Population Health

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Deborah S. Porterfield

Introduction

Population health, which examines the health outcomes of a group of individuals and the distribution of defined outcomes within the group [1], has become a focal area of interest in clinical practice at a time of value-based health care. Measuring and ultimately improving population health have particular relevance to chronic disease care. Although population principles of health measurement and management can be applied to all patient populations, the potential for improving health outcomes and cost savings in chronically ill patients is considerable and timely. This chapter provides an overview of population health and population health management and will introduce applications of population health management principles to clinical practice, with a focus on chronic disease care.

The first section introduces the concepts and principles of population health and the historical development of these concepts. The subsequent section will illustrate population health concepts, with attention to measurement and applications to chronic illness care. Content will focus on the areas that are most relevant to health-care systems and health plans that are considering or adopting a population health improvement approach. Finally, an appraisal of the state of the science of population health and future directions in the field will be provided.

Defining Population Health

Population health is best understood as an outcome, rather than in terms of structure or process, which may help to distinguish it from other related concepts in the field [1]. In this way of thinking, population health can be conceptualized of as the sum of specific health outcomes, in domains such as mortality rates, disease burden, and health behaviors, that collectively provide a measure of the health of a defined group of individuals. A more refined understanding of population health would not only examine the health outcomes of a group of individuals but also the distribution of such outcomes within that group [2]. Specific measures of population health include infant mortality rates, prevalence of diabetes, and prevalence of smoking in a given population.

A related concept is population health management, which is the collective systems and policies that affect health-care quality, access, and outcomes for a defined population, with an ultimate goal of improving the health of that group [3]. Population health management focuses on the strategies that improve or promote population health. When the population of interest is a clinical or health-care-based population rather than a general population, the concept of population medicine may be used. This associated term is sometimes synonymous with population health management and has been defined by the Institute of Healthcare Improvement as the design, delivery, coordination, and payment of high-quality health-care services to manage the Triple Aim for a population, using the resources available within a health-care system [4].

There are several strategies that may be designed and implemented in a population management or population medicine approach, such as the use of data registries to identify persons in need of specific clinical preventive service and the use of care managers. For clarity, the term population medicine may be used when clinical populations are being considered and population health for more geographically based populations [5]. However, the term population health can be applied in both situations.

A consistent and rigorous method for determining the numerator and denominator of the defined group is critical in measuring population health. However, clearly delineating the denominator for a clinical population (e.g., health system, health plan, or practice) in particular can be challenging.

D.S. Porterfield (✉)
Department of Family Medicine, UNC School of Medicine,
Chapel Hill, NC, USA

RTI International, RTP, NC, USA
e-mail: dport@med.unc.edu

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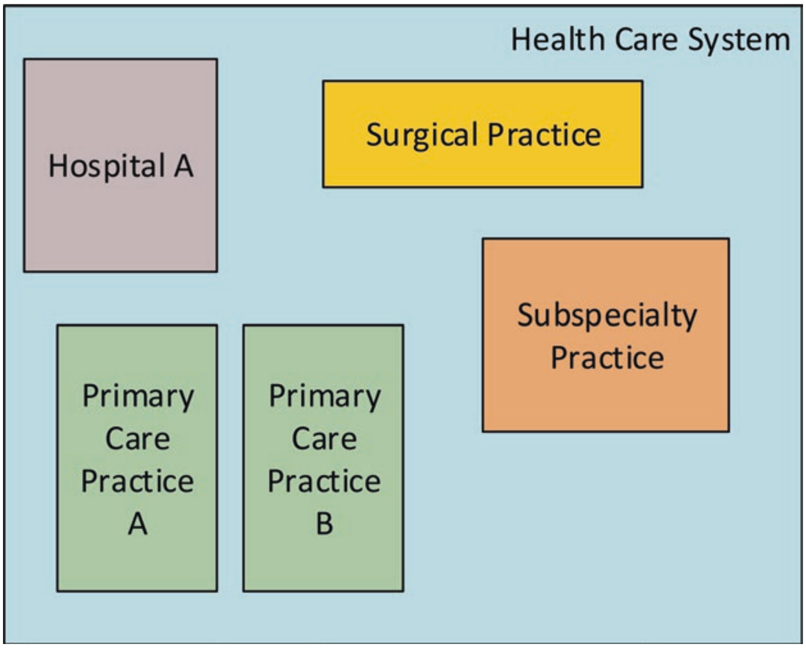

Fig. 42.1 Ideal integrated health service system

For example, at the health system level, hospital service areas overlap in geographic regions and may share patient populations, and patients may receive primary and specialty care in more than one practice. In an ideal and well-integrated health service ecosystem, (see Fig. 42.1) patient populations would easily be identified and attributed and their health outcomes readily measured longitudinally across practice settings. However, health service systems vary considerably in their level of integration and patient attribution (see Fig. 42.2).

One additional clarification is needed to distinguish between public health and population health. These two concepts have sometimes been used interchangeably, for example, to describe the impact of an intervention (e.g., smoking cessation) for a specific population's health (e.g., smokers with emphysema), as well as the public's health (e.g., non-smokers who benefit from reduction in secondhand smoke). In addition, the term public health is most often used to describe an approach to protecting and improving the health of a geographic population, such as a city, county, or state, which is often tied to government or other regulatory agencies (e.g., health departments) with jurisdiction over that population [6].

Intellectual Developments in Population Health

When compared to the long history of public health, the evolution of key ideas in population health is relatively recent [5]. In 1994, members of the Population Health Program of the Canadian Institute for Advanced Research published the text, *Why Are Some People Healthy and Others Not? The Determinants of Health of Populations* [7]. Although this source did not use or define population health, it provided an important early articulation of the concept and, in particular, the need to understand the underlying determinants of population health. A seminal definition came 3 years later with the publication of *Purchasing Population Health: Paying for Results*, in which population health was characterized as "the aggregate health outcome of health-adjusted life expectancy (quantity and quality) of a group of individuals, in an economic framework that balances the relative marginal returns from the multiple determinants of health" [8]. In 2003, this definition was sharpened yet notably broadened the range of health outcomes to include the health outcomes of a group of individuals, including the distribution of such outcomes within the group [2].

A subsequent milestone in the development and application of population health came when the Institute of Healthcare Improvement (IHI) first defined and promoted the notion of the Triple Aim to improve the health of populations in 2008 [9]. The Triple Aim is focused on improving the patient experience of care, improving the health of populations, and reducing the per capita cost of health care [9]. Although population health is not defined or operationalized in the earliest references to the Triple Aim, the IHI has devoted attention to measurement of population health in a recent measurement guide [10].

The concept of population health was operationalized in the Affordable Care Act (ACA) of 2010, which included the phrase "accountability for a patient population" in section 3022, and created the Medicare Shared Savings Program and Accountable Care Organizations (ACOs). The Centers for

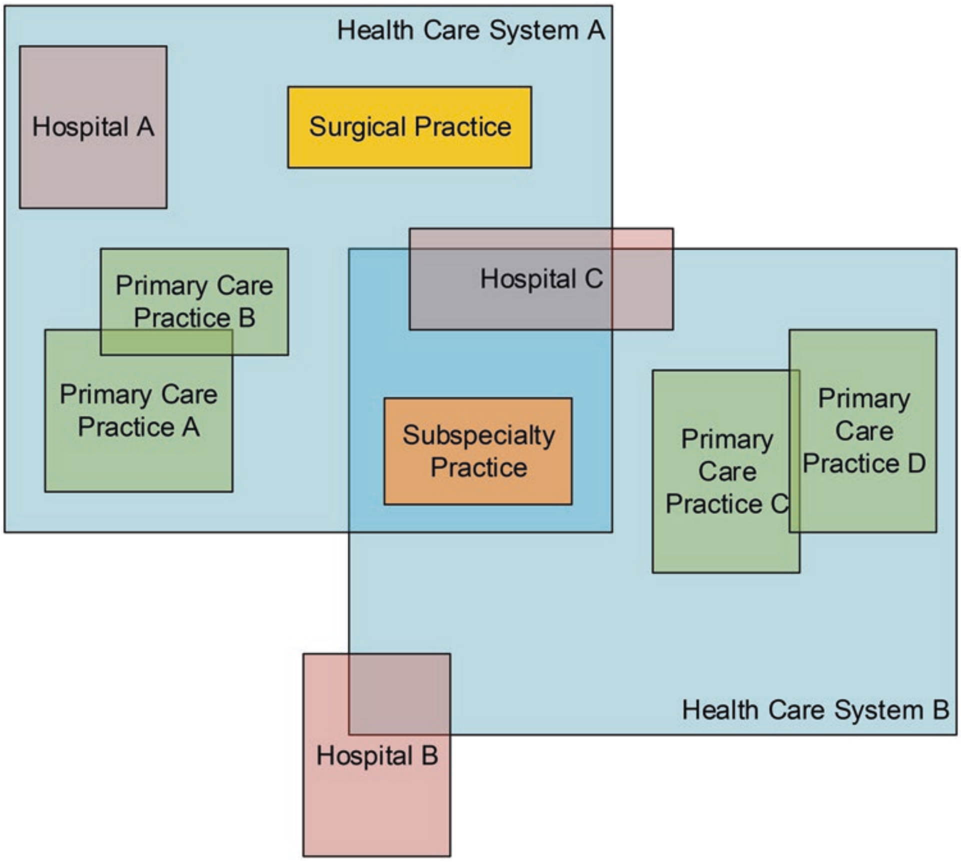

Fig. 42.2 Real-world health service systems

Medicare and Medicaid Services (CMS) defines Shared Savings Program ACOs as groups of doctors and other health-care providers who voluntarily work together with Medicare to give high-quality service to Medicare fee-for-service beneficiaries [11]. ACOs in this way of thinking are accountable for the quality, cost, and overall care of the Medicare beneficiaries assigned to it and must have a formal legal structure that allows the organization to receive and distribute shared savings [12]. The ACA helped direct the focus of health-care delivery systems from improving quality of care for a clinical population to improving its overall health. However, the use of the term population health raised questions and some confusion about the scope of accountability in an ACO, particularly around improving the health of a wider geographic population [13].

A white paper commissioned for the National Quality Forum (NQF) in 2012 helped to further an understanding of population health by providing an environmental scan of population health programs and models and by articulating a rationale for a consistent use in terminology [14]. The report recommended using "total population health" to describe geographic populations, reserving use of the term population health for clinical subpopulations [14]. This recommendation has not been widely adopted, and, as noted earlier, a standard practice has been to clearly define the denominator when using the term population health [14].

A final milestone in the history of population health, and specifically in chronic disease care, came with the development and dissemination of the Chronic Care Model (CCM) in the 1990s [15]. Although this organizational framework to chronic disease care did not specifically use the term population health, the model is an early articulation of population health management principles. For example, the six domains of the CCM overlap with current thinking in population health management strategies (as shown in Table 42.1, below). Specific interventions that are central to the CCM model are also key to current population health management paradigms (Table 42.1) and include measurement of quality of care using information systems and proactive population management strategies based on data [16].

The CCM and the development of quality improvement collaboratives (QICs) had widespread impact on promoting population health thinking and practices in health-care systems, particularly in federally qualified health centers [17]. QICs are structured, multi-organizational learning initiatives in which multidisciplinary teams from each organization focus on a specific health-care quality issue, design and implement a quality improvement plan, measure and report

Table 42.1 Population health management and Chronic Care Model

Population identification	Clinical knowledge of determinants of health
Registry/data warehouse	**Integration with public health/ community systems**
Risk stratification modeling	Utilization of evidence-based guidelines **and embedded decision support**
Use of registry/electronic medical record for: identification of subpopulations for tailored interventions; tracking of referrals to specialists and other providers in the medical neighborhood	Providing of culturally and linguistically appropriate care
Personalized patient-centered care that includes **self-management,** health promotion, disease management, case management	Ongoing evaluation of outcomes with feedback loops
Medical home	Interoperable cross sector health information technology
Interdisciplinary health-care team	*Ongoing quality improvement efforts addressing prioritized health and health-care areas*

Adapted from Siderov and Romney [16]
Bold, also named in the Chronic Care Model; *italicized*, added by the authors

on care processes or outcomes, and engage in organized learning activities [18, 19]. The CCM model was disseminated via national and regional QICs to over 1000 health-care systems [20]. The model also arguably influenced health policy, such as current payment models developed and implemented the by Centers for Medicare and Medicaid Services for chronic care management [21]. The practice and system-level changes envisioned by the CCM promoted widespread adoption of population improvement approach, as well as policies to support it.

Measuring Population Health

Measurement is an essential component to population health, and candidate measures need to have rigor in areas such as validity, reliability, responsiveness, functionality, credibility, and feasibility [22, 23]. Amidst a plethora of measurement sets – from nongovernmental recommendation-making bodies to federal agencies and payors – end users (e.g., health systems, insurance plans) should weigh relevant criteria before choosing a source for general population health measures and for more discrete measures. A key consideration is whether the measurement sets have been developed for clinical populations, geographically based populations, or both.

There are several population health measurement sets that have potential applications to chronic illness. The Institute of Healthcare Improvement's white paper, *A Guide to Measuring the Triple Aim: Population Health, Experience of Care, and Per Capita Cost*, provides a set of population health measures in a menu format, including data sources and representative measures [10]. The paper organizes measurement categories for population health as follows; health outcomes, disease burden, behaviors, and physiological factors (e.g., HbA1c). Electronic health records and patient or health plan participant self-reported surveys are suggested data sources for the candidate measures [10]. For chronic disease, measures include categories of life expectancy, mortality rates, health and functional status, disease burden (e.g., the incidence and/or prevalence of chronic disease), and behavioral and physiological factors such as smoking, physical activity, diet, blood pressure, BMI, and cholesterol [10].

The National Quality Forum (NQF) is another source for validated measures of care and outcomes for clinical populations. The NQF has worked to strengthen a collaborative approach across clinical, public health, and other sectors in order to measure and improve population health [24]. In 2012 the NQF endorsed two specific sets of population health measures – a total of 24 measures – including items such as late HIV diagnosis, adult smoking prevalence, and BMI screening and follow-up [24, 25]. In a subsequent activity, the Health and Well-Being Project, the NQF focused on measures of health and well-being that were applicable across a subset of contexts including health-care settings and communities. The currently endorsed 22 indicators include cancer screenings, immunizations, HIV screening, and population-level HIV viral suppression [26]. The NQF also published a report entitled, *Improving Population Health by Working with Communities: Action Guide 3.0* [27], which, although is not a measurement set, does identify data sources for measuring population health and recommendations on how to select measures of population health to use in improvement efforts.

The Institute of Medicine (IOM) has led several initiatives relevant to population health, with key recommendations to promote population health measurement, and cautions about the proliferation of measurements and the need for alignment [28]. To account for the number of overlapping measurement sets, the IOM presented a streamlined core set of 15 measures of health and health care, with an additional 39 priority measures, designed to assess and monitor progress in the national's health and to be used across sectors [28]. Candidate population health measures from the IOM report include self-reported health status, life expectancy, body mass index, addiction death rate, teen pregnancy rate, and preventable hospitalizations [28]. The IOM also explored approaches to measurement capture since multiple initiatives to improve population health have provided a landscape of population health metrics, as well real-world examples [29].

A number of health-care quality measurement sets may be considered as sources of population health measures, although health-care quality is usually not considered a domain of population health. There are several examples of health-care quality measurement, including the Medicaid Core Set of Adult Health Quality Measures [30], the Health Resources and Services Administration Uniform Data System [31], Agency for Healthcare Research and Quality's (AHRQ) Prevention Quality Indicators [32], and HEDIS Health Plan Measures [33]. These measurement sources of health-care quality may be relevant if there is a focus on process – in addition to outcome – measures for a specific condition that can enhance strategies to improve health outcomes.

Finally, an additional source for population health measurement may be found in AHRQ's National Healthcare Quality and Disparities Report Chartbooks [34]. The chartbooks are organized in a similar fashion to the IOM's domains of quality of care (e.g., safe, effective, patient-centered, timely, efficient, equitable); however, there are multiple health status measures (e.g., deaths from colorectal, breast, and lung cancer, HIV viral suppression, high blood pressure prevalence) in the dataset that reside in the population health measurement domain. The distribution of health outcomes in specific subpopulations (e.g., persons of color) is a specific and important aspect of population health.

Models and Applications of Population Health

It is critical to have a conceptual framework, theory, or an evidence-based model to guide the selection of measures and interventions when considering approaches to measuring, and ultimately improving, the health of populations. A model provides an organizing framework in terms of plausible interventions to improve health outcomes. Specificity is required when applying a model in order to gauge fidelity to the intervention and development of a measurement and analytic approach to determine the effect of the intervention. This is important when working with health-care systems and/or health insurance plans that may be less familiar with methods to identify and address more "upstream" factors, such as social determinants of health. A well-developed theory, which elucidates the important drivers of population health, can map out pathways to determine how health system-level factors influence those drivers of population health. A theoretical or empirically based model can also identify potential levers to those upstream drivers, pointing out ways to synergistically work with clinical care interventions to improve health.

There have been several models of population health, and two have particular relevance to chronic illness care [10, 15]. The Chronic Care Model (CCM) is a foundational framework for chronic disease population health improvement (Fig. 42.3). As noted earlier, the CCM does not specifically use the term population health but instead describes "health outcomes" [15]. The CCM focuses on clinical service delivery and is comprised of several domains; organization of health care, decision support, delivery system design, clinical information systems, and self-management support. The sixth domain included in the model – community resources and policies – is the most underdeveloped of the domains.

The CCM has been evaluated in systematic reviews, most recently in a review that included 77 original studies of implementation of the CCM for patients with chronic disease [36]. All but two studies reported improvements in health-care practice or health outcomes, and the review described specific elements of the CCM that were included in the interventions. Self-management support and delivery

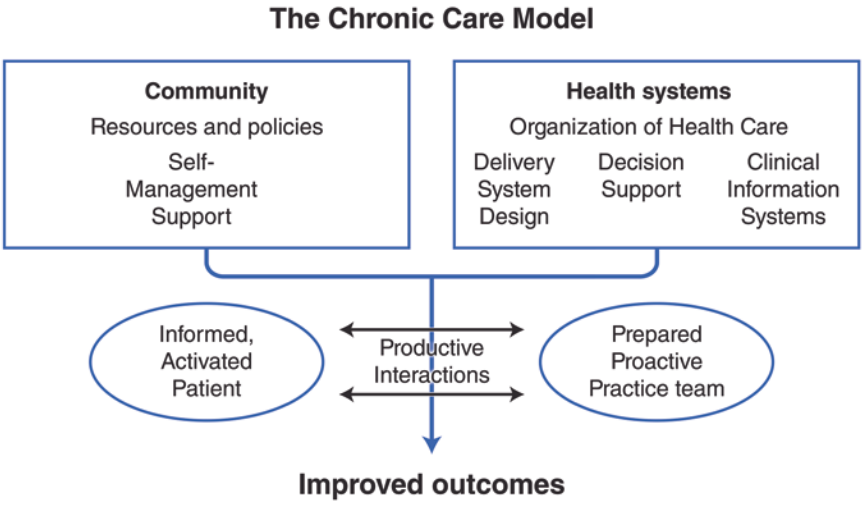

Fig. 42.3 Adapted from the Chronic Care Model developed by the MacColl Institute [35]

system design were the most commonly used approaches; however, it was unclear which combinations of interventions were most effective.

The CCM has had broad influence in clinical practice and policy [20]. An "Expanded Chronic Care Model" of the CCM includes elements of chronic disease prevention, social determinants of health, and the role of community supports to positively impact population health for patients with chronic disease [37]. These targeted areas enriched the original CCM, which had a primary focus on care delivery for chronic disease, by expanding the scope beyond clinical settings as well as highlighting the importance of primary and secondary prevention. An "eHealth Enhanced Chronic Care Model" potentiated each of the CCM elements by applying health and communication technologies, as well as adding a new element of "eHealth Education," or the promotion of skills for persons with chronic disease in areas such as texting, websites, and mobile phone applications [38, 16].

The Institute of Healthcare Improvement's guide to measurement of the Triple Aim A is a second model of population health that is relevant to chronic disease care [10] (Fig. 42.4). This framework organizes a menu of measures for the Triple Aim components and is comparable to the Expanded Chronic Care Model in its depiction of how health-care delivery systems can work with preventive services to promote population health [10]. In the model, prevention and health promotion efforts influence upstream factors, such as the social determinants of health, and individual factors, such as health behaviors. In contrast, health care is depicted as influencing disease burden, health and function, and mortality.

Two IHI model features of population health measurement are noteworthy. First, the IHI model does not include health-care delivery measures within its population health aim but collapses these in the experience of care aim. Second, the model does not include social determinants of health in the measure set, although health equity is featured prominently in the model.

Information Technology

Information technology (IT) is a prerequisite and a key component in population health management. The federal Office of the National Coordinator defines health information technology as the "array of technologies to store, share, and analyze health information [39]," including EHRs, personal health records (PHRs), and e-prescribing. Well-integrated and high-functioning IT systems can potentially facilitate population health management in multiple ways: through the identification of a population at risk, either by health outcomes or lack of preventive or clinical services, by tailoring clinical services to subpopulation identified through queries or risk modeling, and by ongoing evaluation of outcomes and quality improvement efforts. One framework of health IT in ACOs describes a set of tools needed to accomplish the functions of IT and population health management: electronic health records, clinical data warehouses, registries, predictive modeling/risk stratification abilities, decision support tools, patient portals, and data analytics tools [40]. An Agency for Healthcare Research and Quality report specified requirements and functions for IT systems in order to support population health management [41]. These requirements

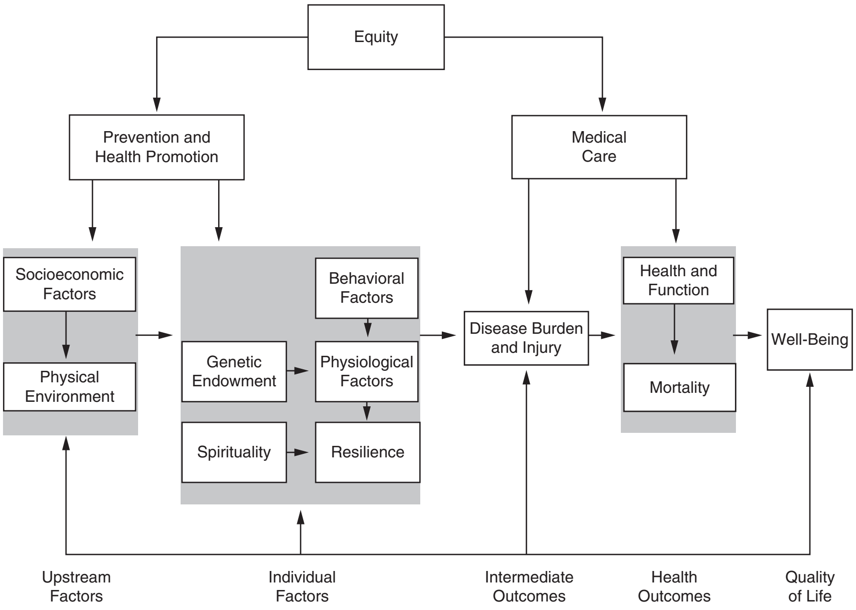

Fig. 42.4 The Institute of Healthcare Improvement's model of population health. (Adapted from [10])

include technical functionalities to identify subpopulations of patients, examine detailed characteristics of identified subpopulations, create reminders for patients and providers, track performance measures, and make data available in multiple forms [41].

The applications of IT are being adopted into organizational levels, as evidenced by the formation of Accountable Care Organizations (ACOs) and several other national initiatives such as recognition of clinical practices as patient-centered medical homes (PCMH) and the spread of meaningful use. The PCMH Recognition Program of the NCQA [42] includes a specific standard of "Population Health Management" with elements such as clinical data and use of data for population management. Meaningful use of certified electronic health record technology, a term developed and promoted by the federal government, promotes the use of EHRs to improve care delivery, population health, and health data security [43]. The sustained adoption of the meaningful use of EHRs will be incentivized through payment programs of Medicare and Medicaid.

Table 42.2 displays the domains and features of IT systems that are required to support respective functions. Of note, the second and third domains support population health management [44].

A survey of early ACOs found that about half reported complete or near complete capability for the most common IT functions [40]. Only 36% of ACOs were able to integrate outpatient and inpatient data from providers within the organization, and only 34% had the IT capability for primary care physicians to bidirectionally share referral information with specialists.

Table 42.2 Domains of information technology systems for provider organizations

Domain	System features	Purpose
Transaction systems	Patient registration and scheduling	Care of the individual patient
	Electronic health record, including orders, e-prescribing, and patient portal	
	Patient billing and collection	
	General financial systems	
Population management	Patient registries; care coordination and case management	Population-level view
	Risk stratification: predictive analytics, protocols for intervention	
	Task tracking and documentation	
Data warehouse and analytics	Analytical models	To develop knowledge
	Cost accounting	
	Comparative data, benchmarking	
	Exploratory analyses	
	Practice profiles for clinicians	
	External reporting	

Adapted from [44]

Social Determinants of Health

Another focus in population heath management is increasing the awareness of individual providers and health-care organizations to address the social determinants of health (SDOH), which are key drivers of health of populations [45]. The World Health Organization defines SDOH as "conditions in which people are born, grow, work, live, and age, and the wider set of forces and systems shaping the conditions of daily life" [46]. Some proponents of population health improvement have advocated for measurement and intervention in the SDOH, including a recent call for including SDOH and behavioral factors as part of the medical record, a key first step toward clinicians to identify and address these factors [4]. In addition, the Centers for Medicare and Medicaid Services has promoted the Accountable Health Communities initiative, a program to promote screening approaches for adverse SDOH in clinical care settings as a central part of managing of the health of the populations [47]. This initiative has drawn some criticism since criteria for an effective SDOH screening are underdeveloped [48].

Independent of the Accountable Health Communities program, there has been interest in promoting collaborations between health-care systems and public health or community-based organizations, in order to address behavioral and social determinants of health [49]. Early work in this area was led by the Agency for Healthcare Research and Quality, specifically for the delivery of preventive services [50], but other sources of resources to promote these collaborations, in addition to AHRQ, are now available, such as the Practical Playbook [51]. However, evidence for these collaborations is early, and emerging research will need to elucidate efficacy for chronic disease states and effectiveness in health-care organizational contexts [52, 53].

Future Directions

Population health is best understood as a set of outcomes that describe the health status of a defined population. As such, the state of the science of population health is tied to the measurement science of key outcomes. To further this science, more robust measures and data collection strategies will be needed in chronic disease population health. Although there is not a paucity of measures of chronic disease population health, evidence mapping, which includes the synthesis, consensus, and identification of measurement gaps, will be needed from the patient, the health-care system, the health payor, and larger social perspectives. Collaborative activities and neutral convening bodies, such as IOM and NQF, can guide approaches to promote alignment among various stakeholders and achieve consensus in measurement priorities. Payors will continue to heavily influence measurement priorities; however, public health agencies (e.g., health departments, CDC) will also provide important input, even in clinical population health measurement.

The development of new data sources and acquisition methods is another gap area, especially as IT systems and connectivity mature. For example, collecting quality of care data (e.g., delivery of preventive services) at a geographic level is possible from patient self-reported surveys, but the capacity to systematically gather and synthesize this data from electronic medical records (EMRs) is uneven and made possible only by shared data systems, data warehouses, and health information exchanges. IT compatibility to facilitate measurement for both the clinical and geographic populations must be prioritized, developed, and implemented to decrease fragmentation of efforts. The area of population health informatics needs further development to facilitate measurement [54].

The evidence base is evolving in the science of population health management. The toolkit for population health management has included interventions such as the patient-centered medical home (PCMH) model, patient registries through electronic health records, and a plethora of quality improvement activities. Given the wide range of interventions, it is unclear which of these strategies are effective – in combination with others or as stand-alone interventions – and highlight the challenges of evaluating population health management strategies as a single package or toolkit. For example, the Chronic Care Model (CCM) has been evaluated in systematic reviews, and all but two studies reported improvements to health-care practice or health outcomes; however, the wide variation among interventions that were implemented precluded the identification of the most effective interventions [36].

These prior evaluations of the CCM can inform the future of evaluating population health management strategies. Standardized evaluation, research, and quality improvement can evaluate and promote the evidence base for targeted population health management interventions and the practice level. One intervention, for example, would link facilitated communication through an electronic health record between a physician and a midlevel provider, with a care management model that allows the midlevel to implement a care management protocol.

Population health management is becoming an integrated part of clinical practice, and there is a growing need to include population health and population health management in the curriculum of undergraduate, graduate, and postgraduate education [55]. The American Association of Medical Colleges and the Centers for Disease Control and Prevention have spearheaded efforts to develop curriculum and competencies in population health [55, 56], but dissemination efforts are limited, and adoption is unknown. Current postgraduate opportunities are growing in number, and there are online and in-person degrees in public health, population health, preventive medicine, and health-care administration or business. For example, there are 73 residencies in Preventive Medicine, which provide 2-year training in population health, including a Master's in Public Health Degree. In addition, the American Board of Preventive Medicine has recently developed board certification in Clinical Informatics. These advancements begin to address the gap in population health in medical education; however, incorporating population health into undergraduate and graduate education will be a high priority to ensure that the health-care workforce of the future has acquired basic competencies in this critical area.

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