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Multimorbidity in Older Patients with Cardiovascular Disease

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Abstract

Multimorbidity affects more than two thirds of older individuals and the vast majority of patients with chronic cardiovascular disease. Patients with multimorbidity have high resource utilization, poor mobility, and poor health status and are at an increased risk for death. The presence of multimorbidity imposes numerous management challenges in caring for patients with chronic cardiovascular disease. It complicates decision-making, promotes fragmented care, and imposes an immense burden on the patient and their social support system. Novel models of care, such as the cardiovascular patient-centered medical home, are needed to provide high-quality, efficient, effective care to this growing population.

Keywords

Cardiovascular; Multimorbidity; Multiple chronic conditions; Elderly

Introduction

Multimorbidity in older individuals is an emerging epidemic. As medical care has advanced and mortality has improved, individuals are now surviving well into old age while accumulating multiple chronic conditions. While cardiovascular conditions such as hypertension, heart failure, and atrial fibrillation are highly prevalent in older patients with multimorbidity, they are usually accompanied by concomitant non-cardiovascular conditions, such as arthritis or chronic kidney disease. The presence of multiple chronic conditions greatly increases the complexity of patient management, and our traditional approach of providing condition-specific care no longer works. A paradigm shift is required to provide high-quality, patient-centered, holistic care to older patients with cardiovascular disease and multimorbidity. In this article, we review recent evidence on multimorbidity in older patients with cardiovascular disease, including its epidemiology, association with

Compliance with Ethical Standards

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outcomes, management challenges, and new models of care that have been proposed to meet the needs of this growing population.

Multimorbidity: Scope of the Problem

Multimorbidity is present when a person has two or more coexistent chronic conditions. A condition is considered chronic if it is present for a year or more and requires ongoing medical care and/or limits a person's ability to perform daily activities such as bathing, dressing, and doing housework [1]. There is no standard definition of multimorbidity, and the number and types of chronic conditions considered vary by study. Nevertheless, multimorbidity imposes a major burden on our healthcare system. It is estimated that 28 % of Americans currently have multimorbidity, and these persons are responsible for two thirds of healthcare spending [2]. Among Medicare beneficiaries, over two thirds of expenditures are used for persons with five or more chronic conditions. This problem continues to grow, and by 2030, 171 million Americans are expected to have two or more chronic conditions.

Multimorbidity is especially important for the care of the elderly, as the incidence and prevalence of multimorbidity increases with age. St Sauver et al. followed residents in Olmsted County, Minnesota for 14 years for the development of dyads and triads of 20 chronic conditions and found that the incidence of both increased with age [3]. For example, in men, the incidence of multimorbidity was 85.2 per 1000 person-years at age 50–59, but more than doubled to 209.9 per 1000 person-years by age 70–79; similar trends were seen in women. Among Medicare beneficiaries, two thirds have multiple chronic conditions, with the prevalence increasing from 50 % in those <65 years to 62 % for those age 65–74, 75.7 % age 75–84, and 81.5 % in those 85 years and older [4]. Similarly, the prevalence of multimorbidity in those 65 and older was 67.5 % in Spain, 62 % in Germany, and 77.3 % in Olmsted County, Minnesota [5, 6, 7], though the prevalence is dependent upon the number and type of conditions captured. A summary of contemporary reports on the prevalence of multimorbidity is shown in Table 1. While the prevalence of multimorbidity increases with age, a longitudinal study by Fabbri et al. reported that the rise of multimorbidity with aging is not linear, but actually accelerates with age [16]. Among the 1031 older (>60 years) participants in Chianti, Italy, followed for 9 years, the rate of change in the number of chronic conditions per patient was higher in patients who were older upon entering the study.

Most [4, 5, 7, 9, 12], but not all [6] studies have reported a higher prevalence of multimorbidity in older women than men. Among Medicare beneficiaries in 2011, women had a higher prevalence of multimorbidity across all ages examined (<65 to 85 and older), though the gender gap was most prominent in younger beneficiaries [4]. By contrast, the prevalence of multimorbidity was similar in older male and female residents of Olmsted County, Minnesota, but the prevalence of five or more chronic conditions was higher in older men compared with women [6].

There have been very few reports of differences in multimorbidity by race and socioeconomic status [6, 9]. Data from the 2012 National Health and Nutrition Evaluation Survey suggested multimorbidity was more common in non-Hispanic whites and blacks

compared with Asians and Hispanics [9]. In Olmsted County, Minnesota, before age 60, multimorbidity was more common in blacks and less common in Asians compared with whites. However, after age 60, multimorbidity was more common in whites compared with both blacks and Asians [6]. In Scotland, individuals living in areas of lower socioeconomic status developed multimorbidity 10–15 years earlier than persons living in more affluent areas. Mental health disorders, in particular, disproportionately affected those in less affluent areas. With regard to cardiovascular conditions, persons living in less affluent areas were more likely to have coronary artery disease and diabetes, though atrial fibrillation was more common in more affluent areas [12].

Cardiovascular conditions tend to be among the most common conditions present in patients with multimorbidity. Across multiple populations, hypertension is the most common chronic condition, and hyperlipidemia and ischemic heart disease are also frequently present among the top 3 most common chronic conditions (Table 1). Hypertension-hyperlipidemia represents the most common multimorbidity dyad in older men and women [6, 11, 17], and a cardiovascular condition including hypertension, hyperlipidemia, arrhythmia, diabetes, and coronary artery disease is present in each of the top 10 dyads after age 60 [6].

The vast majority of patients with chronic cardiovascular conditions have multimorbidity. The American College of Cardiology/American Heart Association (ACC/AHA) recently published data elucidating the burden of multimorbidity in Medicare beneficiaries with chronic cardiovascular conditions including ischemic heart disease, heart failure, and atrial fibrillation [17]. Across all three conditions, the most common comorbidity present was hypertension (81–86 % of patients). In patients with ischemic heart disease and atrial fibrillation, hyperlipidemia is the second most common comorbid condition (present in 69 and 64 % of patients, respectively), whereas ischemic heart disease is the second most common condition in patients with heart failure (72 % of patients). Other frequent comorbidities included diabetes (37–47 % of patients), anemia (39–51 % of patients), and arthritis (41–46 % of patients).

A few authors have sought to group comorbidities into patterns of conditions that tend to cluster together, with cardiovascular conditions playing a prominent role [15, 18–22]. Prados-Torres et al. used exploratory factor analysis to identify five patterns of multimorbidity among primary care patients in Spain [23]: cardiometabolic, mechanical, psychogeriatric, depressive, and psychiatric-substance abuse. Each pattern consisted of several chronic conditions that tended to occur together and the authors assigned a name to each cluster based on the types of conditions present. Only these first three patterns were prevalent in older men and women, and only about one third of older men and half of older women could be assigned to one of the three patterns [5, 23]. The cardiometabolic pattern included atherosclerosis/ischemic heart disease, heart failure, arrhythmia, diabetes, iron deficiency, and gout. The mechanical pattern consisted of conditions such as arthropathy, low back pain, osteoporosis, thyroid disorders, varicose veins, and anxiety. The psychogeriatric pattern included conditions such as dementia, Parkinson's, cerebrovascular disease, skin ulcers, heart failure, and arrhythmia. The cardiometabolic pattern was the dominant pattern in older men (21.2%) and was present in 17.3% of women, whereas the mechanical pattern was the dominant pattern in women (33.3 %) [5]. The psychogeriatric

pattern was least common of the three patterns in both sexes (2.4 % of men, 3.5 % of women).

Multimorbidity: Association with Outcomes

Patients with multimorbidity are at increased risk of death; however, these relationships are complex and may be mediated by disability. For example, in a Canadian cohort of persons 65 and older, multimorbidity was associated with an increased risk of death, but the association was mitigated by adjusting for functional status [13]. In a Swedish study, having one or more chronic conditions was associated with an increased risk of death, though the hazard ratio was unchanged with increasing comorbidity. There was a stepwise increase in disability with increasing comorbid conditions, and disability, rather than comorbidity, had the greatest association with mortality [24]. Finally, a report from the Health and Retirement study found that among older patients with chronic conditions, the concomitant presence of functional limitations or geriatric syndromes such as hearing or visual difficulties was associated with a markedly increased risk of 2-year mortality [25].

Among patients with multimorbidity, the presence of cardiovascular conditions adversely impacts survival. In Medicare beneficiaries with coexisting conditions, heart failure was the single largest contributor to mortality, accounting for 20 % of deaths [26]. Data from 689,300 participants in the Emerging Risk Factors Collaboration demonstrated mortality rates of 15–17 per 1000 person years in individuals with a single cardiovascular condition (diabetes, myocardial infarction, stroke) compared with only 6.8 per 1000 in those with none of the conditions [27]. However, co-existent conditions had a multiplicative association with mortality, and patients with all three conditions had a mortality rate of 59.5 per 1000 person years. Just as concomitant cardiovascular disease portends poor survival in patients with multimorbidity, the reverse is also true. It is well established that in patients with a variety of chronic cardiovascular conditions, non-cardiovascular comorbidity is associated with increased mortality [28–30]. For example, patients hospitalized with myocardial infarction with multiple noncardiac comorbidities had longer hospital stays and were less likely to survive to hospital discharge [28]. Similarly, in patients with heart failure, there is a step-wise increase in mortality with increasing comorbidity [31].

In addition to experiencing increased mortality, patients with multimorbidity have higher healthcare resource utilization, including more hospitalizations, outpatient visits, and subspecialist referrals [14, 32–34]. In one large Swiss study, multimorbid patients were 5.6 times as likely to be hospitalized and had more than three times as many outpatient clinical visits compared to patients without multimorbidity. As a result, total health care costs were 5.5 times higher in patients with multimorbidity and increased by 33 % with each additional chronic condition [14].

Multimorbidity can also adversely impact functional status and quality of life. In the Cardiovascular Health Study, patients with a single comorbid condition, such as heart failure, COPD, or cognitive impairment, had more difficulty with activities of daily living (ADL) [35]. However, patients with multiple conditions had even greater difficulty with ADLs, such that the impact of each condition on mobility appeared to be synergistic. A synergistic effect on ADL difficulty was seen for combinations of chronic conditions

including heart failure plus COPD, heart failure plus depression, osteoarthritis plus depression, and depression plus cognitive impairment. Survey data from a large US adult population indicates that persons with three or more chronic conditions are at an 8-fold increased odds of reporting poor health status [36]. The association between multimorbidity and poor health status was particularly strong in patients with cardiovascular conditions including myocardial infarction and stroke.

Multimorbidity: Management Challenges

The presence of multimorbidity imposes numerous management challenges in caring for patients with chronic cardiovascular disease. It complicates decision-making, promotes fragmented care due to involvement of multiple providers, and can be burdensome to both patients and their caregivers.

Decision-making can be challenging in patients with a single chronic condition, but becomes increasingly challenging in patients with multiple chronic conditions. Clinical practice guidelines are generally written with a single-disease focus, and designing a comprehensive plan of care for patients whose comorbid conditions require integration of numerous sets of guidelines can represent a formidable challenge. There are several ways in which comorbid conditions and their treatment can interact in clinical practice. First, treatment of one comorbid condition can have an impact on another comorbid condition. For example, treatment with a non-steroidal antiinflammatory drug in patients with osteoarthritis can worsen heart failure symptoms. Second, pharmacologic treatment of two separate conditions can modify the pharmacokinetics of either drug to result in toxicity or undertreatment. For example, the risk of myopathy is increased when statins are coadministered with medications that inhibit their metabolism, such as the azole antifungals, colchicine, and amiodarone. In response to this clinical challenge, investigators formulated the Improving Guidelines for Multimorbid Patients Group and published a list of recommendations for consideration of multimorbidity when developing practice guidelines [37]. They suggested several frameworks to approach comorbidities in clinical practice guidelines, such as focusing on a single condition and the common comorbidities vs. developing guidelines to address conditions that often occur together (e.g., guideline for managing patients with heart failure and chronic kidney disease). Given the burden of comorbidity in patients with cardiovascular disease, the ACC/AHA also published a statement outlining the high burden of comorbidity in patients with chronic cardiovascular disease and stating their intent to include discussion of the impact of the most common comorbid conditions on the applicability of recommendations published in clinical practice guidelines in the future [17••]. The most recent heart failure guidelines have taken a step in this direction, as they discuss comorbid conditions including atrial fibrillation, anemia, and depression [38]. Until all cardiovascular practice guidelines better address the management of patients with multimorbidity and cardiovascular disease, when approaching the management of an older patient with multimorbidity, it is crucial to recognize the limitations in available evidence and guidelines as they may apply to a specific patient [39••].

In treating older patients with multimorbidity and cardiovascular disease, the first inclination of treating clinicians is often to continue adding treatments to achieve guideline-directed

goals for care. Before initiating a new therapy, the risks and benefits of treatment need to be considered in the context of the patient's preferences and prognosis [39••]. In addition to carefully considering each new potential treatment, medication lists should be reviewed and medications discontinued or reduced in dose when appropriate. There are numerous scenarios where decreasing or eliminating therapies may be in the patient's best interest. First, there are instances where overtreatment is occurring and causes harm. As an example, despite current guidelines recommending a goal blood pressure of <150/90 in patients age 60 and older and <140/90 in the presence of diabetes or chronic kidney disease [40], 19 % of older treated hypertensive patients have a systolic blood pressure <120 mmHg [41], which may be associated with increased mortality [42]. When evaluating an older patient being treated for hypertension, consideration can be given to cutting back on medications if the blood pressure is far below goal, even in the absence of overt symptoms. Second, there are instances where no treatment recommendations are given for the elderly, and an individualized approach must be adopted. For example, many older patients are maintained on aspirin for the primary prevention of cardiovascular disease, though a large recent clinical trial found no difference in cardiovascular death in patients treated with this approach [43]. While guidelines differ by organization, the US Preventive Services task force recommends individualizing the decision by balancing the risks of potential reduction in stroke and myocardial infarction with the harm of bleeding in patients <80 years old, and made no recommendation for or against use of aspirin for primary prevention in patients 80 and older. Finally, in patients with cardiovascular disease and limited life expectancy, the risks and benefits of initiation and continuation of medications must be carefully considered. In a recent trial, discontinuation of statin therapy was safe and associated with improved quality of life and lower costs in patients with an expected survival of less than 1 year [44]. As patients with life-limiting illnesses approach death, they often shift their goals of care toward optimizing quality of life and medications should be reviewed to ensure they continue to offer potential benefit in meeting the patient's goals.

The added complexity of caring for patients with multimorbidity frequently results in fragmentation of care. Patients often see many subspecialty clinicians in addition to their primary care provider. In an elderly Swiss population, one in five patients with multimorbidity saw more than one primary care provider and over half saw two or more specialists annually. The mean number of annual outpatient visits in patients with multimorbidity was 15.7 compared to 4.4 in patients without multimorbidity, and the number of visits increased by 3.2 for each additional comorbid condition [14•]. Similar findings of increased outpatient care utilization and subspecialist referral in patients with multimorbidity have been reported in German [8], Dutch [34], and US [33] populations. In many care systems, there is inadequate communication between the multiple clinicians caring for a patient with subsequent duplication and overuse of services. In a Canadian study, duplicate laboratory testing in patients with cardiovascular disease, kidney disease, and diabetes resulted in more than \$3 million per year of unnecessary expenditures [45]. The use of acute care services is also higher in patients with multimorbidity, and may be due in part to increased fragmentation of care. Liu et al. found that the number of emergency room visits increased with the number of clinics visited by patients with multimorbidity [46]. Models of care to reduce fragmentation will be discussed in detail later in this article.

The care required to manage multiple chronic conditions can also be frustrating and burdensome to both patients and caregivers. The burden of treatment in patients with multimorbidity is often under recognized. One review estimated that patients with chronic conditions and their caregivers spend an average of 2 h per day on health-related activities [47]. Caregivers are often responsible for much of the day-to-day patient care, such as coordinating and providing transportation to clinician visits and ensuring adherence to medical recommendations. Frustrations voiced by caregivers of patients with multimorbidity include poor communication with the healthcare team, lack of coordination of care across multiple providers, and frustration with care recipients who refuse to adhere with medical recommendations [48]. In one study of caregivers of patients with heart failure, 37 % found communication with their care recipients challenging; the desire for more communication was linked with higher caregiver burden and stress [49]. The AHA acknowledges the importance and potential stress of providing care to patients with cardiovascular disease and offers useful tips and resources for caregivers on their website (www.heart.org).

Multimorbidity: Models of Care

We now face the daunting task of providing optimal care to the growing population of older patients with multimorbidity. Boulton et al. outlined four processes, based on expert opinion, that are critical to providing high-quality, effective, and efficient care to older patients with multiple comorbid conditions (Box 1.) [50]. These processes include comprehensive patient assessment, comprehensive care planning, promotion of the patient's active engagement in their health care, and communication and coordination with all clinicians involved in the care of the patient.

Several models of care have been proposed to meet these goals, including Guided Care [51–53], Geriatric Resources for Assessment and Care of Elders (GRACE) [54], and the Program of All-Inclusive Care of the Elderly (PACE). One potential framework that has received substantial attention is the patient-centered medical home [55]. A medical home has been described as “a clinical setting that serves as a patient's resource for ongoing medical care.” The concept of the medical home has been around for decades, and many formats of the medical home model have been tested and exist in clinical practice. While existing medical homes may differ in the patient populations they treat, one common concept of medical homes is direct engagement between a patient and a provider who is responsible for ensuring comprehensive integrated care through use of a team of medical professionals and community-based resources. Most successful medical home models have utilized a dedicated non-physician care coordinator to organize and manage the patient care. Medical homes have been shown to reduce healthcare costs [55] and improve adherence in patients with multiple chronic conditions [56].

Most medical home models place a primary care physician at the center of the patient's care with specialists such as cardiologists providing consultation as needed. However, the ACC has recognized that some patients with complex, advanced cardiovascular disease may require care by supervising clinicians who are experts in cardiovascular disease [57••]. They have proposed a cardiovascular patient-centered medical home, run by cardiologists surrounded by a team of other professionals, such as nurse practitioners, pharmacists, and

social workers, who would be found in any medical home setting. The cardiovascular patient-centered medical home may represent an excellent fit for patients whose multimorbidity is primarily driven by cardiovascular disease, such as patients with congenital heart disease or advanced heart failure.

Multimorbidity: Putting It All Together

The factors that contribute to health behaviors and outcomes in multimorbid older patients with cardiovascular disease are complex and plentiful (Fig. 1). Patient-level factors such as beliefs and attitudes, ability to understand and contextualize medical problems (cognition, health literacy), motivation to engage and improve health (activation), and capacity to meet healthcare demands can all play roles in influencing health behaviors and outcomes. As care needs grow more complex and burdensome, social support becomes increasingly critical for building capacity to meet the demands of health providers and systems. This interaction between the patient and the healthcare system is a critical determinant of health outcomes. For patients with multimorbidity, it is increasingly important that systems support patients' complex needs. To be optimal, this support almost universally requires care from a multidisciplinary team of medical professionals, each supplying his or her expertise in tailoring care to meet individual patient needs. Communication among those individuals and caregivers is paramount to successful care integration. Without question, building effective and holistic systems of care for patients with multimorbidity and cardiovascular disease will be one of the most formidable challenges we face as our population ages.

Multimorbidity: Future Directions

While our understanding of multimorbidity in older patients with cardiovascular disease has been enhanced over the last several years, key gaps in knowledge still exist. It is well established that individual comorbidities are common and can be associated with adverse outcomes in patients with cardiovascular disease, but a more thorough understanding of how comorbidities cluster across populations and the potential impact on outcomes such as death, health care utilization, and quality of life is needed. Future cardiovascular guidelines should address common comorbidities encountered in patients with chronic cardiovascular disease and how they may impact medical management. Additional data are needed to inform such guidelines, as older patients with multimorbidity have frequently been excluded from clinical trials; the emerging use of big data may play a role in filling this gap. While integrated medical care using frameworks such as the cardiovascular patient-centered medical home hold promise, we need a better understanding of which patient populations may benefit from this model and what infrastructure and team members are most critical to providing the best care. Many of the services that may be most beneficial to patients with multimorbidity, such as home health, physical therapy/cardiac rehabilitation, and nutrition services, may not be readily available or may impose added financial burden on specific patients. As such, closer alignment of healthplan coverage (reimbursement for services, patient out-of-pocket costs) with individual patient needs is essential. Finally, we need a better way of measuring the care we provide to patients with multimorbidity. The National Quality Forum is developing a set of measures that reflect universal health outcomes [58], which may provide a better way to measure care quality provided to patients with

multimorbidity compared with the condition-specific performance measures that have been historically utilized.

Conclusions

The majority of older patients with cardiovascular disease have multimorbidity. With aging of the population, the prevalence of multimorbidity in patients with cardiovascular disease will continue to rise. Caring for older patients with multimorbidity and cardiovascular disease represents a formidable challenge. As a cardiovascular community, we need to embrace this daunting task to continue to be successful at providing high-quality patient-centered care.

References

Papers of particular interest, published recently, have been highlighted as:

- Of importance
 - Of major importance
1. [Accessed July 19, 2015] U.S. Department of Health and Human Services HHS Initiative on Multiple Chronic Conditions. http://www.hhs.gov/ash/initiatives/mcc/#_edn3
 2. Anderson, G. [Accessed July 20, 2015] Chronic care: making the case for ongoing care. Robert Wood Johnson Foundation. 2010. <http://www.rwjf.org/en/library/research/2010/01/chronic-care.html>
 3. St Sauver JL, Boyd CM, Grossardt BR, Bobo WV, Finney Rutten LJ, Roger VL, et al. Risk of developing multimorbidity across all ages in an historical cohort study: differences by sex and ethnicity. *BMJ Open*. 2015; 5(2):e006413.
 4. Salive ME. Multimorbidity in older adults. *Epidemiol Rev*. 2013; 35:75–83. [PubMed: 23372025]
 5. Abad-Diez JM, Calderon-Larranaga A, Poncel-Falco A, Poblador-Plou B, Calderon-Meza JM, Sicras-Mainar A, et al. Age and gender differences in the prevalence and patterns of multimorbidity in the older population. *BMC Geriatr*. 2014; 14:75. [PubMed: 24934411]
 6. Rocca WA, Boyd CM, Grossardt BR, Bobo WV, Finney Rutten LJ, Roger VL, et al. Prevalence of multimorbidity in a geographically defined American population: patterns by age, sex, and race/ethnicity. *Mayo Clin Proc*. 2014; 89(10):1336–1349. [PubMed: 25220409] This article offers a comprehensive population-based report on the burden of multimorbidity in a community
 7. van den Bussche H, Koller D, Kolonko T, Hansen H, Wegscheider K, Glaeske G, et al. Which chronic diseases and disease combinations are specific to multimorbidity in the elderly? Results of a claims data based cross-sectional study in Germany. *BMC Public Health*. 2011; 11:101. [PubMed: 21320345]
 8. van den Bussche H, Schon G, Kolonko T, Hansen H, Wegscheider K, Glaeske G, et al. Patterns of ambulatory medical care utilization in elderly patients with special reference to chronic diseases and multimorbidity—results from a claims data based observational study in Germany. *BMC Geriatr*. 2011; 11:54. [PubMed: 21914191]
 9. Ward BW, Schiller JS, Goodman RA. Multiple chronic conditions among US adults: a 2012 update. *Prev Chron Dis*. 2014; 11:E62.
 10. Lochner KA, Cox CS. Prevalence of multiple chronic conditions among medicare beneficiaries, United States, 2010. *Prev Chron Dis*. 2013; 10:E61.
 11. Ashman JJ, Beresovsky V. Multiple chronic conditions among US adults who visited physician offices: data from the National Ambulatory Medical Care Survey, 2009. *Prev Chron Dis*. 2013; 10:E64.

12. Barnett K, Mercer SW, Norbury M, Watt G, Wyke S, Guthrie B. Epidemiology of multimorbidity and implications for health care, research, and medical education: a cross-sectional study. *Lancet*. 2012; 380(9836):37–43. [PubMed: 22579043]
13. St John PD, Tyas SL, Menec V, Tate R. Multimorbidity, disability, and mortality in community-dwelling older adults. *Can Fam Physician*. 2014; 60(5):e272–e280. [PubMed: 24829022]
14. Bahler C, Huber CA, Brungger B, Reich O. Multimorbidity, health care utilization and costs in an elderly community-dwelling population: a claims data based observational study. *BMC Health Serv Res*. 2015; 15:23. [PubMed: 25609174] This study provides quantification of the substantial differences in healthcare utilization and costs in patients with multimorbidity compared to those without in a large elderly Swiss population
15. Kirchberger I, Meisinger C, Heier M, Zimmermann AK, Thorand B, Autenrieth CS, et al. Patterns of multimorbidity in the aged population. Results from the KORA-Age study. *PLoS One*. 2012; 7(1):e30556. [PubMed: 22291986]
16. Fabbri E, An Y, Zoli M, Simonsick EM, Guralnik JM, Bandinelli S, et al. Aging and the burden of multimorbidity: associations with inflammatory and anabolic hormonal biomarkers. *J Gerontol A Biol Sci Med Sci*. 2015; 70(1):63–70. [PubMed: 25104822]
17. Arnett DK, Goodman RA, Halperin JL, Anderson JL, Parekh AK, Zoghbi WA. AHA/ACC/HHS strategies to enhance application of clinical practice guidelines in patients with cardiovascular disease and comorbid conditions: from the American Heart Association, American College of Cardiology, and U.S. Department of Health and Human Services. *J Am Coll Cardiol*. 2014; 64(17):1851–1856. [PubMed: 25219921] In addition to providing recommendations to address comorbidities in future clinical practice guidelines for patients with cardiovascular disease, this manuscript also provides important data on the prevalence of comorbidities in older patients with cardiovascular diseases including heart failure, ischemic heart disease, stroke and atrial fibrillation
18. Prados-Torres A, Calderon-Larranaga A, Hancoco-Saavedra J, Poblador-Plou B, van den Akker M. Multimorbidity patterns: a systematic review. *J Clin Epidemiol*. 2014; 67(3):254–266. [PubMed: 24472295]
19. Schafer I, von Leitner EC, Schon G, Koller D, Hansen H, Kolonko T, et al. Multimorbidity patterns in the elderly: a new approach of disease clustering identifies complex interrelations between chronic conditions. *PLoS One*. 2010; 5(12):e15941. [PubMed: 21209965]
20. Newcomer SR, Steiner JF, Bayliss EA. Identifying subgroups of complex patients with cluster analysis. *Am J Manag Care*. 2011; 17(8):e324–e332. [PubMed: 21851140]
21. Marengoni A, Rizzuto D, Wang HX, Winblad B, Fratiglioni L. Patterns of chronic multimorbidity in the elderly population. *J Am Geriatr Soc*. 2009; 57(2):225–230. [PubMed: 19207138]
22. Garcia-Olmos L, Salvador CH, Alberquilla A, Lora D, Carmona M, Garcia-Sagredo P, et al. Comorbidity patterns in patients with chronic diseases in general practice. *PLoS One*. 2012; 7(2):e32141. [PubMed: 22359665]
23. Prados-Torres A, Poblador-Plou B, Calderon-Larranaga A, Gimeno-Feliu LA, Gonzalez-Rubio F, Poncel-Falco A, et al. Multimorbidity patterns in primary care: interactions among chronic diseases using factor analysis. *PLoS One*. 2012; 7(2):e32190. [PubMed: 22393389]
24. Marengoni A, von Strauss E, Rizzuto D, Winblad B, Fratiglioni L. The impact of chronic multimorbidity and disability on functional decline and survival in elderly persons. A community-based, longitudinal study. *J Intern Med*. 2009; 265(2):288–295. [PubMed: 19192038]
25. Koroukian SM, Warner DF, Owusu C, Given CW. Multimorbidity redefined: prospective health outcomes and the cumulative effect of co-occurring conditions. *Prev Chron Dis*. 2015; 12:E55.
26. Tinetti ME, McAvay GJ, Murphy TE, Gross CP, Lin H, Allore HG. Contribution of individual diseases to death in older adults with multiple diseases. *J Am Geriatr Soc*. 2012; 60(8):1448–1456. [PubMed: 22734792]
27. Di Angelantonio E, Kaptoge S, Wormser D, Willeit P, Butterworth AS, Bansal N, et al. Association of cardiometabolic multimorbidity with mortality. *JAMA*. 2015; 314(1):52–60. [PubMed: 26151266] This manuscript uses data from more than 269,000 patients in the Emerging Risk Factors Collaboration to provide estimates of the reductions in life expectancy associated with cardiometabolic multimorbidity

28. Chen HY, Saczynski JS, McManus DD, Lessard D, Yarzebski J, Lapane KL, et al. The impact of cardiac and noncardiac comorbidities on the short-term outcomes of patients hospitalized with acute myocardial infarction: a population-based perspective. *Clin Epidemiol.* 2013; 5:439–448. [PubMed: 24235847]
29. McManus DD, Nguyen HL, Saczynski JS, Tisminetzky M, Bourell P, Goldberg RJ. Multiple cardiovascular comorbidities and acute myocardial infarction: temporal trends (1990–2007) and impact on death rates at 30 days and 1 year. *Clin Epidemiol.* 2012; 4:115–123. [PubMed: 22701091]
30. Saia F, Latib A, Ciuca C, Gasparetto V, Napodano M, Sticchi A, et al. Causes and timing of death during long-term follow-up after transcatheter aortic valve replacement. *Am Heart J.* 2014; 168(5): 798–806. [PubMed: 25440810]
31. Oudejans I, Mosterd A, Zuithoff NP, Hoes AW. Comorbidity drives mortality in newly diagnosed heart failure: a study among geriatric outpatients. *J Card Fail.* 2012; 18(1):47–52. [PubMed: 22196841]
32. Condelius A, Edberg AK, Jakobsson U, Hallberg IR. Hospital admissions among people 65+ related to multimorbidity, municipal and outpatient care. *Arch Gerontol Geriatr.* 2008; 46(1):41–55. [PubMed: 17403548]
33. Starfield B, Lemke KW, Herbert R, Pavlovich WD, Anderson G. Comorbidity and the use of primary care and specialist care in the elderly. *Ann Fam Med.* 2005; 3(3):215–222. [PubMed: 15928224]
34. vanOostrom SH, Picavet HS, deBruin SR, Stirbu I, Korevaar JC, Schellevis FG, et al. Multimorbidity of chronic diseases and health care utilization in general practice. *BMC Fam Pract.* 2014; 15:61. [PubMed: 24708798]
35. Tinetti ME, McAvay GJ, Chang SS, Newman AB, Fitzpatrick AL, Fried TR, et al. Contribution of multiple chronic conditions to universal health outcomes. *J Am Geriatr Soc.* 2011; 59(9):1686–1691. [PubMed: 21883118]
36. Chen HY, Baumgardner DJ, Rice JP. Health-related quality of life among adults with multiple chronic conditions in the United States, behavioral risk factor surveillance system, 2007. *Prev Chron Dis.* 2011; 8:A09.
37. Uhlig K, Leff B, Kent D, Dy S, Brunnhuber K, Burgers JS, et al. A framework for crafting clinical practice guidelines that are relevant to the care and management of people with multimorbidity. *J Gen Intern Med.* 2014; 29(4):670–679. [PubMed: 24442332]
38. Yancy CW, Jessup M, Bozkurt B, Butler J, Casey DE Jr, Drazner MH, et al. 2013 ACCF/AHA guideline for the management of heart failure: a report of the American College of Cardiology Foundation/American Heart Association Task Force on practice guidelines. *Circulation.* 2013; 128(16):e240–e327. [PubMed: 23741058]
39. Guiding principles for the care of older adults with multimorbidity: an approach for clinicians: American Geriatrics Society Expert Panel on the Care of Older Adults with Multimorbidity. *J Am Geriatr Soc.* 2012; 60(10):E1–E25. [PubMed: 22994865] This guide provides practical, comprehensive tips for systematically approaching older patients with multimorbidity in clinical practice
40. James PA, Oparil S, Carter BL, Cushman WC, Dennison-Himmelfarb C, Handler J, et al. 2014 evidence-based guideline for the management of high blood pressure in adults: report from the panel members appointed to the Eighth Joint National Committee (JNC 8). *JAMA.* 2014; 311(5): 507–520. [PubMed: 24352797]
41. Bromfield SG, Bowling CB, Tanner RM, Peralta CA, Odden MC, Oparil S, et al. Trends in hypertension prevalence, awareness, treatment, and control among US adults 80 years and older, 1988–2010. *J Clin Hypertens (Greenwich).* 2014; 16(4):270–276. [PubMed: 24621268]
42. Sim JJ, Shi J, Kovessdy CP, Kalantar-Zadeh K, Jacobsen SJ. Impact of achieved blood pressures on mortality risk and end-stage renal disease among a large, diverse hypertension population. *J Am Coll Cardiol.* 2014; 64(6):588–597. [PubMed: 25104529]
43. Ikeda Y, Shimada K, Teramoto T, Uchiyama S, Yamazaki T, Oikawa S, et al. Low-dose aspirin for primary prevention of cardiovascular events in Japanese patients 60 years or older with atherosclerotic risk factors: a randomized clinical trial. *JAMA.* 2014; 312(23):2510–2520. [PubMed: 25401325]

44. Kutner JS, Blatchford PJ, Taylor DH Jr, Ritchie CS, Bull JH, Fairclough DL, et al. Safety and benefit of discontinuing statin therapy in the setting of advanced, life-limiting illness: a randomized clinical trial. *JAMA Intern Med.* 2015; 175(5):691–700. [PubMed: 25798575]
45. Levin A, Chaudhry MR, Djurdjev O, Beaulieu M, Komenda P. Diabetes, kidney disease and cardiovascular disease patients. Assessing care of complex patients using outpatient testing and visits: additional metrics by which to evaluate health care system functioning. *Nephrol Dial Transplant.* 2009; 24(9):2714–2720. [PubMed: 19395415]
46. Liu CW, Einstadter D, Cebul RD. Care fragmentation and emergency department use among complex patients with diabetes. *Am J Manag Care.* 2010; 16(6):413–420. [PubMed: 20560685]
47. Jowsey T, Yen L, Mathews WP. Time spent on health related activities associated with chronic illness: a scoping literature review. *BMC Public Health.* 2012; 12:1044. [PubMed: 23206340]
48. Gill A, Kuluski K, Jaakkimainen L, Naganathan G, Upshur R, Wodchis WP. “Where do we go from here?” health system frustrations expressed by patients with multimorbidity, their caregivers and family physicians. *Healthc Policy.* 2014; 9(4):73–89. [PubMed: 24973485]
49. Fried TR, Bradley EH, O’Leary JR, Byers AL. Unmet desire for caregiver-patient communication and increased caregiver burden. *J Am Geriatr Soc.* 2005; 53(1):59–65. [PubMed: 15667377]
50. Boulton C, Wieland GD. Comprehensive primary care for older patients with multiple chronic conditions: “Nobody rushes you through”. *JAMA.* 2010; 304(17):1936–1943. [PubMed: 21045100]
51. Boyd CM, Boulton C, Shadmi E, Leff B, Brager R, Dunbar L, et al. Guided care for multimorbid older adults. *Gerontologist.* 2007; 47(5):697–704. [PubMed: 17989412]
52. Boyd CM, Reider L, Frey K, Scharfstein D, Leff B, Wolff J, et al. The effects of guided care on the perceived quality of health care for multi-morbid older persons: 18-month outcomes from a cluster-randomized controlled trial. *J Gen Intern Med.* 2010; 25(3):235–242. [PubMed: 20033622]
53. Boulton C, Reider L, Leff B, Frick KD, Boyd CM, Wolff JL, et al. The effect of guided care teams on the use of health services: results from a cluster-randomized controlled trial. *Arch Intern Med.* 2011; 171(5):460–466. [PubMed: 21403043]
54. Counsell SR, Callahan CM, Buttar AB, Clark DO, Frank KI. Geriatric resources for assessment and care of elders (GRACE): a new model of primary care for low-income seniors. *J Am Geriatr Soc.* 2006; 54(7):1136–1141. [PubMed: 16866688]
55. Fields D, Leshen E, Patel K. Analysis & commentary. Driving quality gains and cost savings through adoption of medical homes. *Health Aff.* 2010; 29(5):819–826.
56. Beadles CA, Farley JF, Ellis AR, Lichstein JC, Morrissey JP, DuBard CA, et al. Do medical homes increase medication adherence for persons with multiple chronic conditions? *Med Care.* 2015; 53(2):168–176. [PubMed: 25517069]
57. Walsh MN, Bove AA, Cross RR, Ferdinand KC, Forman DE, Freeman AM, et al. ACCF 2012 health policy statement on patient-centered care in cardiovascular medicine: a report of the American College of Cardiology Foundation Clinical Quality Committee. *J Am Coll Cardiol.* 2012; 59(23):2125–2143. [PubMed: 22591882] This article proposes and discusses the concept of the patient-centered medical home for cardiovascular care
58. [Accessed August 21, 2015] National Quality Forum: Multiple Chronic Conditions (MCC) Measurement Framework. http://www.qualityforum.org/Projects/Multiple_Chronic_Conditions_Measurement_Framework.aspx

Box 1**Processes required to provide high-quality care for older patients with multimorbidity**

- Comprehensive assessment of the patient's health, environment, values, and preferences
- Creation and implementation of a comprehensive plan of care that addresses all of the patients health-related needs and aligns with their preferences
- Communication and coordination of care with all clinicians and personnel involved with the patient's care
- Promotion of the patient's active engagement (activation) in their own healthcare

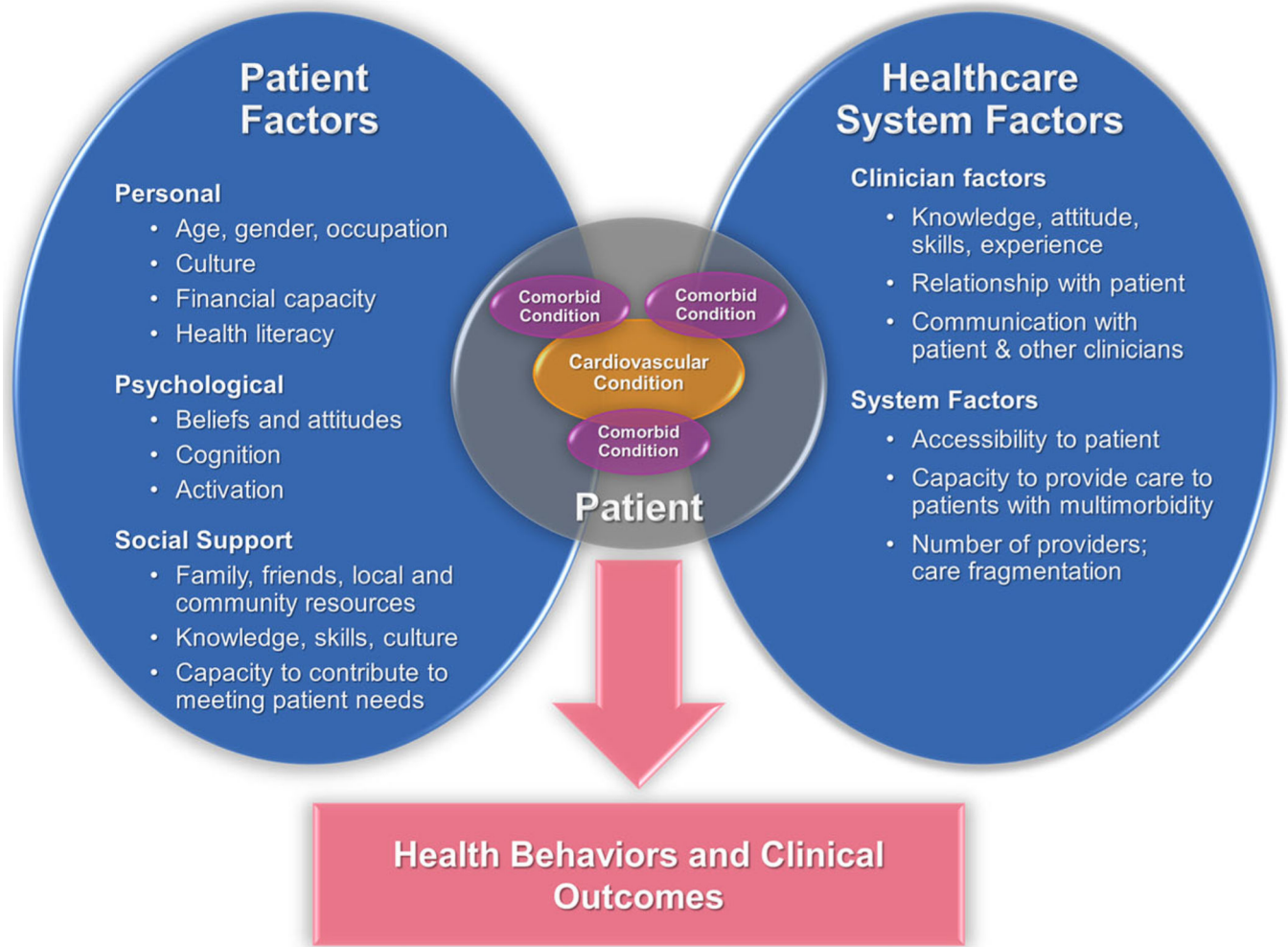


Fig. 1. Factors contributing to health behaviors and outcomes in older patients with multimorbidity and cardiovascular disease

Table 1

Selected contemporary reports on the prevalence of multimorbidity in older individuals

Author Year	Population	No. of patients Age of patients	No. of chronic conditions Examined	Multimorbidity definition	Prevalence of multimorbidity	Top 3 chronic conditions
Salive 2013 [4]	2008 Fee-for-service Medicare beneficiaries	30,923,846 16.5 % <65 years	15	2 or more conditions	67%	Hypertension Hyperlipidemia Ischemic heart disease
Abad-Diez 2014 [5]	19 centers in Spain	72,815 65 years	NA	2 or more conditions	67.5 %	NP
Rocca 2014 [6*]	Rochester Epidemiology Project	138,858 All ages	20	2 or more conditions	22.6 % all ages 77.3 % >65 years	Hypertension Hyperlipidemia Diabetes
Van den Busche [7, 8]	Policy holders in a national health insurance company in Germany	123,224 >65 years	46	3 or more conditions	62%	Hypertension Lipid disorders Chronic low back pain
Ward 2014 [9]	2012 National Health Interview Survey	34,525 Adults	10	2 or more conditions	25.9 % adults 30.8 % >65 years	NP
Lochner 2013 [10]	2010 Fee-for-service Medicare beneficiaries	31 million 17.1 % <65 years	15	2 or more conditions	68.4 %	NP
Ashman 2013 [11]	2009 National Ambulatory Medical Care Survey	28,693 Adults	13	2 or more conditions	37.6 % of total office visits by adults MCC	Hypertension Hyperlipidemia Diabetes
Barnett 2012 [12]	314 practices in Scotland	1,751,841 All ages	40	2 or more conditions	23.2 % overall 64.9 % 65–84 years 81.5 % >85 years	NP
St John 2014 [13]	Community dwelling adults in Manitoba	1751 >65 years	20	Divided into 0, 1–3, 4–6, >7	Mean conditions 4.4	NP
Bähler 2015 [14*]	Beneficiaries leading health insurer Switzerland	229,943 >65	22	2 or more conditions	76.6 %	NP
Kirchberger 2012 [15]	Community dwelling adults in Augsburg Germany	4127 65–94 years	13	2 or more conditions	58.6	Hypertension Eye disease Heart disease

NP not provided