Collaborative Visualization to Support Doctors' Shared Decision-Making on Antibiotic Prescriptions

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PURPOSE

• Antibiotics are some of the most commonly yet injudiciously prescribed medications worldwide. Inappropriate use of antibiotics can result in unnecessary medication of patients, adverse drug events, increase in healthcare costs and development of antimicrobial resistance [1].

• The prescription of antibiotics needs to be optimized.

• We designed a visual analytics tool that supports doctors' asynchronous, distributed collaboration for antibiotic choices. It visualizes the spectrum of antibiotics for target pathogens, and the knowledge generated from the system is shared among users.

• This research aims at providing a design prototype to support the asynchronous collaborative functionality among doctors, which is crucial for their decision-making process but is less addressed in previous work [2,3].

DESIGN PRINCIPLES

• By examing physicians' routine sensemaking processes of antibiotics prescription, we found that for a patient with suspected infection, doctors select antibiotics based on the suspect pathogens and a patient's personalized information.

• To achieve the optimal selection of antibiotics, doctors usually refer to previous experience, search pharmaceutical databases, or discuss with colleagues.

• The traditional sensemaking process may not be comprehensive. Also, doctors may not have a clear idea about the antibiotic coverage spectrum, which may lead to overprescribing that poses a risk to antibiotic resistance [4].

• To solve the clinical gap, we designed a prototype which shows the coverage spectrum of each candidate antibiotic visually. The collaborative function allows users to refer to other physicians' knowledge and experience.

DESIGN ITERATION

Visualizing the Antibiotic Coverage Spectrum

• Since both the pathogen and antibiotic variables have a one-to-many relationship, we selected three candidate visualization models: matrix, bipartite, and circular connection (Figure 1).

• The matrix model was chosen as the fittest one, since it provides more information on the spectrum as well as enables multiple antibiotics comparisons.

• A web application prototype was developed based on the matrix model. After the user selected the *suspect pathogens*, the system generates a matrix visualization. The rows repesent the *antibiotic list*, which contains all the possible antibiotics that include one or more suspect pathogens in its indication. The columns represent the *pathogen list*, which includes all the pathogens that are covered in the indications of each antibiotic in *antibiotic list*. Each grid is filled with color if its corresponding pathogen is included in the indication of the corresponding antibiotic (Figure 2).

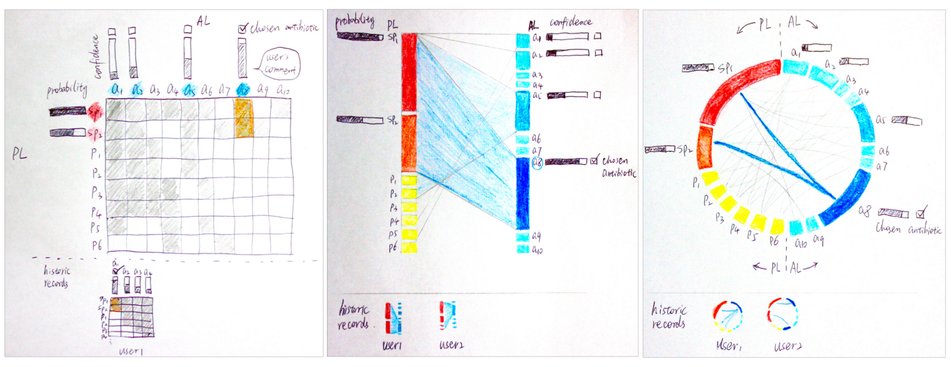

Figure 1. Three visualization models: (A) Matrix; (B) Bipartite; (C) Circular Connection.

Figure 2. The implementation of the matrix model.

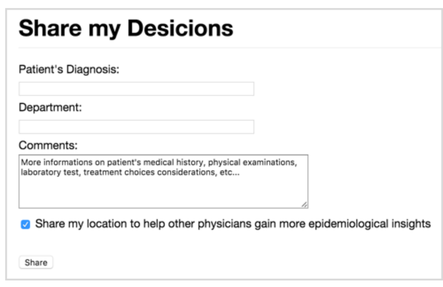

Figure 3. The present user can share his/her treatment decision to facilitate further collaboration.

Asynchronous Collaboration

• By allowing the present user to refer to previous choices of users who faced similar cases, the system provides both awareness of previous users' decisions and in doing so, provides an asynchronous collaborative function.

• The users make personal marks on the main visualization by adjusting the slider to indicate how likely they will be to choose a particular antibiotic. The antibiotics with the highest likelihood are the user's final decision. Users can leave comments and share their decision-making thoughts to facilitate further collaboration (Figure 3).

• The system provides awareness of previous users' decisions, which allows the present user to refer to choices of previous users who faced similar cases. This asynchronous collaboration mimics the knowledge and experience of the consultation process during the clinical decision-making. (Figure 4).

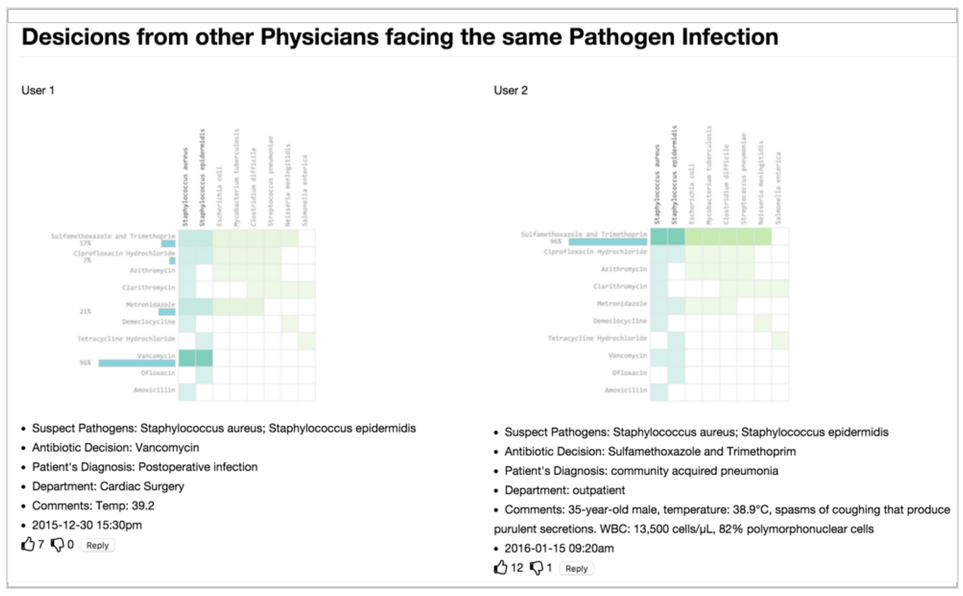

Figure 4. A view of previous users who dealt with the same pathogen infection case. The asynchronous collaboration shows their visualization state and comments.

CONCLUSION & FUTURE WORK

• We present a system that facilitates physicians' sensemaking process of antibiotic selection. This system visualizes the antibiotics' coverage spectrum. The asynchronous collaboration mimics the actual collaboration scenarios in clinical settings. The system aims to avoid antibiotic misuse and to prevent antibiotic resistance.

• The further work includes strengthening the prototype to promote user engagement and collaboration among the professional community, and implementing strategies to protect user-generated information that may contain patients' medical information. A usability study with clinicians will also be conducted to evaluate its potential as a clinical application.

References

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