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Computerized Decision Support Systems for Multimorbidity Care: An Urgent Call for Research and Development

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INTRODUCTION

Multimorbidity is defined as the coexistence of two or more chronic illnesses in an individual (Smith & O'Dowd, 2007). General Practitioners (GPs) and healthcare systems, worldwide, are overwhelmed by the growing number of patients with multimorbidity (Kenning, Fisher, Bee, Bower, & Coventry, 2013; Smith, O'Kelly, & O'Dowd, 2010). Yet, healthcare itself and its associated software systems are primarily configured to support healthcare providers in managing individual diseases rather than multimorbidity (Barnett et al., 2012). Moreover, there have been calls for new interventions to promote the provision of high quality care that meets the needs of people with multimorbidity (cf. Hobbs, Baker, & Davies, 2015; Marengoni et al., 2011; Mason et al., 2014; Mercer, Smith, Wyke, O'Dowd, & Watt, 2009; Muth et al., 2013).

This chapter highlights the potential benefits of one such intervention – that is the deployment of computerized decision support systems (CDSS) which are specifically designed to support multimorbidity care. The chapter begins by reviewing the impact of growing numbers of patients with multiple chronic conditions, particularly in a primary care setting. It then draws on extant literature to consider the benefits of CDSS, particularly those benefits that could be applicable to the multimorbidity context. Subsequently, the chapter emphasizes the urgent need for further research and development in this area if we are to exploit the potential offered by CDSS for multimorbidity care. It proposes the required features of a CDSS for multimorbidity support (in light of the potential benefits identified) and concludes by underlining some of the key challenges that must be overcome in order to increase the likelihood of success in such an endeavor.

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BACKGROUND

Advances in preventative and curative medicine as well as increasing life expectancy in the developed world have contributed to increasing multimorbidity (Smith et al., 2010). For example, an extensive cross-sectional study which extracted data on 40 morbidities from a database of 1,751,841 people registered with 314 medical practices in Scotland found that 42.2% of all patients had one or more morbidities and 23.2% were multimorbid (Barnett et al., 2012). Indeed, healthcare globally is faced with the need to cope with rising costs, aging populations and chronic disease (Kenning et al., 2013; Wills, Sarnikar, El-Gayar, & Deokar, 2010). In a study of 99,997 patients across 182 general practices in England, the majority of consultations were found to involve patients with multimorbidity (Salisbury, Johnson, Purdy, Valderas, & Montgomery, 2011).

Patients with multimorbidity often have frequent healthcare visits and frequent hospital admissions with enormous costs for the individuals and for the healthcare provider involved (C. M. Boyd et al., 2005). The healthcare costs for individuals with at least 3 chronic diseases accounted for 89% of Medicare's annual budget in the US (Anderson & Horvath, 2004). The treatment of chronic illness patients in Europe was estimated to account for 70-80% of health care expenses in countries such as Denmark and comprise 8 of the top 11 causes of hospital admission in the UK (WHO, 2006).

Furthermore, it is widely accepted that the care of these patients is complex (Muth et al., 2013; Smith, Soubhi, Fortin, Hudon, & O'Dowd, 2012) and that this care should incorporate an integrated view of the patients' multiple conditions (Stange, 2005). The majority of clinical practice guidelines and healthcare software systems address single diseases and their evidence is regularly based on studies which excluded patients with other diseases – but these guidelines may have undesirable effects when applied to patients with multimorbidity (C. M. Boyd et al., 2005; Fortin, Bravo, Hudon, Vanasse, & Lapointe, 2005; Murphy, Fahey, & Smith, 2014).

In relation to primary care in particular, GPs regularly encounter patients with multimorbidity, yet many practitioners feel overwhelmed when trying to manage these patients (Smith et al., 2010). In a qualitative study that explores the views and attitudes of Irish GPs and pharmacists who manage patients with multimorbidity in primary care, “GPs described a strategy of treating simpler and more manageable (acute) conditions in preference to opening the Pandora's box of multimorbidity” (Smith et al., 2010).

Furthermore, the model of care for multimorbidity is changing from a disease approach to patient-centered holistic care, with primary care as the key integrator/coordinator of various professions and organizations (Fraccaro, Arguello Casteleiro, Ainsworth, & Buchan, 2015). It is not surprising, therefore, that extant research has found that GPs would welcome decision support when dealing with multimorbid patients (cf. Grace et al., 2013; Schuling, Gebben, Veehof, & Haaijer-Ruskamp, 2012).

CDSS AND THEIR RELEVANCE TO MULTIMORBIDITY

In the clinical context, CDSS have been defined as ‘any electronic system designed to aid directly in clinical decision making, in which characteristics of individual patients are used to generate patient specific assessments or recommendations that are then presented to clinicians for consideration (Kawamoto, Houlihan, Balas, & Lobach, 2005).

While CDSS have shown great promise for reducing medical errors and improving patient care (Kawamoto et al., 2005), evidence that clearly demonstrates the positive effects of CDSS on clinical and

economic outcomes remains surprisingly sparse. This may be, in part, because CDSS have sometimes been seen as a challenge to professional decision-making (Fortier, Jagannathan, Michel, Dluhy, & Oneill, 2003). It may also be because of the relative difficulty of implementing randomized controlled trials in real clinical settings as well as the logistics of measuring the direct clinical effect of CDSS (Bright et al., 2012). Another barrier to successful CDSS evaluation is its broad definition adopted by the research community which encompasses a diverse range of interventions and functions (Moja et al., 2014).

Nevertheless, for some time, healthcare organisations have been turning to CDSS to address ongoing healthcare deficiencies and inadequate quality of healthcare, including preventable medical errors and adverse healthcare events (Kawamoto et al., 2005). For example, there is empirical evidence that demonstrates the effectiveness of CDSS for improving health care process measures across diverse settings (cf. Berner, 2007; Bright et al., 2012). Of particular interest to this discussion is the fact that CDSS have been found to play a critical role in primary care and have shown to improve practitioner performance in 64% of studies (Garg et al., 2005).

Moreover, previous studies have found a number of advantages of CDSS which could be applicable to the multimorbidity context. For example, CDSS have been found to have a favorable effect on the quality/safety medication prescribing and to decrease the rate of prescription errors (cf. Bright et al., 2012; Kaushal, Shojania, & Bates, 2003). Multimorbid patients often require multiple drugs to be administered to them simultaneously and they are particularly susceptible to the hazards of polypharmacy (Cynthia M Boyd & Fortin, 2010).

Previous studies have also shown that CDSS help to increase clinician adherence to guideline or protocol based care (Chaudhry et al., 2006; P. S. Roshanov et al., 2013) and reduce clinical decision errors (cf. Cantrill, 2010). Because multimorbidity involves clinical complexity and requires multiple guidelines to be followed simultaneously (cf. Cynthia M Boyd & Fortin, 2010; Schuling et al., 2012), this would be particularly beneficial. However, this would not be a simple case of listing the guidelines for each disease that the patient has and removing overlaps. Integration and prioritization of such guidelines would be necessary and would be extremely challenging (Cynthia M Boyd & Fortin, 2010; Grace et al., 2013). CDSS that systematize clinical practice guidelines without considering the interactions of different conditions and care processes may lead to harmful clinical actions (Fraccaro et al., 2015).

CDSS helps to facilitate communication between providers and patients (cf. Moja et al., 2014). Such systems add value by informing rather than completely automating the decision making process (Farwell, 1984; Hesse & Shneiderman, 2007) and to be successful, they must be partnered with the human element to complete the process (Farwell, 1984). When a physician and a patient are faced with alternative treatments, they may seek help to choose among them (e.g. the estimation of prognosis for cure or risk of complications), but it is them and not the CDSS who must decide among the treatments available (Musen, Middleton, & Greenes, 2014). Indeed, it is particularly notable that recent evidence suggests that CDSS are more likely to be successful if they provide advice for patients in addition to practitioners (P. S. Roshanov et al., 2013).

Doctor/patient communication is important to all patients, but is particularly critical and challenging in the case of multimorbidity. This is because the presence of simultaneous care plans for multiple conditions leads to confusion and, in turn, generates safety hazards (Fraccaro et al., 2015). Clearly communicated plans that are patient centered and that blend clinical care with self-management are essential in multimorbidity (Bayliss, Ellis, & Steiner, 2007; Grace et al., 2013). Indeed, according to Reuben and Tinetti (2012), the patient centered goal oriented approach to making healthcare decisions has several advantages including:

1. It frames the discussion in terms of individually desired rather than universally applied health states;
2. It simplifies decision making for patients with multiple conditions by focusing on outcomes that span conditions and aligning treatments toward common goals;
3. It prompts patients to articulate which health states are important to them and their relative priority; and
4. If they jointly agree what health states are most desired, patients and clinicians can agree on steps that can be taken to achieve these goals and monitor progress in reaching them.

In addition to doctor/patient communication and decision making, CDSS could also facilitate communication and decision making of others involved in the patient's care. Indeed, it has been argued that greatest impact of a software system is its "ability to create linkages, not its ability to process internal data into information" (Warkentin, Bapna, & Sugumaran, 2001, p. 152). The nature of multimorbidity is such that it typically involves a large number of healthcare professionals and this creates a combinatorial explosion of communication interfaces, often resulting in the patient having difficulty in understanding and recalling guidance (Eichner & Blumenthal, 2003). Other common problems arising from the large number of individuals involved in multimorbidity care are duplication of tests and harmful decisions made on the basis of incomplete or incorrect information (Haggerty, 2012; Kuperman, 2011).

FUTURE RESEARCH AND DEVELOPMENT DIRECTIONS

While CDSS for chronic disease management has been extensively studied (cf. P. Roshanov et al., 2011), the study of CDSS designed specifically to support decision making in the case of multimorbidity remains largely unexplored.

For example, Smith *et al.* (2012) carried out a systematic review of extant interventions for enhancing multimorbid care in primary care settings and found that, to date, efforts have been made to improve outcomes in patients with multimorbidity by focusing largely on five key interventions. These include:

1. Professional interventions (e.g. education design);
2. Financial interventions (e.g. financial incentives to providers to reach treatment targets);
3. Organizational interventions (e.g. case management);
4. Patient oriented interventions (e.g. patient education); and
5. Regulatory interventions (e.g. changes to local or national regulations).

A more recent systematic review also clearly shows that the adoption of CDSS in multimorbidity is under investigated (Fraccaro et al., 2015). Given the potential benefits of CDSS within this context (as outlined in the previous section), there is no doubt that this is an avenue now worth pursuing in earnest.

CDSS for Multimorbidity: Required Features

A systematic review of randomized control trials has identified several general features as being of particular importance within any CDSS (Kawamoto et al., 2005). These are:

1. Decision support provided automatically as part of clinician workflow;
2. Decision support delivered at a time and location of decision making;

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3. Actionable recommendations provided; and
4. Computer based.

A more recent study of the features of effective CDSS in 162 randomized trials (P. S. Roshanov et al., 2013) found that CDSS are more likely to be successful if they:

1. Are standalone rather integrated into other systems – for example, within electronic health records/charts or within order entry systems;
2. Provide advice for patients in addition to practitioners; and
3. Require practitioner to give explanations for overriding advice.

In light of the earlier discussion in this chapter about the challenges posed by multimorbidity specifically and the relevance of CDSS to at least tackling if not addressing some of these challenges, the following features should also be incorporated in any CDSS for multimorbidity support:

- Tracks patient medications and prompts for regular reviews of these medications (to mitigate against a prescribing cascade where drugs are prescribed to treat the adverse effects of other drugs).
- Prompts for all status information/tests needed for a particular patient (to enable review of all chronic conditions for a patient simultaneously and eliminates duplicate tests).
- Uses an open architecture (to support electronic updates and interoperability with existing electronic health records and other healthcare software systems).
- Produces an integrated healthcare plan that integrates guidelines across multiple conditions and considers interactions between pathologies and treatments (to facilitate a more holistic, patient centered plan that incorporates all of their conditions).
- Allows customization/prioritization of healthcare plan to incorporate patient goals/preferences and to enable targets to be set that have been jointly agreed with the patient (to increase patient concordance by enabling multimorbid patients to play a more active role in setting their own targets).
- Enables healthcare plan to be remotely accessed and updated by patient (to facilitate patient reflection on agreed plan/targets and to support self-management of conditions).
- Provides remote access to allow collaboration with 3rd parties – for example, healthcare specialists and family carers (to facilitate collaboration between all involved in the care of the patient and to support continuity of care).

Key Challenges

In order to increase the chances of successfully developing and deploying a patient-centered multimorbidity CDSS, there are a number of challenges that must be addressed. Not least of these will be the integration of clinical practice guidelines for multiple chronic illnesses. Interactions between diseases in multimorbidity have barely been touched upon to date (Weiss et al., 2014). Interoperability with existing healthcare software systems will also be a key challenge.

Consideration will have to be given to regulatory and legal requirements for any new CDSS for multimorbidity care. Within a European context, these include:

1. Good Automated Manufacturing Practice incorporating both ISO:9001 and IEC62304;
2. Patient rights legislation including ‘The Mental Health Act 2001’, ‘The Health Act 2005’, and ‘Medical Practitioners Act 2007’.

Given that there is no widely accepted model for computer use in the clinical consultation (cf. de Lusignan & Chan, 2008), another key challenge will be to integrate such a system into the everyday work practices of ‘very busy’ clinicians. Well thought out mobilization and training plans will be critical to the successful adoption of any CDSS for multimorbidity care.

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KEY TERMS AND DEFINITIONS

Chronic Disease: Long lasting disease that can be managed to some extent, but that cannot be cured.

Clinical Pathways: Also known as care pathways or care maps, these are used to manage the quality in health care concerning the standardization of care processes. They promote organized and efficient patient health care based on evidence based practice.

Clinical Practice Guidelines: Recommendations that are intended to optimize patient care for a particular disease or illness. These are informed by a systematic review of evidence and an assessment of the benefits and harms of alternative care options.

Computerized Decision Support Systems (Clinical Context): Any electronic system designed to aid directly in clinical decision making, in which characteristics of individual patients are used to generate patient specific assessments or recommendations that are then presented to clinicians for consideration.

Electronic Health Record: Digital version of a patient’s paper chart.

General Practitioner: A medical practitioner who treats patients of all ages in the general community, as well as providing preventative and health education to these patients.

Multimorbidity: The coexistence of two or more chronic illnesses in an individual.