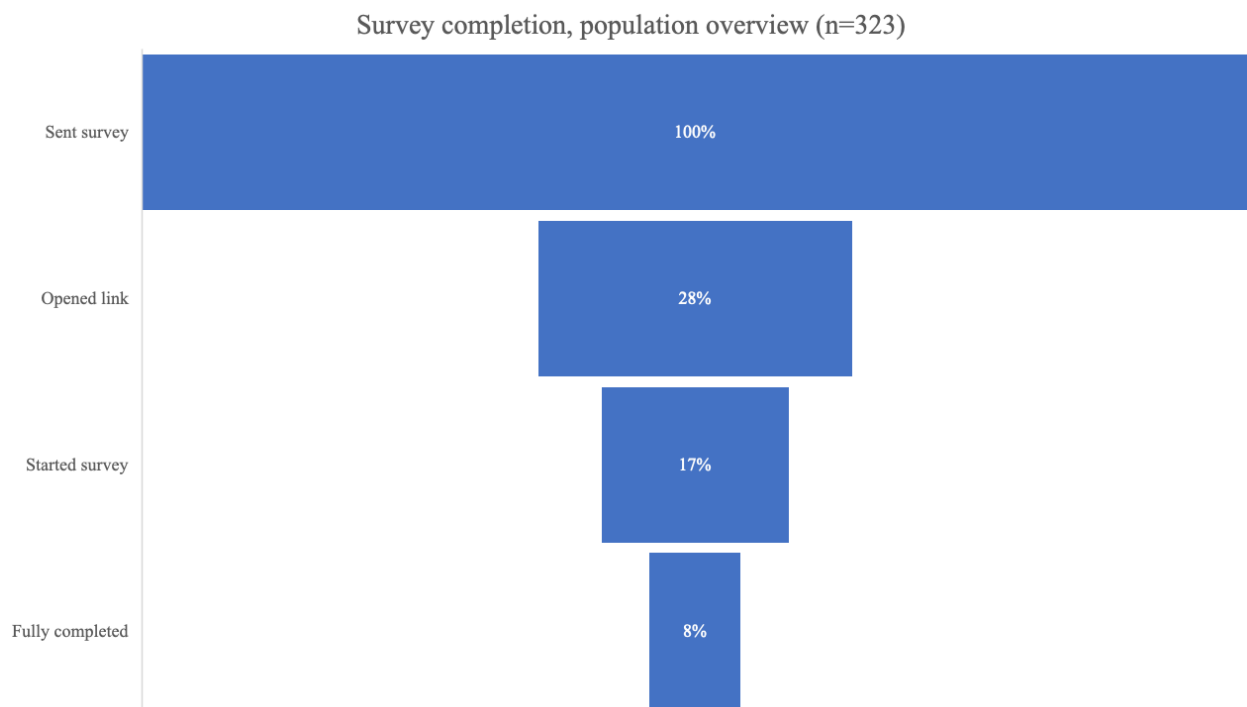


Figure 2: Survey Completion, population overview. Survey non-response across all residencies is summarized above. Of 323 total residents, only 28% of residents even opened the link sent to them. 17% started the survey and 8% even completed the survey.

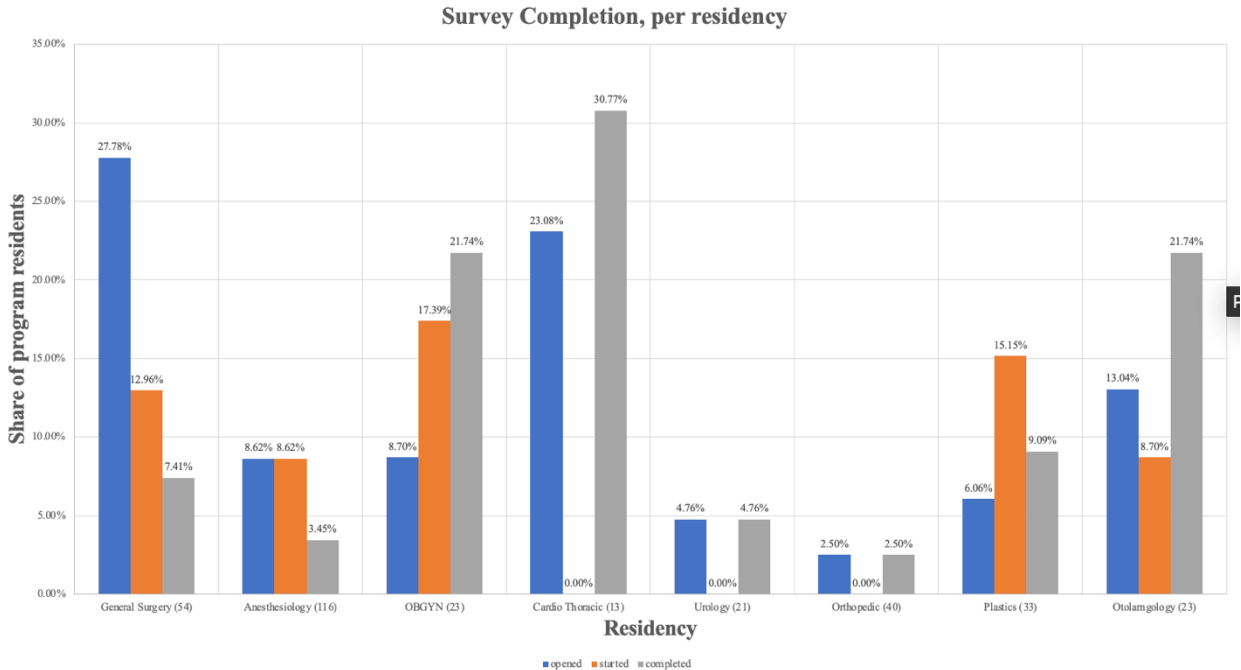


Figure 3: Survey completion per residency. Residencies varied both in terms of size and response rates. Programs ranged from as small as 13 residents (Cardio Thoracic) to 116 residents (Anesthesiology). Response rates ranged from a max of 31% to as small as 2.5%.

DISCUSSION

Based on a lack of results, it's clear that this study was unsuccessful. After data collection stopped, researchers identified five main problems with the study design that contributed to this failure. First, medical residents are experiencing heavy survey fatigue right now, so it's not surprising that they were unwilling to fill out another survey that was sent out to them. Exacerbating this frustration with surveys was likely the format of this survey's particular method of collecting network data. As mentioned earlier, residents were asked to identify and list out the people in their social networks, which is a big ask. One study found that rosters were much more effective because they required less thinking and didn't ask people to try and go through their own mental roster (Thaden and Rotolo, 2009). That said, this format was chosen because of IRB constraints and likely cannot be changed in the future.

A second issue was the survey's original reliance on goodwill. The study should have used an incentive from the start, however, the researchers naively believed that they would be able to get enough responses on goodwill alone. The study context is also an interesting factor in the failure of the survey; in other literature, such as those seen in the "Literature Review" section of this report, researchers likely had a higher response rate because they had a stronger presence or reputation at the hospital's they were studying, rather than being a random student working in a research office.

The short timeline was another potential pitfall of this study. However, given all of the other things noted, it is unlikely that having more time to run the study would have been helpful. Finally, network data is super identifiable and while there were steps in place to make sure only the primary investigator had access to the sensitive data, participants were likely unsure about the survey and, consequently, didn't fill it out.

CONCLUSION

In all, while the original objectives of this study were not met, still revealed a lot about the ways in which a network study may not work in a medical context.

First, applying a business theory in the context of a hospital was much less streamlined than originally anticipated. In looking at the way network data is often presented in a corporate context, surveys usually come from management and are more like internal reviews than they are a research project. Keeping that idea in mind would likely help improve the study in the future. Additionally, one of the things that proved difficult for this survey was using third-party data such as work schedules. We tried to evaluate this kind of network when asking about with whom

residents had done research, but this still proved to be pretty obtrusive. In the future, using ways that are more observational, rather than asking people about their networks, may prove beneficial for the success of the study. Finally, in running the study again, researchers would consider the five issues that were previously identified.

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