# Towards a framework for comparing functionalities of multimorbidity clinical decision support:
A literature-based feature set and benchmark cases

Session 32: Identifying Better Approaches to Clinical Decision Support and other Clinical Informatics Interventions

D. O'Sullivan, W. Van Woensel, Sz. Wilk, S. W. Tu, **W. Michalowski**, S. Abidi, M. Carrier, R. Edry, I. Hochberg, S. Kingwell, A. Kogan, , M. Michalowski, H. O'Sullivan, M. Peleg.

Learning Objectives
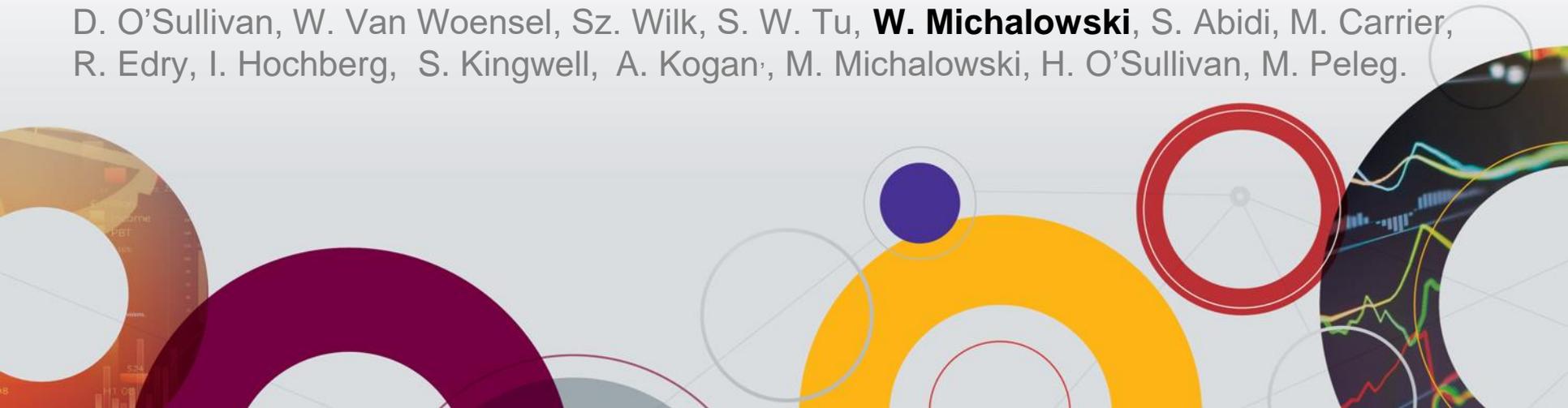
After participating in this session the learner should be better able to:

- Understand the challenges around developing clinical decision support systems (CDSS) targeting multimorbidity

- Appreciate the unique features that CDSS for multimorbidity should include

Introduction

- Multimorbidity has become prevalent as mortality rates have declined and populations have aged

- Multimorbidity presents significant challenges for CDSS, particularly in cases where recommendations from clinical guidelines offer conflicting advice

- We are presenting a framework for multimorbidity CIG-based clinical decision support (MGCDS)
  - A set of features for MGCDS derived using a literature review and evaluated by physicians
  - A set of benchmarking case studies which illustrate the clinical application of these features
  - A standard for reporting MGCDS solutions
  - Criteria for evaluating MGCDS solutions

Examples of Approaches to MGCDS

- Goal-oriented MGCDS by Kogan et al[1]
  - GoCom relies on CIGs represented in PROforma and augmented with knowledge about goals and physiological effects of specific CIG task

- Planning-oriented MGCDS by Michalowski et al[2]
  - MitPlan constructs a plan for a given time horizon that optimizes some objective function (e.g., overall cost) and allows to mitigate adverse interactions between multiple CIGs

- Ontology-based MGCDS by Van Woensel, Abidi et al[3]
  - CIG-IntO ontology used to represent integration policies that are are instantiated and applied to mitigate adverse interactions at execution-time

- Multi-Agent Planning MGCDS by Fdez-Olivares et al[4]
  - MAP framework relies on Hierarchical Task Networks to represent and control the planning process and involves multiple agents that develop different candidate management plans

1. Kogan A, Peleg M, Tu SW, Allon R, Khaitov N, Hochberg I. Towards a goal-oriented methodology for clinical-guideline-based management recommendations for patients with multimorbidity: GoCom and its preliminary evaluation. J. Biomed. Inform. 2020;112:https://doi.org/10.1016/j.jbi.2020.103587.
2. Michalowski M, Wilk S, Michalowski W, Carrier M. MitPlan: A planning approach to mitigating concurrently applied clinical practice guidelines. Artif Intell Med. 2021 Feb 1;112:102002.
3 Van Woensel W, Abidi S.S.R., Abidi, S. Decision support for comorbid conditions via execution-time integration of clinical guidelines using transaction-based semantics and temporal planning. Artif Intell Med 2021;118. https://doi.org/10.1016/j.artmed.2019.02.003 9
4 Fdez-Olivares J, Onaindia E, Castillo L, Jordán J, Cózar J. Personalized conciliation of clinical guidelines for comorbid patients through multi-agent planning. Artif Intell Med [Internet]. 2019;96(November):167– 86. Available from: https://doi.org/10.1016/j.artmed.2018.11.003

Methods

- This research is about:
  - Identifying features for MGCDS
    - Based on literature review and experts' assessment
  - Creating a set of benchmarking clinical case studies
    - Based on published clinical guidelines and expert consultations

Literature Review

- In line with the PRISMA systematic review process, we searched Google Scholar, PubMed and Web of Science with relevant keywords with a focus on computer-interpretable guidelines (CIG) research

- We identified 18 multimorbidity features which are categorized as follows:

  - Interaction features: types of adverse interactions among recommendations coming from CIGs

  - Mitigation features: types of mitigation strategies when CIGs offer interacting recommendations

  - Other features

Case Studies

- Research community was asked to contribute case studies

- With help of physicians we selected 4 case studies that together cover all identified multimorbidity features

  1. TIA/Duodenal ulcer/Osteoporosis
  2. Chronic kidney disease/hypertension/atrial fibrillation
  3. Venous thromboembolism /Urinary tract infection
  4. Drug-eluting stent / lung mass surgery

- Case studies describe realistic patient scenarios

Available via GitHub repository:
https://github.com/MGCDS/benchmark-framework

Sample features

Interaction features	Example	Case study
Drug from one CPG has an effect on a comorbid condition.	The cardiovascular disease CPG recommends low-dose aspirin, which may cause or worsen duodenal ulcer (DU) as a comorbid condition.	1,2,4
Two or more drugs from different CPGs interact	The bacterial urinary tract infection CPG recommends antibiotics such as trimethoprim, which impacts the anticoagulant effect of warfarin that is recommended by the venous thromboembolism CPG.	2,3
Mitigation Features		
Add a drug to mitigate an adverse effect	Add a PPI to mitigate the effect on DU caused by aspirin.	1
Replace a drug with a safer / more effective drug for comorbidity	Replace low-dose aspirin with clopidogrel for a patient with DU.	1,2,4
Other Features		
Patient preferences and/or patient burden	Choosing one drug over another due to lower price; or choosing any of direct oral anticoagulants over warfarin to avoid checking INR on regular basis.	1,2,3,4

Validation of features

- Recruited 15 physicians of different specialties and different levels of experience for assessing and commenting on the features

- Used an online survey instrument to validate the features
  - Short examples from the developed case studies were included to illustrate each feature

- Respondents were asked to:
  - Evaluate whether a feature was relevant for treating multimorbidity
  - Add and describe any missing features

Survey Results

- Overall, the results confirmed the relevance of the features

- No new features were proposed

- Some features where not endorsed unanimously:

  - Identification of duplicate or redundant advice from different CPGs: 9 out of 15 respondents considered it relevant

  - The mitigation strategy of monitoring the effect of a drug: 13 out of 15 respondents considered it relevant

  - Explanation of mitigation strategies: 11 out of 15 respondents considered it relevant

  - Optimization of clinical resources: 12 out of 15 respondents considered it relevant

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Survey Results

- Some additional comments:

  - To ignore clinical actions that are associated with less important goals and prioritize goals based on clinical needs.

  - To prioritize goals based on what treatment a patient can or is willing to follow.

  - To address a challenge of an assessment of risks and benefits when guidelines are in conflict

Future Work

- Development of the remaining aspects of our framework for MGCDS

  - A standard for reporting MGCDS solutions

  - Criteria for evaluating MGCDS solutions

- A comparison study to evaluate existing MGCDSs and their underlying methodologies

  - A quantitative evaluation of the functionalities of MGCDS

  - A qualitative evaluation of MGCDS solutions and outputs

  - The identification of latent features of the MGCDS through one-on-one interviews with physicians

Conclusions

- There exist a large number of MGCDS, with none of them covering all possible aspects associated with supporting the management of multimorbidity patients

- The results described in this paper represent first steps towards creating a unified framework for comparing functionalities of MGCDS
  - We identified a set of MGCDS features, developed 4 case studies covering those features, and conducted a survey with physicians to confirm the features

- Having a unified framework will enable:
  - Comparing functionalities of existing MGCDS
  - Guiding the development of new systems by highlighting gaps in research

Questions?