UNDERSTANDING THE AFFLICTIONS-TREATMENT NETWORK IN AN EARLY 20TH CENTURY MEDICAL MANUSCRIPT FROM THE JARRING COLLECTION

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INTRODUCTION

Libraries and archives contain many examples of miscellany documents that bring together disparate works such as anthologies of poetry, collections of essays, recipe books, gatherings of folk wisdom, and collections of practical advice about subjects such as farming, building, painting, and medicine. These anthologies provide historians and literary scholars with valuable insights into the nature of a broad range of cultural and historical practices. While scholars often mine these compendia *ad hoc* for individual quotes about specific practices, it is much more difficult to form a picture of the conceptual worlds that tie these seemingly disparate nuggets of wisdom together. Metrics from network analysis can offer more substantial insights into the range of topics covered in these collections than other quantitative or qualitative methodologies. In particular, the network metrics of modularity and centrality can help scholars identify and explore the range of topics and interrelationships in these sorts of collections.

As part of the *Annotated Turki Manuscripts from the Jarring Collection Online* (ATMO-1) and the *Analyzing Turki Manuscripts from the Jarring Collection Online* (ATMO-2) projects (Dwyer et al., 2015–2022), we have applied lessons that we have learned from a study of Pliny the Elder's large encyclopedia of the natural world from the Roman Empire to explore an early 20th-century medical manuscript from Eastern Turkistan (Rydberg-Cox, 2022).[1] This *Handbook of Medicine* (Jarring Prov. 351), copied in the early 20th c. but whose contents likely date from preceding centuries, consists of a series of prescriptive medical formulae, each containing a

[1] A preliminary version of this essay was also presented at the Visual and Material Culture of the Silk Roads Symposium held at the University of Kansas Center for East Asian Studies on September 11, 2020. Many points were also presented in a 13 November 2019 symposium presentation at LACITO, Paris, entitled "Using network analysis to explore etymological clustering in Chaghatay medicine."

physical or psychological ailment and the ingredients used to treat them. In her introduction to this manuscript, Arienne Dwyer describes it as follows:

The work was likely copied from several sources, since there are prescriptions against diseases, prescriptions against general misfortunes, and also amulet drawings..... The *Handbook of Medicine* begins with a prayer, and then an invocation of the planets.....The treatments and prescriptions begin on f. 5 and follow the pattern in two-clause sentences: a diagnosis *x* in the first clause, and a treatment in the second clause *y* (for *x*, do *y*). Many afflictions appear on a single folio, and it is often difficult to discern a systematic pattern or ordering of the afflictions; at most, a number of cures for the same or similar afflictions will appear together (e.g. earaches, childbirth difficulties, etc.) This apparent lack of systematicity suggests that the copyist may have copied from many sources, with each copyist adding new formulae over time (Dwyer, 2018).

This apparently unstructured medical handbook contains 726 prescriptions that mention 180 distinct medicinal ingredients for 55 unique ailments. Most prescriptions combine multiple elements to treat each condition. The most common ailments in the document are as follows:

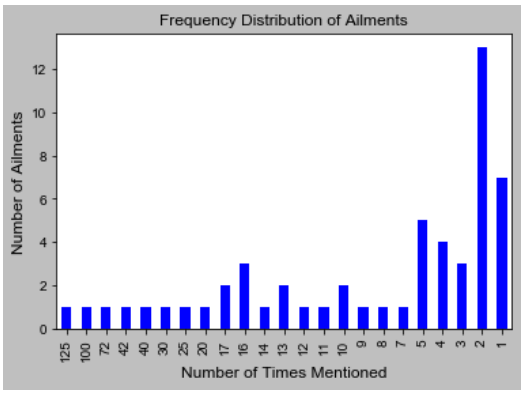
Ailment	**Times Mentioned**	**Ailment**	**Times Mentioned**
Sexual Stamina	125	Excess Phlegm	16
Excess Cold	100	Excess Cold or Heat	16
Excess Wind	72	Pleurisy / Chest Pain	16
Swelling	42	Sexual Endurance	14
Ache	40	Excess Heat	13
All Illnesses	30	Erectile Dysfunction	13
Sexual Performance	25	Impurity	12
Cataracts	20	Dampness, Aging, Weakness	11
Hair Health	17	Skin Spots	10
Child's Cough	17	Stomach/Liver/Heart - Heat or Cold	10

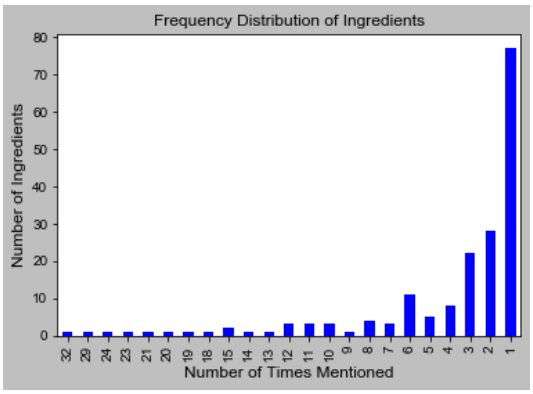
The most common ingredients in the document are as follows:

Ingredient	**Times Mentioned**	**Ailment**	**Times Mentioned**
ginger	32	anise	14
sugar	29	cumin	13
fennel	24	aniseed	12
black peppercorn	23	musk	12
saffron	21	violet	12
honey	20	nutmeg	11

manna	19	atlas daisy	11
cinnamon	18	radish seed	11
hyacinth	15	barley	10
coriander	15	lilac	10

Based solely on these frequency charts, it might appear that this document is primarily about sexuality, body aches and chills, and respiratory issues. These are primarily treated with ginger, sugar, fennel, and black peppercorn. Frequency counts alone, however, mask the much broader range of ailments described in the manuscript. While a few conditions are mentioned frequently, most appear five times or fewer. Similarly, most treatments are mentioned six times or less.





Focusing on the most-mentioned items ignores the broader collection of diagnoses and treatments that comprise the bulk of the *Handbook*, and their similarities. Network metrics can take these elements into account to identify the conceptual and thematic threads that tie them together.

Clusters of Medical Knowledge

While networks are usually used to explain relationships between individuals in social contexts, networks can also reveal connections between other categories of information (Easley 2021:40-44). One study, for example, has used network analysis to demonstrate connections between disease symptoms and their underlying genetic and chemical properties (Zhou et al., 2014). This latter study created a network that defined both diseases and their symptoms as nodes within a network. The co-occurrence of a symptom and disease in bibliographic metadata derived from the PubMed Medical Subject Headings established the edges between them. This

network helped illuminate how shared symptoms indicate either shared genes or shared protein interactions in diseases. It also suggested avenues for further research in understanding disease clusters and the development of pharmaceuticals to treat them.

We have applied this conceptual framework to Jarring Prov. 351 by constructing a table that lists each affliction and the ingredients used to treat it. For each clause that reads, "for diagnosis x in the first clause, and a treatment in the second clause y (for x, do y)," we link the diagnosis and the ingredients used to treat it in a network as follows: diagnosis x -> ingredient y1, diagnosis x-> ingredient y2, diagnosis x ->ingredient y3, etc. The terminology is normalized to account for variability in the manuscript language. The frequency of the co-occurrence of an affliction and a treatment throughout the document establishes the weight of their connection in the network.

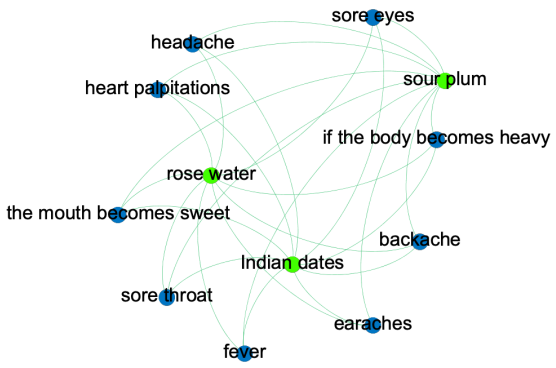
The section at the beginning of Jarring Prov. 351 describes four humors (phlegm, melancholy, bile, and blood), the ailments associated with each of the humors, and the amounts of ingredients used to cure them. Building a network from this section can illustrate our approach. Rendered in English from the original late Chaghatay language, the passage from the document that describes the humor related to blood reads as follows:

If one suffers from a fever, if the body becomes heavy, the mouth becomes sweet, [and] one suffers from headache, all these [symptoms] are due to their blood. And a sore throat, backache, sore eyes, heart palpitations, and earaches are all due to blood.

The cures for these ailments are described as follows:

To heal the blood, a syrup of Indian dates, sour plum, and rose water is prepared; [if it is] drunk at breakfast for three days, the blood will be healed.

This description creates a set of aliment nodes (in blue below): fever, the body becoming heavy, the mouth becoming sweet, headache, sore throat, backache, sore eyes, heart palpitations, and earaches. The ingredients connected to these afflictions (in green below) are Indian dates, sour plum, and rose water. This data produces the following network graph:



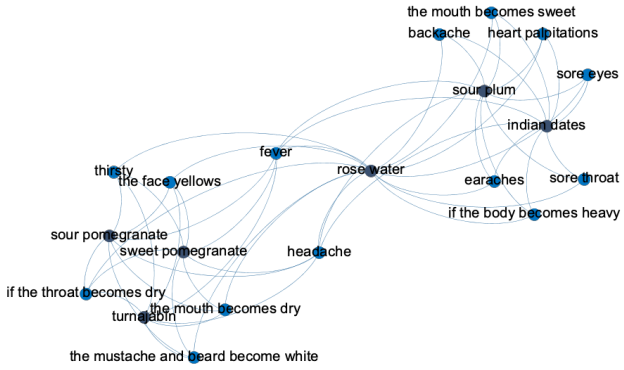
The manuscript continues with the following ailments resulting from an excess of bile:

If the mouth becomes dry, if one often becomes thirsty, if the throat becomes dry, the face yellows and the mustache and beard become white, trembling hands, if one becomes feverish (تب لرزه), if the hip aches, if food is not digested, all of these are due to bile.

The cures for maladies related to excess bile are:

If one wants to suppress bile, [mix] an equal amount of sour and sweet pomegranate together with an equal amount of rose water, apply it [somewhere] for one night. And then make a salve using *turnajabin* [Persian manna]. If one drinks it at breakfast for three days, one's bile heals.

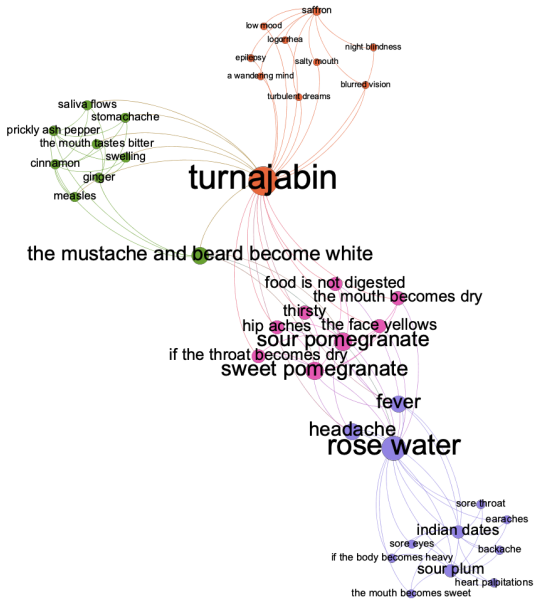
Adding this list of ailments and ingredients to the network produces the following results:



This graph begins to show how a network can help identify patterns that might not appear immediately to a human reader. The network clusters the ingredients and ailments into two groups that reflect conditions and cures associated with the two humors. It also immediately makes apparent that the two lists share only one component – rose water – and two ailments – fever and headache – in common.

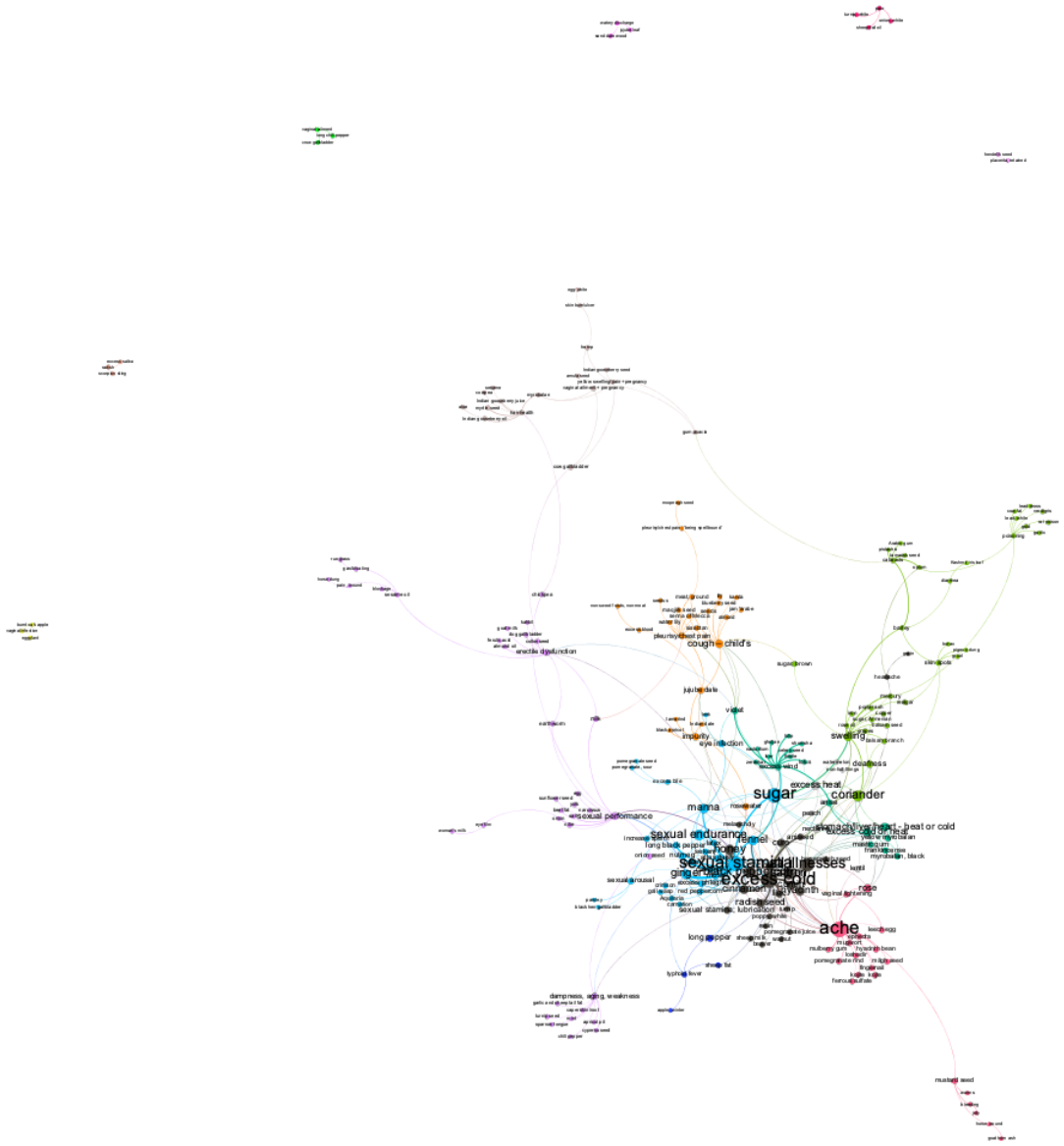
While these common elements and clusters might be easily determined from the two short passages in this example, they are more difficult to discern in longer, unstructured documents with numerous ailments, ingredients, and treatments. Both the visual representation of the graph and its underlying statistical measures reveal these clusters and common features; the centrality measure identifies the elements that unite different clusters, while the modularity class identifies the clusters themselves.

Expanding the graph to reflect the ailments and ingredients associated with all four humors produces the network graph below. Here, the colors highlight clusters of diagnoses and ingredients, the larger the node's dot, the more frequent term's occurrence. Finally, of all the several dozen ingredients represented below, we can easily see the central importance of turnajabin (Persian manna) and rose water.



Thus, the network metrics and visualization again identify the four clusters that we already know exist in the description of ailments and cures associated with each of the four humors. It also identifies the shared ingredients and symptoms that we can also identify as human readers of the text. Because this approach identifies known clusters from a short section of the text, we can pursue our hypothesis that these measures will also identify the clusters and central elements that are more difficult for human readers to discern when reading the entire document.

The network generated from the complete document contains two hundred thirty-three nodes and three hundred forty-nine edges.



The network clusters around a densely connected core that contains most of the symptoms and treatments mentioned in the *Handbook*. A series of smaller isolated groups surrounding the core reflects the conditions with fewer ingredients in common with those in the core. Examining the most common conditions illustrates how network measures help us better characterize medical treatment in premodern Central Asia, via the *Handbook*'s contents. The frequency list of disorders shows that excess cold, aches, excess wind, swelling, sexual function, and cataracts are the most frequently mentioned diagnoses. The modularity class calculation adds nuance by connecting ingredients and ailments in ways that are not apparent in the frequency list. Similarly, the network draws connections between different illnesses based on the method used to treat them. For example, excess cold aligns with headache and a general

designation of 'all illnesses,' and coughing is connected to excess blood and chest pain. The network transforms the frequency list of ailments from an undifferentiated mass into 15 separate affliction clusters.

1. Pain
2. Excess Saliva
3. Watery Discharge
4. Cough, Excess Blood, Impurity, and Chest pain
5. Aches and Bleeding
6. Hair Health, Skin Burns, and Swelling and Pain from Pregnancy
7. Excess Cold, Headache, and 'All Illnesses'
8. Vaginal Ailments
9. Excess Heat
10. Excess Bile, Excess Phlegm, Sexual Dysfunction and Arousal, and Eye Infection
11. Vaginal Infections
12. Weakness from Aging, Gas/Bloating, and Erectile Dysfunction
13. Swelling, Cataracts, Deafness, Diarrhea, Poisoning, and Skin Spots
14. Typhoid Fever
15. Excess Wind, and Excess Cold or Heat

These clusters provide a much stronger sense of the depth and breadth of the medical wisdom in this manuscript than can be gleaned from the word frequency list for the document.

Salient Ailments and Ingredients in the *Handbook*

While the modularity measure helps provide a more nuanced view of the manuscript's contents than a simple frequency list, it does not show the relative importance of the different items within each cluster or the document. Network centrality measures provide one method for defining the manuscript's central elements. The most straightforward measure of centrality is 'degree,' or the number of other nodes that connect to any given node (Kadushin, 2012, p. 29). A pharmacological ingredient with many connections will treat more conditions, while an element with fewer connections helps cure a smaller range of ailments. For example, ginger and sugar are the two most frequently mentioned ingredients in the document, with ginger mentioned 32 times, sugar 29 times, and fennel 24 times. However, the number of connections for each element reveals these ingredients' distinct roles. The manuscript lists ginger as a treatment for ten ailments, including six related to sexual health and performance. Sugar is used to treat a broader list of 14 conditions, including swelling, hearing loss, chills, swelling, and eye infection. Although fennel occurs in the document almost as frequently as sugar and ginger, it helps treat an even narrower list of only five afflictions.

Degree is just one of many centrality measures that can provide insight into the roles of different ingredients and ailments in the network. In contrast to degree, which measures the number of items attached to each node, betweenness centrality measures the extent to which a node connects different topic clusters. An ingredient that has a high betweenness centrality can treat a broader range of ailments than one with a lower score using this metric. This calculation also helps us distinguish between those ailments that co-occur more broadly across the manuscript and those unique to specific clusters. For example, the four most frequent ailments in the manuscript are sexual stamina (125), excess cold (100), excess wind (72), swelling (42), and ache (40). The generalized complaint 'ache' is only the fifth most common ailment. Still, it has the highest centrality score suggesting that aches commonly co-occur with many distinct types of sickness. Similarly, 'swelling' has the second-highest centrality score, indicating that it also co-occurs with many other ailments in the manuscript.

CONCLUSION

This exploration begins to show how network analysis, particularly the modularity and centrality measures, can be used to characterize the range of Central Eurasian medical knowledge contained in the manuscript Jarring Prov 351, *A Medical Handbook*. In particular, commonalities between treatments and their ingredients for diverse ailments and diagnoses can be explored, as well as which illnesses were considered most salient. Such results must be compared with analyses of similar manuscripts (as is ongoing in the ATMO projects); such medical treatments were practiced by élites and are only one of several medical practices of Chinese Turkestan and Central Eurasia.

At the same time, this exploration also hints at how techniques such as these can be used more broadly in other miscellany documents, encyclopedias, and other collections of knowledge. These networks, particularly when generated automatically, can scale across even larger corpora and help provide an overview of the clusters of knowledge contained within them, how the topics are interconnected, and suggest avenues for further exploration.

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