Computerized clinical decision support systems (CCDSS) and patient reported outcomes (PRO) - A systematic literature review

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Cancer related symptoms are inadequately managed
Background

• According to a systematic review
  – 64% of patients with incurable cancer reports pain\(^1\)
  – 33% of cancer outpatients are undertreated for pain\(^2\)

• Pain is insufficiently documented in medical records, in one study in only 57% in cancer outpatients\(^4\)

• Implementation of pain guidelines improves pain control in randomized studies\(^3\)

1. van den Beuken-van Everdingen et al, Ann Oncol, 2007
2. Fisch et al, JCO, 2012
Improvements in computer technology
Background

• Rapid development in computer technology
  – Increased processing power
  – Smaller devices
  – Enhanced mobility

• Expanding employment of computers in general
  – Laptops
  – Tablets
  – Smartphones
Background

- Electronic medical records (EMR) introduced in most hospitals in Western Europe and USA

- Several benefits

- EMR is commonly applied to store and retrieve medical data
Can we improve treatment of cancer related symptoms by applying modern computer technology?

Cancer related symptoms are inadequately managed

Improvements in computer technology
Computerized decision support systems (CCDSS)

- CCDSS is an elaboration of EMR
- Integrates patient data from various sources
- Several types of CCDSS

Sucher, J Trauma, 2008
Several types of CCDSS

- Alerts and reminder systems
- Order entry systems for prescriptions
- Expert systems
Computer based clinical decision support systems (CCDSS) and patient reported outcomes (PRO), a systematic review

Computer based clinical decision support systems (CCDSS) and patient reported outcomes (PRO) - A systematic literature review

Blum D., Raj S.X., Oberholzer R, Riphagen I.I., Florian S., Kaasa S., EURO IMPACT, European Intersectorial and Multidisciplinary Palliative Care Research Training
Aim of the study

Investigate context, content and application of CCDSS on patient reported outcome
Inclusion criteria

- CCDSS incorporating a clinical guideline
- CCDSS is compared to patient care without a CCDSS
- CCDSS applied by a healthcare professional in a clinical practice
- CCDSS provides treatment recommendations
- Trials investigating patient reported outcomes
Research questions

• In what context is the CCDSS applied?
• How is the flow of data in and out of the CCDSS?
• What guidelines did the CCDSS employ?
• What was the efficacy of CCDSS?
What is patient reported outcome (PRO)?

• Information on symptoms reported directly by patients

• Main purpose: Conveying this information to the clinician at point-of-care

• Generic (QoL) and specific (symptoms) PRO

• PRO may improve physician-patient communication$^1$ and hQoL$^2$

1. Takeuchi et al, JCO, 2011
2. Velikova et al, JCO, 2004
Method

• Medline and Embase 1996 – September 2011

• Search terms covered CCDSS and PRO

• Two reviewers screened citations and abstracts independently, disagreements resolved by consensus

• Full text articles retrieved for all potentially relevant articles
Consort diagram

1. Records identified through database searching:
   - Medline (n=741), Embase (n=199)
2. Records after duplicates removed (n=906)
3. Update (n=235)
4. Records screened (n=1159)
5. Records excluded (n=1069)
6. Full-text articles assessed for eligibility (n=72)
7. Studies included in synthesis (n=15)
Results

• 15 trials representing 13480 patients were included
  – 10 RCT
  – 5 non-RCT

• Range of included patients per trial was 44 to 4851
In what context is the CCDSS applied?

- 14 trials in outpatient setting

- Diagnosis
  - Lung disease 4 trials
  - Psychiatric disease 4 trials
  - Cardiovascular disease 3 trials
  - Pain treatment 2 trials
  - Primary care 2 trials
How is the flow of data in and out of the CCDSS?

• Data input
  – Patients actively completed data in 7 trials
  – Telephone interview in 2 trials
  – Clinician completed patient data 3 trials
  – Unclear in 3 trials

• Data output
  – Treatment recommendations were delivered to the physician at point-of-care in 11 trials
What guidelines did the CCDSS employ?

• National or regional guidelines were applied in 11 trials, other types of guidelines in the rest of the trials
What was the efficacy of CCDSS?

3 of 15 trials demonstrated significant impact of CCDSS on PRO

- Two trials on patients with schizophrenia
- One trial on patients with COPD/asthma
<table>
<thead>
<tr>
<th>Author</th>
<th>Design</th>
<th>Allocation concealment</th>
<th>Losses to follow-up</th>
<th>Intention to treat analysis</th>
<th>Randomization</th>
<th>Sample size calculation</th>
<th>Industry independent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kattan</td>
<td>RCT, children were randomized</td>
<td>Yes</td>
<td>5 in the intervention group, 3 in the control group</td>
<td>Yes</td>
<td>Yes</td>
<td>Not described in methods chapter</td>
<td>Yes</td>
</tr>
<tr>
<td>Tierny 1</td>
<td>RCT, both clinicians and patients were randomized</td>
<td>Yes, sort of.</td>
<td>74 in group 1, 75 in group 2, 71 in group 3 and 83 in group 4</td>
<td>No. Not stated explicitly</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>McCowan</td>
<td>RCT</td>
<td>Yes</td>
<td>9 of 16 practices lost to follow up in the intervention group, 12 of 25 in the control group. No statement about the number of patients</td>
<td>No</td>
<td>Yes, both with practices and patients</td>
<td>Yes</td>
<td>No. Practices received grant from Glaxo.</td>
</tr>
<tr>
<td>Eccles</td>
<td>Pragmatic cluster RCT using 2 x 2 blocks</td>
<td>Yes</td>
<td>Two practices in the angina group withdrew from trial after randomization. None in the asthma group.</td>
<td>Yes. Pragmatic intention to treat analysis</td>
<td>Yes</td>
<td>Yes</td>
<td>No, seems like an IT company provided some funds</td>
</tr>
<tr>
<td>Tierny 2</td>
<td>RCT</td>
<td>Yes, sort of.</td>
<td>164 of 870 patients were lost to follow up after inclusion</td>
<td>No. Not stated explicitly</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Subramanian</td>
<td>RCT, clinicians were randomized</td>
<td>Yes, sort of.</td>
<td>Unclear, not stated in the article</td>
<td>No. Not stated explicitly</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Murray</td>
<td>RCT, 2 x 2 design</td>
<td>Yes, sort of.</td>
<td>91 in group 1, 113 in group 2, 105 in group 3 and 102 in group 4</td>
<td>No. Not stated explicitly</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Morrison</td>
<td>No RCT, sequential design with study period</td>
<td>Not applicable</td>
<td>Unclear, not stated in the article</td>
<td>No. Not stated explicitly</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Bertsche</td>
<td>No RCT, but a prospective cohort study with two consecutive study periods</td>
<td>Yes, sort of.</td>
<td>Unclear, not stated in the article</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Unclear, the study received grants from a private institution</td>
</tr>
<tr>
<td>Rollman</td>
<td>RCT, physicians were randomized</td>
<td>Yes</td>
<td>10/78 in the intervention group, 9/71 in the control group</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Janssen</td>
<td>No RCT, but three independent study groups located in separate cities</td>
<td>Yes, sort of.</td>
<td>4% in Dusseldorf (intervention) and 8% in Freiburg (control) and none in Munich (control)</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Schmidt</td>
<td>Non-Randomized controlled intervention study</td>
<td>No</td>
<td>11% in the intervention group, control group not specified</td>
<td>Yes, probably</td>
<td>No</td>
<td>No</td>
<td>Unclear, not stated in the article</td>
</tr>
<tr>
<td>Kaeppelin</td>
<td>RCT</td>
<td>Yes</td>
<td>79% follow up rate in the control group and 70% in the intervention group (p=0.006)</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Thomas</td>
<td>RCT</td>
<td>Yes</td>
<td>29/253 in the intervention group, 37/258 control group</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Holbrook</td>
<td>Pragmatic randomized trial</td>
<td>Yes</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Nader</td>
<td>No RCT, sequential study with two study groups</td>
<td>Yes, sort of.</td>
<td>98% follow up rate</td>
<td>No, no stated explicitly</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Results – positive studies

• Outpatients with schizophrenia. N=522.
• In the intervention group a CCDSS was connected to EMR and national guidelines
• When a predefined constellation of symptoms occurred, a treatment advice was displayed on the physician’s computer.

• Significant efficacy on positive symptoms applying CCDS (p=0.004)
• Lower amounts of rehospitalization applying CCDSS (p=0.016)

Jansen et al, Eur Arch Psych Clin Neurosci, 2010
CCDSS quality

• Key factors for successful CCDSS systems have been identified\(^1\)\(^{-2}\):
  – Patients fill in data
  – Decision support at point-of-care
  – CCDSS system integrates with EMR

• All included trials were reviewed for these key factors

1. Delpierre et al, Int J Qual Health Care, 2004
2. Kawamoto et al, BMJ, 2005
CCDSS quality

- 7 trials fulfilled all three criteria

- Of the 3 trials with a positive impact of CCDSS on PRO
  - Only one fulfilled all three criteria
  - Two other studies fulfilled 2 of 3 criteria
CCDSS quality

• In a recent published meta-regression analyses of randomized controlled trials the following criteria defined effective CCDSS¹

  – Clinician provide reason for not accommodating to an advice
  – Offer advice concurrently to both practitioners and patients
  – CCDSS evaluated by the developers of the CCDSS

• None of the positive trials fulfill these criteria

1. Roshanov, BMJ, 2013
Discussion

- Only 3 out of 15 trials demonstrated significant efficacy of CCDSS on PRO
- Trials in psychiatric disease may be more likely to be positive
- Data entry requirements for clinicians time consuming\(^1\)
- Clinicians have mistrust in CCDSS and guidelines\(^2\)

\(^1\) Tierny et al, J Gen Intern Med, 2003
\(^2\) Murray et al, Pharmacotherapy 2004
Limitations

• We applied a narrow definition of CCDSS

• We focused on PRO, not clinical outcomes. Many studies are designed to detect differences in clinical outcome rather than PRO

• Due to the great variability of studies and outcomes, meta-analysis of the data was not possible
Conclusion

• Limited evidence that CCDSS improve PRO

• We need to improve CCDSS
  – collaboration of patients and clinicians in developing CCDSS
  – simplified methods of data entry for clinician
  – tighter integration with EMR
  – providing decision support with research data
  – reason to override a decision support
  – CCDSS systems that also provide advice for patients
<table>
<thead>
<tr>
<th>Author/Year</th>
<th>Patients fill in data</th>
<th>Data presented to care-taker at point of care</th>
<th>Integrates with electronic medical journal</th>
<th>Number of criteria fulfilled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kattan 2006</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>0/3</td>
</tr>
<tr>
<td>2 Tierney 2005 Health-Serv-Research</td>
<td>Unclear, but probably no</td>
<td>Yes</td>
<td>Yes</td>
<td>2/3</td>
</tr>
<tr>
<td>3 McCowan 2001 Medical-Infor</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>3/3</td>
</tr>
<tr>
<td>4 Eccles 2002 BMJ</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>3/3</td>
</tr>
<tr>
<td>5 Tierney 2003</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>2/3</td>
</tr>
<tr>
<td>6 Subramanian 2004 Am-J-Med</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>3/3</td>
</tr>
<tr>
<td>7 Murray 2004 Pharmacotherapy</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>3/3</td>
</tr>
<tr>
<td>8 Morrison 2006 Ann-Int-Med</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>3/3</td>
</tr>
<tr>
<td>9 Bertsche 2009 Pain</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>0/3</td>
</tr>
<tr>
<td>10 Rollman 2002 J-Gen-Int-Med</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>1/3</td>
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<tr>
<td>11 Janssen 2009 Eur-Arch-Psycho-Clin-Neurosc</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>2/3</td>
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<tr>
<td>12 Schmidt Kraepelin Eur-Arch-Psycho-Clin-Neurosc 2009</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>2/3</td>
</tr>
<tr>
<td>13 Thomas 2004 Br-J-Gen-Prac</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>2/3</td>
</tr>
<tr>
<td>14 Holbrook 2009 CMAJ</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>3/3</td>
</tr>
<tr>
<td>15 Nader 2009 AIDS patients care STDS</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>3/3</td>
</tr>
</tbody>
</table>