Hospital infections electronic surveillance

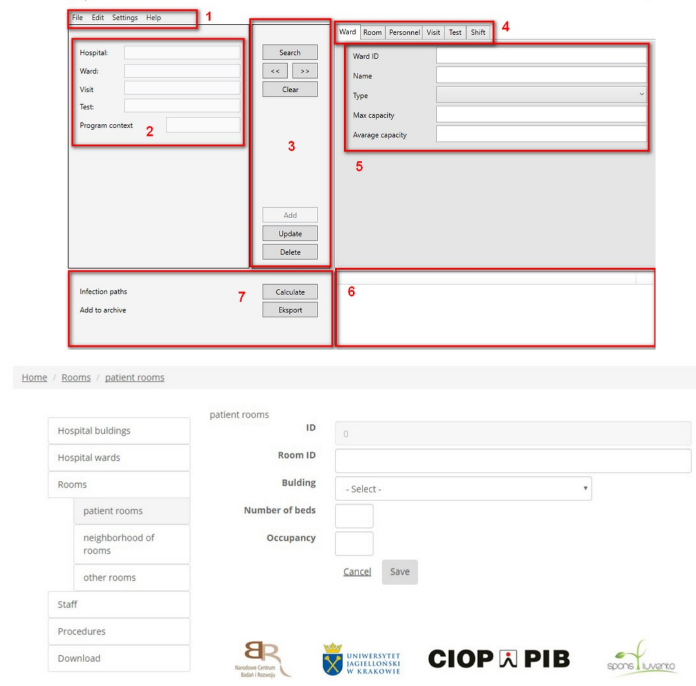
Andrzej Jarynowski[1], Ireneusz Skawina[1,2]

[1] Interdisciplinary Research Institute in Głogów/Wrocław

[2] University of Social Science, Świdnica

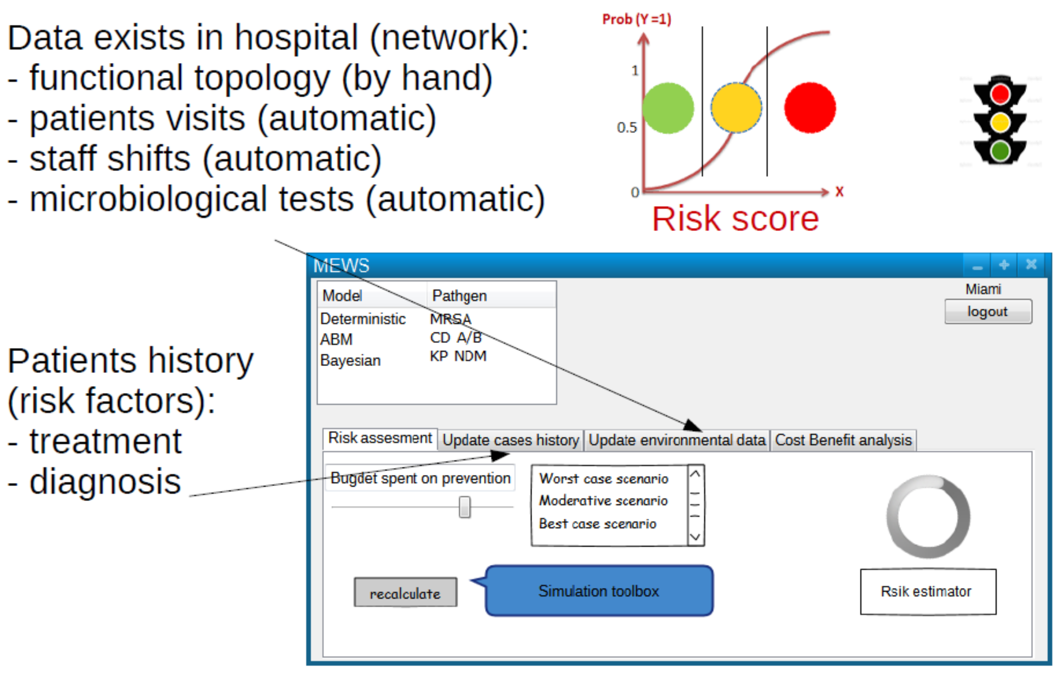
Aim: Contact networks play a crucial role in infectious disease propagation and position in the network mediate risk of acquiring or sending infections. We study the spread of hospital-associated infections through computer simulations on two layers of contact networks: organizational and empirical. We have validated our 'computer assisted' risk assessment with 'human' risk assessment in a prospective study.

Material. We have collected time-varying structure of contacts and covariates reconstructed from Polish Hospitals:



1. The organizational structure is mapped by a set of questionnaires, CAD maps integration, functional paths annotation and local vision. It is done mostly by surveys within medical staff through an interactive web application.

2. The empirical layer processes data from the registry of patient admissions and discharges from each hospital unit (wards, clinics, etc.), microbiological laboratory test results and medical staff register.



However, a lot of information about personnel was missing. Epidemiological models of various alarm pathogens are implemented on a temporary network of contacts (parameters estimated in retrospective study).

We developed a (free of charge, open-licensed) system to support hospital infection control teams, regional epidemiologists and patients in preventing hospital infections.

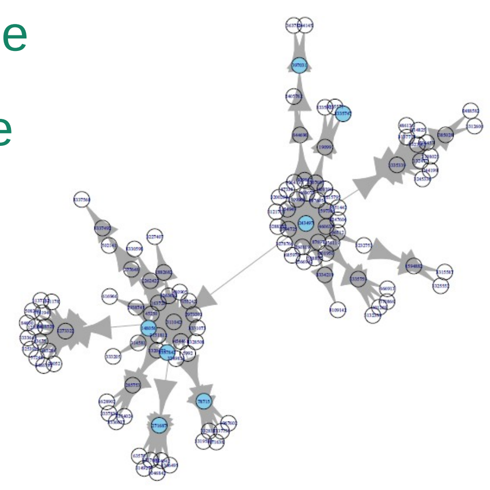
http://www.sirsz.pl

Method: We used Social Network Analysis (SNA), a method commonly applied to interpret the nature of relationships (links) between individuals (nodes) by looking into the interactions that occur between the network members. One's position (importance) in the network can be quantified through a number of network measures ('centralities').

Results: With simulated infection paths, we were able to compute network centrality measures for patients. We obtained the risk of getting infected, based on the patient's incoming connections, and the risk of spreading infections resulting from outgoing connections. We compare various standard centrality measures – position of patients and staff in contact network ('computer assisted' risk assessment) of both contacts and paths networks, which reveal what the best predictor of 'human' risk perception (based on 205 patients) is Temporal Adjusted Rage Rank algorithm on paths. However, **surprisingly good predictive power in risk assessment was found in betweenness centrality of underlying network of contac**t.

Correlation between centrality and risk assesment	*risk in*	*risk out*
betweenness contacts	0.30**	0.63
betweenness paths	0.02	-0.64
closeness paths	0.20*	-0.15
eigenvector paths	0.19*	-0.18
PageRank paths(in/out)	0.35**	0.3
adjusted PageRank paths (in/out)	0.42**	0.39

Take home message: *Simple* (CONTACTS, co-occcurence, similarity) networks could be as good as *Complicated* (infectious disease modeling PATH) networks if there is only limited knowlage of contacts within hospital



Conclusion: We conclude that specific epidemiology of a given pathogen in a given place and time could be explained only with the contact network. In spring wave 2020 around 10% of transmissions of SARS-CoV-2 in Poland were happening in health-care setup. However, further possibility of the collection, processing and storage of the data on individual person, translated to mathematical modelling could lead in future to satisfactory improvement in risk assessment.

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