Towards Usability Evaluation of Family Physicians Interaction with COMET: Comorbidity Ontological Modelling & ExecuTion System

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Presentation Outline

• COMET Tool
  • Clinical Domain
  • Intended Users
  • Conceptual Framework & System Architecture
  • COMET functionalities
  • Preliminary Evaluation
• Research Objectives
• Research Methodology
• Plan for data analysis
• Future work & Conclusions
COMET: Comorbidity Ontological Modeling & Execution

• Clinical Domain
  • Comorbidity of Chronic Heart Failure (CHF) and Atrial Fibrillation (AF)
    • Two new epidemics of cardiovascular diseases
      • Complicates management of each other
        • Rx needs to be individualized

• Intended Users
  • Family practitioners
  • CHF-AF often managed at General Practice
    • Problems in CHF Diagnosis (Hobbs, Davis, & Lipp 2000)
    • Under diagnosed concurrent AF (Hobbs, Davis, & Lipp 2000)
    • Concerns regarding starting and monitoring treatment

• Care Gap in management (Tremblay et al. 2004)
  • Discrepancy between evidence based care and standard care
  • Evidence Based Clinical Algorithms (EBCA) – to reduce this gap

• Knowledge Sources to fill the gap
  • Canadian CPG, ACC/AHA CPG, Uptitration Protocols, Domain Experts
COMET: Framework

- Health Knowledge Management Framework

1. **Generation** of CP (derived from CPG)
   - Knowledge Identification
   - Knowledge Synthesis

2. **Development** of a ‘unified’ ontologically modeled CP to handle comorbidities
   - Knowledge Formalization

3. **Alignment** of temporal and procedural aspects of computerized comorbid CP
   - Knowledge Alignment

4. **Execution** of computerized CP at point of care for clinical decision support
   - Knowledge Execution
Knowledge Synthesis Step II: Ordering of tasks specific heuristics: Effective, efficient and logic alignment and execution

CHF Diagnosis

Clinical Assessment

- CHF Symptoms → CHF Signs → NYHA Class
  - Class III & IV: Refer to cardiologist
  - Class I & II: To exclude other conditions
    - To exclude heart failure: Routine blood work and Chest X-ray

Evaluation of diagnostic tests results

- Boston Score (S/S & X-ray)
  - <4: HF unlikely
  - 5-7: HF possible
  - >8: HF definite

- BNP
  - Normal: Refer or reassess
  - Abnormal: When any one of these is abnormal

- ECG
  - Normal
  - Abnormal for AF

Evaluation of Echo results

- Inconclusive → Refer to cardiologist
- Diastolic CHF +/- AF: Alignment of CHF and AF treatment
  - CHF with AF
  - CHF without AF
- Abnormal for CHF → CHF confirmed → CHF Treatment
Descriptive OWL Ontology Instantiated by CHF and AF synthesized Knowledge

Recommendation

1. All patients with heart failure and an LVEF less than 40% should be treated with an angiotensin-converting enzyme (ACE) inhibitor in combination with a Beta Blocker unless a specific contraindication exists. (Class of recommendation: Class 1, Level of evidence: Level A)

2. ACE inhibitors should be used in all asymptomatic patients with an LVEF less than 35%. (Class of recommendation: Class 1, Level of evidence: Level A)

3. ACE inhibitors should be used in all patients with symptoms of heart failure and an LVEF less than 40%. (Class of recommendation: Class 1, Level of evidence: Level A)

Source: Canadian Cardiovascular Society consensus conference recommendations on heart failure 2006: Diagnosis and management
Temporal & Functional Knowledge Alignment: of discrete care plans at modeling level in response to CHF, AF or CHF-AF preconditions

<table>
<thead>
<tr>
<th>Chronic Heart Failure</th>
<th>Alignment</th>
<th>Atrial Fibrillation</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHF entry point 1</td>
<td>AF entry point 1</td>
<td>AF entry point 1</td>
</tr>
<tr>
<td>Clinical history &amp; Exam</td>
<td>Clinical assessment and initial testing</td>
<td>Clinical assessment and initial testing</td>
</tr>
<tr>
<td>CHF entry point 2</td>
<td>AF entry point 2</td>
<td>AF entry point 2</td>
</tr>
<tr>
<td>Assessment of test results</td>
<td>Assessment of left ventricular function</td>
<td>Assessment of left ventricular function</td>
</tr>
<tr>
<td>Normal ECG</td>
<td>Impaired left ventricular function</td>
<td>Normal left ventricular function</td>
</tr>
<tr>
<td></td>
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<td>AF entry point 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stroke risk stratification and anticoagulation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AF entry point 4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Treatment of atrial fibrillation</td>
</tr>
<tr>
<td>CHF entry point 3</td>
<td>CHF-AF entry point 1</td>
<td>CHF-AF entry point 1</td>
</tr>
<tr>
<td>Assessment of echocardiography result</td>
<td>Thromboprophylaxis in patients with CHF &amp; AF</td>
<td>Thromboprophylaxis in patients with CHF &amp; AF</td>
</tr>
<tr>
<td></td>
<td>CHF-AF entry point 2</td>
<td>CHF-AF entry point 2</td>
</tr>
<tr>
<td></td>
<td>Treatment of AF in patient with heart failure</td>
<td>Treatment of AF in patient with heart failure</td>
</tr>
<tr>
<td>CHF entry point 4</td>
<td></td>
<td></td>
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<tr>
<td>Pre-treatment electrolyte assessment &amp; correction</td>
<td></td>
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<tr>
<td>CHF entry point 5</td>
<td></td>
<td></td>
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<tr>
<td>Initiation of treatment of heart failure</td>
<td></td>
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</tr>
</tbody>
</table>

ECG: Electrocardiogram

Alignment

Impaired left ventricular function

Normal left ventricular function
COMET: Comorbidity Ontological Modeling & Execution: Architecture
**BETA BLOCKER UPTITRATION REVIEW**

**Recommendation:**

1. Patients with NYHA classification Class I or II can be safely initiated and titrated with a beta-blocker by non-specialist physician.

2. The dose of beta-blocker should be increased slowly (e.g., double the dose every 2 to 4 weeks).

3. All patients with an LVEF equal to or less than 40% should receive a beta-blocker proven to be beneficial in large-scale clinical trials.

**Class of recommendation:** Class I

**Level of evidence:** Level A

4. Therapy should be initiated at a low dose and titrated to the target dose used in large-scale clinical trials or the maximum tolerated dose if less than the target dose.

**Class of recommendation:** Class I

**Level of evidence:** B

**Source:** Canadian Cardiovascular Society consensus conference recommendations on heart
**Assess BNP Result**

- **SELECT**
  - **ITEM**
    - Abnormal (greater than 300 pg/mL)
    - Normal (less than or equals 300 pg/mL)

**Assess ECG Result**

- **SELECT**
  - **ITEM**
    - ECG abnormal for atrial fibrillation
    - ECG is abnormal
    - ECG is normal

**Assess Chest X-ray Result**

- **SELECT**
  - **ITEM**
    - Chest X-ray is abnormal for CHF
    - Chest X-ray is normal for CHF

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**Recommendation:**

Routine tests such as complete blood count, electrolytes, renal function tests, urinalysis, glucose, lipids, liver enzymes and thyroid function are recommended at the time of initial evaluation if diagnostic suspicion is high. Initial investigations such as chest X-ray and ECG should also be performed in all suspected patients. Initial investigations should be targeted to confirm or exclude heart failure as the diagnosis and to identify systemic disorders (e.g. thyroid dysfunction) or co-morbidities (e.g. concurrent atrial fibrillation on ECG) that may affect the development, progression and management of heart failure.

**Source:**

Measurement of BNP or Brain Natriuretic Peptides (also called plasma B-type) is helpful because low concentrations are useful in excluding heart failure and high concentrations can confirm heart failure in patients presenting with dyspnea when the clinical diagnosis remain uncertain.

**<300 pg/mL:** Acute Congestive Heart Failure unlikely

**300 - 1800 pg/mL:** Consider age-stratified cutpoints
COMET Functionalities

• Diagnostic Assistance
  • For CHF and Comorbid CHF-AF
  • Use of NYHA functional classification to identify patients with milder symptoms
  • Automated computation of Boston Criteria Score (Symptoms + Signs + CXR)
    • Better identification of patients for echo

• Therapeutic Assistance
  • Parallel therapies (ACEI/ARB, BB, Diuretics, Anticoagulation)
  • Uptitrations protocols nested within parallel treatment plans
    • Manage uptitrations simultaneously

• Patient education materials

• Recommendation is supported by best evidence from CPG + strength of the evidence

• Recommendations for Specialist Referral
Preliminary Evaluation

1. **Evaluation of modeling of knowledge (ontology)**
   - Consistency & Conciseness using Pellet
     - Subsumption tests (Consistent, no contradictory information, no useless definitions)
   - Completeness
     - Adequate representational capacity to capture comorbid domain and procedural concepts

2. **Evaluation of functionality of COMET**
   - Ability of COMET to provide decision support for CHF and CHF-AF
     - Able to handle single disease and comorbid scenarios

3. **Evaluation of correctness of knowledge**
   - Domain experts: A cardiologist and two GPs
   - Three separate interview style informal sessions
   - Walk through the application, responses recorded
Evaluation for Correctness of Knowledge: Ontology updates after external evaluations
Objectives of this Usability Study

• Two main objectives

• To assess how well COMET system meets functional goal and usability needs of the FP when it comes to management of CHF and comorbid CHF-AF

  • How easy it is to use COMET?
  • How easy it is to follow the protocols and find the desired information in COMET?
  • How clear, understandable, useful and helpful is the information content in COMET for the FP?
  • To establish baseline user satisfaction and recommendation levels of system functionalities, interface and content

• To achieve end-user feedback to identify potential areas of modifications needed to improve content, interface design and task related usability of COMET to enhance its overall usability

  • What are potential usability problems with regards to screen design layout and navigation and what changes will make COMET more acceptable to the target users?
  • What are potential problems with respect to the organization and comprehension of the information content in COMET?
  • What modifications will make information more clear, understandable, useful and helpful when it comes to relevant clinical decision-making and care planning?
Methodology

- Study Design: Non-experimental
  - Pre- and Post-Interaction Questionnaires
  - Think aloud reports
  - Some qualitative responses
- Ethics approval has been sought
Study Participants

• Participants
  • Halifax Family physicians

• Inclusion Criteria
  • All licensed in Nova Scotia/Canada
  • Have access to internet
  • Currently working

• Exclusion Criteria
  • Not licensed in Canada
  • No access to Internet

• Sample Size
  • 10 participants
    • Based on estimation provided by Kushnirk & Patel (2004); Vizri (1992)
      • Up to 75% usability problems can be uncovered within first 5 users, and up to 85% by the 8th users, after which yield drops
Recruitment of FP

• By research assistant (MHI student – Andrea Prada Serrano)
  • Successfully recruited 5 participants so far
  • 4 have already participated
  • 1 next week

• Recruitment Procedure
  • COMET Study Web-site - e-mailed
  • Recruitment Notices mailed
  • Direct E-mails
  • Direct Phone calls
  • Direct visits to FP’s offices

• E-mails, Phone no. & Addresses
  • NS College of Physicians and Surgeons Family Physician directory
  • Department of Family Medicine web-site
    • Publically available
Methodology

• General Study Design

  • Laboratory study with Family Physician

    • FP offices

    • Need Desktop/Laptop with Internet

    • Full-study - 60 min one-on-one sessions with FP

    • Administer informed consent

    • Participant fill pre-study background questionnaire

    • FP receives 10 min standardized training
      • 3 case scenarios

    • Think aloud reports

    • Post-study questionnaire
PART I - PLEASE FILL IN THE FOLLOWING INFORMATION:

1. Age: ________
2. Gender: □ Male   □ Female
3. Years since you graduated from medical school___________________________

4. Your current medical record system is
   Paper-based
   Electronic
   Combination

5. If your current medical record system is electronic, does it have any decision support capabilities?
   No
   Yes

6. If your answer is Yes to question number 5, then which of the following decision support capabilities does your electronic medical record system have? (Check all that apply)
   Identifying possible drug interactions
   Alerts and prompts to ensure regular screening of the patient
   Alerts and prompts to facilitate therapeutic care planning
   Alerts and prompts to facilitate diagnosis
   Alerts and prompts to ensure compliance with clinical practice guidelines
   Other decision support capability: please specify __________________________

7. Do you seek clinical practice guidelines to aid patient care?
   No
   Yes

8. Do you seek patient care information on-line?
   No
   Yes

9. How would you best characterize your practice? (Please check only one)
   Solo primary care practice
   Solo specialty care practice
   Primary care group or partnership
   Single specialty group or partnership
   Multi-specialty group or partnership (including staff or group model HMOs)

10. How comfortable do you feel using computers in general?
    Very comfortable
Methodology: Case Scenarios

A scenario is an easily recognizable patient state for a particular diagnosis

3 Representative case Scenarios

1. Pt. has CHF
2. Pt. has comorbid CHF-AF
3. Inconclusive Diagnosis

Follow the therapeutic plans/referral from here

Reflect essential steps and associated outcome(s)

Each step/outcome combo represents functional goals and usability need of a FP

Developed using CPG/med literature by the researcher

<table>
<thead>
<tr>
<th>Action Steps (Task)</th>
<th>Outcome assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Enter Demographic Information</td>
<td>-</td>
</tr>
<tr>
<td>2 Save and Continue</td>
<td>-</td>
</tr>
<tr>
<td>3 Proceed to Clinical Exam and History</td>
<td>See the displayed CPG recommendations and information related to history and physical exam</td>
</tr>
<tr>
<td>4 Previous Cardiac History</td>
<td>Select ‘Previous Angiography’</td>
</tr>
<tr>
<td>6 Go to Symptom Fields</td>
<td>Select ‘Dyspnea on rest’</td>
</tr>
<tr>
<td></td>
<td>Select ‘Paroxysmal Nocturnal Dyspnea’</td>
</tr>
<tr>
<td></td>
<td>Select ‘Swelling of ankles’</td>
</tr>
<tr>
<td></td>
<td>Select ‘Palpitations’</td>
</tr>
<tr>
<td>7 Go to Risk Factors fields</td>
<td>Select ‘Diabetes Mellitus’</td>
</tr>
<tr>
<td></td>
<td>Select ‘Hyperlipidemia’</td>
</tr>
<tr>
<td>8 Go to Physical Exam fields</td>
<td></td>
</tr>
<tr>
<td>9 For Blood Pressure</td>
<td>Select ‘Normal’</td>
</tr>
<tr>
<td>10 For Abdominal Exam</td>
<td>Select ‘Acites’</td>
</tr>
<tr>
<td>11 For Cardiovascular Exam</td>
<td>Select ‘JVP more than 6cm H₂O with peripheral pitting edema’</td>
</tr>
<tr>
<td></td>
<td>Select ‘Palpable second heart sound’</td>
</tr>
<tr>
<td></td>
<td>Select ‘Parasternal lift’</td>
</tr>
<tr>
<td>12 For Pulmonary Exam</td>
<td>Select ‘Lung crackles more than basilar’</td>
</tr>
<tr>
<td></td>
<td>Select ‘Wheezing’</td>
</tr>
<tr>
<td>13 For Pulse Rhythm</td>
<td>Select ‘Irregularly irregular’</td>
</tr>
<tr>
<td>14 For Pulse Rate</td>
<td>Select ‘Tachycardia more than 110 beats/min’</td>
</tr>
<tr>
<td>15 Go to NYHA Class</td>
<td>Select ‘Class II’ NYHA classification supplementary information is displayed on screen</td>
</tr>
<tr>
<td>16 Click ‘Order tests to exclude heart failure as diagnosis’</td>
<td></td>
</tr>
<tr>
<td>17 Click ‘Confirm Clinical History and Exam Button’</td>
<td>See the pop up the confirmation dialogue box and click Yes.</td>
</tr>
<tr>
<td>18 See the Assessment of initial test results bar</td>
<td>See the recommendations and information related to diagnostic tests displayed</td>
</tr>
<tr>
<td>19 For BNP</td>
<td>Select ‘Normal (Less than or equal 300pg/mL)’</td>
</tr>
<tr>
<td>20 For ECG select Normal</td>
<td>Select ‘Abnormal for atrial fibrillation’ See the pop-up message ‘This is now a CHF and AF Pathway’</td>
</tr>
<tr>
<td>21 For Chest X-ray</td>
<td>Select Abnormal select ‘Bilateral pleural effusions’ select ‘Cardio-thoracic ratio equal to or more than 0.50’</td>
</tr>
<tr>
<td>22 Select Boston Criteria Score and Assessment</td>
<td>See the information regarding Boston Score displayed See the score displayed as more than or equal to 8 points See the message ‘order echocardiography for this patient’</td>
</tr>
</tbody>
</table>
Methodology: Think Aloud Reports

- Participants are encouraged to think aloud
  - Verbalize their thoughts

- Comments along with corresponding screens are noted down

- Data will be used to prepare think aloud reports
  - To improve the system design, functionality and content
Methodology: Post-Test Questionnaires

- 5-point likert scale post-study questionnaire to measure functionality and usability of COMET

- Tools prepared by the researcher
  - Adopted from many existing tools

- 5 themes in the questionnaire

- Some open-ended questions
  - At the end of the questionnaire
Methodology: Post-Test Questionnaires

• We have identified 5 streams of usability evaluation
  
  • Learnability i.e. how easy is it to use and learn COMET?
  
  • Screen design layout and navigation
  
  • Task related usability in terms of searching and finding desired information
  
  • Content helpfulness, usefulness and understandability
  
  • Over all satisfaction and recommendation
1. Learnability

<table>
<thead>
<tr>
<th>Learnability: How easy is it to learn and use COMET</th>
<th>Strongly agree</th>
<th>Moderately agree</th>
<th>Neither agree or disagree</th>
<th>Moderately disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I find the COMET system easy to learn</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2. I find it easy to learn to follow the protocols in COMET</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3. It is easy to remember the field names and interfaces</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. I would imagine that most people could learn to use the COMET system very quickly</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5. I think COMET features are very consistent and therefore are easy to remember</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6. I do not need a lot of training before I can use COMET system effectively</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7. Overall, I am satisfied that how easy it is use the COMET system</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8. The organization of information in COMET is clear</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

3. Content

<table>
<thead>
<tr>
<th>Content helpfulness, usefulness and understandability</th>
<th>Strongly agree</th>
<th>Moderately agree</th>
<th>Neither agree or disagree</th>
<th>Moderately disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Information content (such as signs, symptoms, diagnostic and therapeutic information) in COMET meet my needs</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2. COMET provides useful information for the management of chronic heart failure</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3. COMET provides useful information for the management of comorbid chronic heart failure and atrial fibrillation</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. Information (such as signs, symptoms, diagnostic and therapeutic steps) provided by COMET is helpful for me</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5. Information (such as signs, symptoms, diagnostic and therapeutic information) provided by COMET is clear and understandable</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6. The task related supplemental material (e.g. guideline recommendation and its source) is helpful for patient care</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7. Key decision points and decision options in COMET are clear and understandable</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8. Terminology used in COMET is easy to understand</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9. The information content in COMET system is meaningful</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>10. The information content in COMET system is intuitive</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
Methodology: Post-Study Questionnaires

- Adopted from many standardized tools such as:
  - IBM Computer Usability Satisfaction Questionnaire
  - QUIZ (Questionnaire for User Interface Satisfaction: Web-based, mainly for interface, screen design layout and navigation)
  - Perceived Usefulness and Ease of Use (Learnability and Task-related usability)
  - USE Questionnaires content helpfulness (ease of use and overall satisfiability)
Plan for Data Analysis: Quantitative Data Analysis

• Mean scores for all individual answers

• Mean scores of all answers as a group within each stream of the survey

• Overall satisfaction will be determined by averaging all responses in “Overall Satisfaction and Recommendation” Category

• Likert responses collated into bar-charts
  • Info will be displayed as bar charts for better visualization
  • Summarized by mode
Plan for Data Analysis: Quantitative Data Analysis

- Chi-square
  - To evaluate results of survey both at the question and stream level
    - One dimensional goodness of fit
      - Whether a significant diff. exists b/w observed and expected no. of responses in each stream

- Cronbach alpha to evaluate consistency of the responses within streams
  - Whether the questions in the questionnaire all reliably measure the same latent variable that is inferred from the responses

- Use R2.12 for data analysis
Plans for Data Analysis: Think Aloud Reports

- Large amount of qualitative data
  - Qualitative analysis

- Cognitive processes might not directly manifest in think aloud reports but have to be inferred

- By applying Grounded Theory
  - Process of discovery of theory from data that is systematically gathered and analyzed

- Provisional classification based on sub-set of data

- Continue testing/revision against entire report material
  - Until point of saturation is achieved
    - Further data will not require changes in coding categories

- Theory emerges
Future Work & Conclusions

• Study is in progress
  • 4 + 1 participants so far

• This information will be used to improve the system

• Outcome evaluation
  • Clinical effectives

• Integration with EMR
• Funding for this work has been provided by “Greensheild Canada”

• Thank you

• Any questions????