Real World Applications of Population Segmentation in Population Health Management

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Population Health Management Series: Part 3

February 2021

HSPN Health System Performance Network

The opinions, results and conclusions included in this report are those of the authors and are independent from the funding sources.

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Financial Support

This research was supported by a grant from the Ontario MOH to the HSPN. The funders had no role in data analysis, decision to publish, or preparation of the report.

Suggested citation

Weir DL, Wodchis WP. Real World Applications of Population Segmentation in Population Health Management. Toronto, ON: Health System Performance Network. 2021.

ISBN 978-1-7774610-4-1 (Online)

This document is available at hspn.ca

Executive Summary

Background
Population health management (PHM) is the concept of gathering data and insights about population health and well-being across multiple care and service settings, with a view to identifying the main health and social needs of the community and adapting services accordingly. Population segmentation is an important tool for implementing population health management within a health system since care needs will vary across individuals in the served population. As Ontario aims to shift toward population health management, this report reviews international health systems that have implemented population health management and have used population segmentation to enable their success.

Purpose
The purpose of this report is to describe how population segmentation is practically applied within health care systems that have implemented population health management.

Methods
This review selected a case study approach with narrative review of selected exemplar cases for which documented evidence could be obtained describing the use of population segmentation as a key strategy for population health management. Each health system is profiled, including a description of the organization and the population they serve, their population health management strategy, segmentation approach, data used in segmentation, segment characteristics and management approach for each segment. To gain additional insights into the application of population segmentation in practice which were not available from public data sources, we conducted structured interviews with key system informants. A qualitative narrative review was conducted for each system based on information abstracted from publicly available information and published literature for each system as well as interviews conducted with each key health system informant.

Findings
There was a large similarity in the steps taken by each health system to use population segmentation. All follow a fairly common approach to identifying four to five tiers of risk representing low, rising and high risk clusters with low risk groups receiving routine monitoring possibly enhanced with enhanced health literacy and health promotion programs and highest risk groups receiving intensive team-based approaches with clinical case management. Two systems found that segments lacking clinical interpretation were not readily used by care providers. One system co-designed the segmentation approach, but lack of clinical operability is an impediment to wide use.

Key Learnings
Segmentation approaches that have face validity with clinicians and patients will maximize value by ensuring that the system is used in the organization and delivery of care to better meet patient needs. Collaborative approaches can and should be used to design and make available programs that meet patient needs, but resources and programs must also be available, the potential benefits of this approach can't be realized without changes in patient care. Population segmentation is a tool within a number of equally important tools and strategies required to help achieve population health management.

Conclusion
Leading health systems around the world employ population segmentation in their population health management strategies. There are important lessons from the examples in this report for Ontario Health Teams and abroad.

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Introduction

Population Health Management

Population health management (PHM) is the concept of gathering data and insights about population health and well-being across multiple care and service settings, with a view to identifying the main health and social needs of the community and adapting services accordingly.[1] Generally, health systems adopting a PHM approach aim to address the health needs of the entire population at all points along the continuum of health and well-being.[2] This is done through integrating services across health, prevention, social, and welfare services; it is common for PHM systems to shift the focus toward prevention, determinants of health, equity, and intersectoral action.

Population Segmentation is a Tool

Population segmentation is an important tool for implementing population health management within a health system since care needs will vary across individuals in the served population. Through segmentation, the unique care needs of heterogeneous groups are identified, enabling targeted interventions, policies and financing for each subgroup.[3] This enables the system to match the appropriate services to the appropriate individuals to optimize their health outcomes as well as to improve healthcare service planning at population level.[4]

Real World Applications of Segmentation in Population Health Management

Practically applying population segmentation as a tool to achieve population health management within a real-world health system is not a trivial task. There's considerable tension between what is possible with big data and advanced analytics and what is actually practical and accepted at the point of care in the context of limited clinical and system resources. Therefore, practical learnings from health systems who have experienced the journey from their ideal plan for population health management and segmentation to its actual implementation are important to consider in the early development of Ontario Health Care Teams.

Purpose

The purpose of this report is to describe how population segmentation is practically applied within health care systems that have implemented population health management.

Methods

Selecting real world examples

This review selected a case study approach with narrative review of selected exemplar cases for which documented evidence could be obtained describing the use of population segmentation as a key strategy for population health management. The search began with the HSPN review of population health management[5] and population risk assessment and segmentation tools[6] enhanced by a rapid literature scan and online search for descriptions of the use of population segmentation in the implementation of population health management. Expert opinions served as a third source for cases. Cases were restricted to those for which descriptions were available in English language public documents.

Targeted literature search for each health system

We first conducted a targeted search of the literature, organization websites and internal publicly available documents to abstract information on each systems population management approach as well as methods for and use of population segmentation. Key information collected for each health system included an overall description of the organization and the population they serve, their population health management strategy, segmentation approach, data used in segmentation, segment characteristics and management approach for each segment.

Structured interview with key health system informant

To gain additional insights into the application of population segmentation in practice which were not available from public data sources, we conducted structured interviews with key system informants. We expanded upon publicly available information related to the characteristics of the system and their segmentation approach and also gathered information related to end users of information on population segmentation, delivery of the information, actions that are taken as a result of segmentation, health equity considerations, evaluation and challenges. The interview guide questions are included as an appendix to this report.

Narrative Review

A qualitative narrative review was conducted for each system based on information abstracted from publicly available information and published literature for each system as well as interviews conducted with each key health system informant.

Findings

Five exemplars were selected. The HSPN review of population health management examples suggested two health systems (Gesundes Kinzigtal [GK] and Kaiser Permanente Washington). The HSPN review of population segmentation tools revealed no examples where rigorous assessment of implementation was described (GK and Kaiser's segmentation tools were not available for inclusion in the review of segmentation tools). The literature review identified two more health systems (Denver Health and Partners HealthCare). The online review further identified the North West London Whole Systems Integrated Care initiative. Case descriptions were obtained from all five cases but only three could be available for interviews due to the ongoing COVID19 pandemic throughout our search and interview period in 2020. Because of the essential content of the interviews in understanding the frontline implementation, challenges and key success factors for the utility of the segmentation tools, only three are included in this report with a goal of updating the report with information from Partners HealthCare and Kaiser Washington at a later date.

The three systems are summarized in Table 1 including the setting, population and population health management strategy in each program. North West London (NWL) is the largest of the programs with a insured population of more than 2.4 million while the GK program serves an insured population of a little less than 35 thousand. NWL has the broadest population health mandate and approach while GK focuses on quadruple aim goals and Denver has a greater focus on managing high risk populations.

Table 2 summarizes the segmentation approach and use of segmentation in clinical management for each of the three systems. All follow a fairly common approach to identifying four to five tiers of risk representing low, rising and high risk segments with low risk groups receiving routine monitoring possibly enhanced with health literacy and health promotion programs and highest risk groups receiving intensive

team-based approaches with clinical case management. All segmentation approaches utilize claims data with enhancements from survey data (Denver) and patient health socio-economic factors (NWL).

A summary of practical considerations is presented in Table 3 with information describing end-users, approach to delivering population segmentation information and information about evaluations of the segmentation approaches and population health management systems. Both Denver and GK directly integrated segmentation information within health care provider electronic records while NWL relied on a separate system with robust dashboards for providers to use alongside existing EMRs. There were no evaluations on the use or effects of the segmentation approaches themselves although a few of the population intervention programs had been evaluated across each program.

Denver Health

Setting

Denver Health (DH) is an integrated safety net system in Denver, Ohio and serves approximately 200,000 individuals. Payer mix includes uninsured individuals as well as Medicare, Medicaid and some commercially insured. DH consists of eight federally qualified community health centers, 15 school-based health centers, outpatient specialty services, a 525-bed, acute care hospital with an academic Level One Trauma Center, a 100-bed nonmedical substance abuse and detoxification facility, Denver's 911 emergency medical response system and the Denver Public Health department.[7,8] A shared electronic medical record (EPIC) is used across the organization (including inpatient, outpatient, labs and pharmacies) and provides detailed utilization information across the continuum of care. The systems population health management approach includes thinking about populations in need of primary care services—such as higher-risk patients and out-of-care patients—not solely those who present for care. DH managed-care members are included under the assumption that their enrollment signals an expectation that DH serve as their medical home. Similarly, the utilization behavior of individuals with repeated ED visits, urgent care visits, and hospitalizations suggest that these patients think of DH as their delivery system, and therefore DH should make proactive efforts to engage them in primary care.[7]

Segmentation approach

In the first iteration of Denver Health's population segmentation approach, the organization created a clinically acceptable risk tiering approach based on the 3M Clinical Risk Groups (CRG's) where each of the approximately 300 CRGs was further assigned to 1 of 4 risk tiers by clinicians. Claims data, clinical data from EMR's and survey data are used as data inputs for the risk tiering approach. Four different risk tiers were created with different interventions geared towards each segment such as panel management and e-touch programs in the lowest risk tier and high intensity treatment clinics in the highest risk tier.[7,8]

After the initial iteration of their segmentation approach, the organization decided to move towards a more simplified approach with fewer clinical risk groups. This was done for a number of reasons, including to improve continuity between the tiers with respect to the transition for children into adulthood. This is because a particular clinical program may not always make sense for a child with a given condition which might make sense for the same condition in an adult. Additionally, the system hopes to simplify their approach to align with regional efforts, making it easier to share risk tiering approaches between organizations and develop single programs for individuals across the continuum of care.

End users and delivery of information on segmentation

Although tiering information is relevant across the entire continuum of care, end users of information on population segmentation tends to mainly be those that work in the outpatient setting. The risk tier an individual is in is available as a banner in the patients' electronic medical record (EPIC) where this information is updated on a nightly basis.

In the future, the organization hopes to include information other than just the risk tier within the patients EMR, such as the information that went into creating the tier (e.g., the case mix group) as well as healthcare utilization promotion criteria in a hover bubble above the banner. How an individual is assigned to a particular tier is still a bit of a black box, so this may help a clinician understand why one individual is in a particular tier compared to another and help with the clinical acceptability of this approach. Additionally, some of the information on diagnoses or healthcare utilization used to assign an individual to a particular tier could be sitting outside of the EMR that the clinician can't see. Therefore, including the case mix groups might help clinicians better understand why their patient was assigned to a particular tier.

Actions that are taken as a result of segmentation

Information on the segment a particular individual is assigned to is mainly used to drive workflows within care management teams as well as nurse care coordinator activities that may trigger particular workflows. This means that tier assignment is mainly used to determine whether an individual is eligible for a particular care plan or not. If a patient newly enters into a tier they can show up in a daily list for a nurse coordinator and they can review whether or not they're enrolled in the appropriate care plan. This is an area where if there were additional resources available, it's likely more could be offered to a particular tier, but as it stands, the organization is under resource constraints like any other.

For some patients, risk tiering does not always drive access to particular programs. For example, an individual is eligible to be managed by a clinical pharmacist if they have diabetes, hypertension or using an anticoagulant, if a patient is transitioning out of the hospital they will receive a call from a care navigator, and if a patient screens high on an anxiety test they'll be contacted by a behavioural health consultant, no matter what tier they fall into. Additionally, even if a patient enters into the highest risk tier (Tier 4), their care may not be transferred to a high intensity clinic if they have a good relationship with their current provider and feel confident they can continue to manage their care.

Equity

This health system mostly serves a low income and underinsured population, so the organization is slightly less focused on whether they are using a biased tool in their segmentation approach to direct resources which inadvertently directs services away from the underserved population. Measuring and tracking social determinants of health such as homelessness have been discussed, but remain difficult to capture.

Evaluation

Denver Health's overall population health and segmentation strategy has not been evaluated, however, particular programs have. Appointment reminders through text message were associated with improvements in patient satisfaction and provides a low operating cost approach to reduce operational inefficiencies.[9] A series of quality improvement interventions for pediatric asthma care were associated with a decrease in hospitalizations or urgent care clinic visits.[10]

Challenges

One of the most important challenges facing Denver Health is the tension between the ideal state of population health management and what could be done and then what's actually being done in practice. Overall, their risk tiering approach is good at recognizing which patients are high risk, based on their historical data, however, it is very difficult to recognize who is going to become a high-risk patient in the future. This is important because ideally, a health system would want to intervene prospectively to try and change that trajectory of risk that this individual is on.[11] At the end of the day, it's clinicians on the front

line who are using information on the risk tier an individual is in so any segmentation approach really should be meaningful to them**.** Additionally**,** sometimes there's no point in even tiering or recognizing a patient if you really don't have the resources for them in the first place. Population segmentation is a tool to have in your toolbox, but important to recognize it's a tool among many and it is not going to solve all the particular issues within a health system.

Gesundes Kinzigtal, Hamburg, State of Hessem Networks

Setting

This case study includes three separate networks of integrated care organizations in Germany (Gesundes Kinzigtal [GK], Hamburg, State of Hessem) which are partially managed by Optimedis AG and local physician groups. GK was the first network and was created in 2005. The organization contracts with separate insurers to manage their insured population. The networks also coordinate with a number of other partners including office-based physicians, hospitals, nursing homes and home care services among others.[12–14] The Quadruple Aim framework is used as the foundation for their population health management approach which includes improving patient experience of care, health of populations, reducing cost of health care as well as improving provider experience.

Segmentation approach

When GK was initially established, large investments were made to construct an IT system which linked insurer, hospital and provider information across different settings in order to track individuals across the system. This enabled the networks to develop a data warehouse which includes insurer data on diagnoses, health services, prescription claims and hospital admissions. Additionally, local physician data and survey information is included in the data warehouse. Using this information, the managed population is segmented into different groups including healthy insured, low risk, rising risk and high-risk groups. In an ideal setting, each patient would receive a particular set of interventions based on the risk tier they fell into.[12–14] For example, healthy insured individuals would specifically be targeted to receive health literacy training and high-risk patients would receive intensive health coaching. The population tiering pyramid represents an ideal approach after running a system for a number of years.

In reality, the data, segmentation model and implementation strategies that are used for each network are slightly different depending on the local context and characteristics of the population. If a network is new, they will likely only pick one or two interventions that they are more confident will have impact and expand their approach from this point. This allows a network to roll out interventions for particular types of patients to see if they're acceptable to patients and physicians and allow for their evaluation.

Additionally, using risk scores such as Framingham still has utility in these networks since they have good face validity with clinicians in addition to the fact that basic tools and decisions are important for front line managers with respect to the communication of segmentation results and actionability. GPs tend to find a simple approach more acceptable so that they can focus on caring for patients. This simple approach can include a particular diagnosis, being above a certain age or a recent hospital admission for an ambulatory care sensitive condition.

The results of sophisticated segmentation approaches are rarely used at the point of care within this system. Rather, they tend to be used for program planning and to understand which types of programs should be offered to suit the managed population and their care needs. For example, relationships between different comorbidities in each risk strata were evaluated where the 10 most frequent triplets of chronic conditions were identified and helped to inform components of care management programs. This approach helps the organization to consider a patients care pathway as a whole but at the same time use simple techniques for the GP interface.

End users of information on segmentation and delivery of information

End users of information on population segmentation can be front line clinicians where an EMR pop-up can alert clinicians that an individual is eligible to register a patient in a particular program. Intermediate users can include care program managers who tend to be employed locally and interact with clinicians to understand how information on segmentation can be used to make different care decisions about a particular individual's care.

Actions that are taken as a result of segmentation

One of the simpler segmentation approaches used in practice within this organization is the identification of patients with ambulatory care sensitive conditions. A list of patients who were hospitalized for this particular reason is created for GP's. This list is then used in quality rounds for physicians to discuss what could have been done to prevent these admissions. These discussions help to potentially inform care management strategies to address quality issues since a lot of the time, solutions go beyond what an individual physician may be able to do on their own.

There are particular population health management programs that are offered to patients that do not directly result from segmentation or a particular clinical criterion. Health coaches are hired and trained by the organization to go out into the community to let people know the types of health services and care management programs which are available to them. These individuals may not have a health issue per se but can received information on how to stay healthy. The health coach is more involved in health promotion to promote self-management and efficacy rather than providing medical advice.

Equity

Although the organization acknowledges that equity is an important issue, it is not really part of a unified stream of research or policy. The extent to which equity is taken into consideration tends to be dependent on the individual network itself. GK serves a mostly homogeneous population of individuals where there are not large variations in terms of health literacy or other health related characteristics. A new network being established in Hamburg on the other hand serves a more urban population, a large proportion of which are new immigrants. In an effort to address health inequities in this setting, the health kiosk program was developed. This kiosk is located in a public marketplace where anyone can go irrespective of insurance status and receive health information on social services and social care offers. GP's can refer patients to the health kiosk and the health kiosk can also refer patients back to the GP. A multidisciplinary team works within the health kiosk and can take around 45 minutes with each patient in order to better address their complex health needs where they can tailor their approach to consider family history and social context. The patient can then be referred back to the GP if appropriate. In essence, this is a way of segmenting and providing care for individuals according to sociodemographic characteristics in an effort to address health system inequity.

Evaluation

Overall, the GK systems approach has been associated with cost savings each year.[15] A number of programs have been associated with improved quality of life and an osteoporosis treatment program in particular has been associated with improved health outcomes.[16]

Challenges

Trust is one of the most important issues in population segmentation and data analytics in this organization. There's a lot that can be done with data, but if your goal is to change the behaviour of

patients or clinicians there needs to be a certain level of trust that the data driven recommendation is the right thing for the patient and the information being provided is accurate.

North West London Whole Systems Integrated Care

Setting

North West (NW) London serves over 2.4 million people within 8 boroughs. The population is culturally and socially diverse and is one of the most multicultural areas in the capital. In NW London, health and health care partnerships are a collaboration of over 30 organizations including the National Health Service (NHS), local authorities, voluntary sector and Healthwatch. The health care network includes 360 General Practitioner (GP) practices within 8 Clinical Commissioning Groups (CGCs) representing each borough, 10 acute specialist hospitals and 4 community and mental health service providers.[17] It is the largest health and care partnership in the country. The CCGs are responsible for planning and commissioning (purchasing) health services for the population in their respective areas of NW London. To do this, they assess local health care needs, create plans to prioritize and meet the needs of the citizens and then pay for these services to be delivered to local people. They commission services from local hospitals, clinics and community organizations to provide these services to the population of NW London. Local GPs and each CCG's respective governing body makes decisions about health services based on the feedback received from patients, caregivers, patient experiences and the involvement of local people on committees and governing bodies.[18]

NW London focuses on using integrated care systems to improve population health and social services across entire geographies and to deliver better outcomes for people. Whole population, outcomes-based approaches require population segmentation. The development of NW London's segmentation approach was designed to support the development of Primary Care Networks so that they can take a population-based and network-based approach to improving health.

Segmentation approach

The primary objective of NW London's segmentation approach was to create a framework where providers are able to make specific decisions to tailor the offer of care to individuals. NW London's segmentation approach is called the Risk Segmentation Radar and it was developed by the Population and Outcomes Working Group (included commissioners, clinicians, mental health, social care and public health experts as well as lay partners). A *pragmatic approach* was taken to define the risk groups based on emerging thinking from the Nuffield Trust, NHS England and the Bridges to Health Model.[3,19–21] Electronic patient records (EPR) were integrated across all healthcare settings in NW London (acute, primary mental health, community and social care) and linked using NHS number. This data is housed in a data warehouse and used to determine the segment a patient belongs to. Variables for segmentation were selected based on public health and clinical opinion as well as input from NHS operations. Indicators were grouped into the following major categories: health usage, health indicators, poor management of chronic conditions, socioeconomic status and lifestyle factors.

Health usage includes number of walk-in clinic visits, emergency department visits, non-elective admissions, number of missed visits, if the patient has been seen by a district working team in the last 6 months and if the patient has had no contact with a GP in the last 18 months. Markers of poor chronic condition management include: systolic blood pressure over 150 and diastolic over 90 in those with hypertension, more than 3 ED visits in last 12 months or more than 1 heart failure related emergency admission in last 12 months in patients with heart failure, current smoker status and 2 or more COPD exacerbations in last 12 months in patients with COPD, SMWEMBS (Depression Screening) Score less than or equal to 40 among those with serious mental illness, QRisk (similar to Framingham) greater than or equal to 20 and more than 1 asthma exacerbation in last 12 months in those with asthma. Health

indicators include diagnosis of asthma, atrial fibrillation, cancer, coronary heart disease, chronic kidney disease, COPD, cardiovascular disease, cytology diagnoses, dementia, depression, diabetes, epilepsy, heart failure, hypertension, learning disability, mental health disorder, obesity, stroke, thyroid disease, osteoporosis, peripheral arterial disease and rheumatoid arthritis as well as receipt of palliative care. Patient activation measures (available from the patient record), polypharmacy, and receipt of palliative care were also considered. Socioeconomic and lifestyle factors included harmful alcohol /substance misuse, smoking status, being housebound, recently bereaved, being a caregiver, living alone and area depravation index (according to residence). Risk of hospital admission and the electronic frailty index are also considered separately.

A cumulative score is calculated based on the presence of indicators listed above to assign patients to one of five categories. (1) Specialist/end of life: patients receiving end of life or specialist services (cancer, advanced renal disease) and therefore likely not appropriate for case management or care planning, (2) High risk: very complex patients with comorbidities and high risk of hospital admission who may benefit from case management to coordinate their care, (3) Rising risk: patients with existing conditions who are also outliers for service use or control over their health, may be suitable for proactive care at network or practice level, (4) Stable risk: patients with existing conditions who are not outliers for service use or control of their health, likely suitable for routine management) and (5) Well: patients with no long term conditions or risks who may be most suited for transactional care. The logic for creating these groups was tested pragmatically during GP visits to test for rising risk “false positives” and “false negatives”. Feedback from stakeholders centred around outlying service use being the main indicator of rising risk. Cut offs to define outlying activity were calculated pragmatically to identify an acceptable volume of rising risk for GP’s to manage.[22]

End users and delivery of information on segmentation

A tableau dashboard is used to present information on segmentation. Users must log into a system separate from the EPR in order to view these dashboards. Clinicians, non-clinical care team members and operational leaders and researchers are all users of population segmentation information, however, clinicians are the primary users. Chronic condition dashboards as well as case management/case finding dashboards are available to physicians. The Risk Segmentation Radar displays a list of all a physician’s patients except those categorized as falling into the well group. Patients are sorted and presented according to their likelihood of experiencing hospital admission. Non-clinical team members of a primary care network can also access this information and act as coaches or practice facilitators to extract and review data with clinical teams. Operational leaders use the available population health dashboards in order to have a population level view of chronic conditions and their associated health care use, lifestyle factors and costs.

Actions that are taken as a result of segmentation

A number of different actions occur as a result of presenting information related to population segmentation in the Risk Segmentation Radar. Physicians are able to group and filter patients according to specific criteria presented in the dashboard and use supporting information to assess patients appropriateness of care. For example, a physician could review a rising risk patient who may benefit from care coordination by reviewing the reasons why patients have been flagged as rising risk from their supporting information to establish appropriateness for intervention (eg., failing a clinical marker for effective management of long-term conditions). Clinicians can also identify cohorts of patients for practice or network-based interventions such as case management for high-risk patients or proactive care for rising risk patients. They can also create watch lists to alert clinicians of particular patients whose health status may deteriorate in the near future (e.g., those who may be at high risk of an ED visit). A non-clinical team member can also prepare information from the dashboard to present at multidisciplinary team meetings to drive conversations around planning care pathways for a given patient. Operational

leaders also use the Risk Segmentation Radar for system planning purposes and to develop new clinical pathways.[22]

Equity

Stakeholders taking part in selecting factors to include in NW London's segmentation approach acknowledged that lifestyle and demographic factors such as age, gender, ethnicity, housing status and location, smoking status and alcohol consumption are important to consider alongside patients health needs. Therefore, these factors are included in the overall segmentation approach in order to ensure equity is taken into consideration.

Evaluation

Particular programs within NW London related to integrated care have been evaluated, however, the segmentation approach itself has not.

Challenges

Data quality and coding within patient records has been a barrier to effective use of the Risk Segmentation Radar. When patient factors are not accurately captured and considered in segmentation, this results in the overall approach having poor clinical face validity since it appears as though patients are missing from a particular segment that a clinician would expect to see them in. Time constraints and technical challenges have meant that utilization of the Risk Segmentation Radar is lower than expected. Since different organizations use different clinical systems the dashboard cannot be integrated within the EMR of each practice. Having the dashboard in a separate application that a clinician needs to log into is a barrier to use of these dashboards at the point of care. Determining the best approaches to care overall has also been challenging since each borough in NW London is unique with respect to the population they serve. For example, central London manages substances abuse, homelessness, accidents and injuries to a much greater extent than boroughs outside of central London with older populations with chronic conditions. This meant that when the Network came together to determine which factors to consider in population segmentation, it was difficult to reach consensus with respect to which criteria to consider.

Applying Learnings to Ontario Health Teams

Ontario Health Teams are at the very beginning of undertaking population health management. Historically, forums have not existed for health providers to work together to manage and improve health at the population level. There have been a number of programs implemented to integrate care at the level of service delivery and in some cases programs aimed to improve care coordination and integration of care for individuals with specific conditions or for individuals with high costs and care needs. These instances represent important activities that arise from effective segmentation of the population into target groups for specific interventions. However, much needs to be done to provide a comprehensive view of care needs across an entire population and for multiple providers to work together with patients, caregivers and citizens to use data to design care and implement programs to meet these heterogeneous patient needs in a systematic and coordinated way. Ontario can learn from both the successes and failures or challenges presented by each of the cases reviewed in this report.

A few essential conditions for success can be highlighted:

- To encompass the entire population, segmentation approaches must use data capturing the continuum of care settings accompanied by socioeconomic and demographic data. These must be consolidated into a single repository from which attribution to population segments with similar needs can be accomplished. This is a task that must be undertaken to include as many providers as possible from the network of providers involved in care delivery.

- Segmentation approaches that have face validity with clinicians and patients will maximize value by ensuring that the system is used in the organization and delivery of care to better meet patient needs.

- To be used at the front lines of care to ensure access of appropriate care, the information from segmentation approaches must be available at the point of care. Having a common information system (as in Denver and GK examples) enables multi-way communication amongst providers and patients including for the purpose of identifying patient needs. Having a separate system (as in NWL) severely impairs the use of segmentation approaches in usual clinical care. Instead, individual patients are discussed, and needs planned and addressed in interdisciplinary case-conferencing meetings where facilitators or coaches take on the responsibility of reviewing practice dashboards to identify at risk patients.

- A hybrid approach using data driven population segmentation and clinical judgement in referring patients to suitable programs could be useful in the context of Ontario Health Care Teams.

- Collaborative approaches can and should be used to design and make available programs that meet patient needs, but resources and programs must also be available. The potential benefits of this approach can't be realized without changes in patient care.

- Population segmentation is a tool within a number of equally important tools and strategies required to help achieve population health management.

Conclusion

Leading health systems around the world employ population segmentation in their population health management strategies. This fulfills a necessary element of population health management and the population health alliance analytical framework. Risk assessment and population segmentation can address two aims related to setting funding levels and enabling services to be appropriately directed to those with related needs. Improvements in Quadruple Aim goals are achieved by re-defining care to meet patient specific needs at an individual level and enacted throughout encounters with health providers. Goals are also achieved through identification of social determinants of health needs and population health promotion activities. There are important lessons from the examples in this report for Ontario Health Teams and abroad.

Acknowledgements

The authors are sincerely grateful for the time offered by representatives from each of the health systems who explained the approach to the use of population segmentation and their approaches to population health management. These included Oliver Groene from Gesundes Kinzigtal, Rachel Everhart from Denver Health, and Rachel McCarthy and Kavitha Saravanakumar from North West London Whole Systems Integrated Care.

Tables

Table 1. Population Health Management Approach for Case Studies

System	Setting	Population	Population Health Management Strategy
Denver Health	Integrated safety net system serving commercial and public payers System includes community health centers, 15 school-based health centers, outpatient specialty services, acute care hospital with an academic Level One Trauma Center, a 100-bed nonmedical substance abuse and detoxification facility, Denver's 911 emergency medical response system, Denver Public Health department	Nearly one third of residents in city and county of Denver Serves ~200,000 individuals annually ~65% of patients have incomes below 185 percent of the federal poverty level, 75 percent are members of racial and ethnic minority groups, and approximately 40 percent were uninsured in 2013 (prior to affordable care act)	Considers populations in need of primary care services—such as higher-risk patients and out-of-care patients—not solely those who present for care. Utilization behavior of individuals with repeated ED visits, urgent care visits, and hospitalizations suggest that these patients think of DH as their delivery system, and therefore DH should make proactive efforts to engage them in primary care
Gesundes Kinzigtal, Hamburg, State of Hessem Networks	Shared savings, universal coverage and voluntary enrollment into integrated care. Separate insurance organizations contract with the system and members of the health insurers can choose to opt into the system and retain their preferred primary care provider, they have the option to opt out at the end of each quarter Coordinates with approximately 160 partners, consisting of office based physicians, hospitals, nursing homes, home care services, and others.	Insured population of 33,000 in GK network, more metropolitan population served in Hamburg	Achieve quadruple Aim goals: improving patient experience of care, health of populations, reduce cost of health care and improve provider experience
North West London	Health and health care partnerships are a collaboration of over 30 organizations, including NHS, local authorities, voluntary sector and Healthwatch. The health care network includes 360 General Practitioner practices, 10 acute specialist hospitals, 4 community and mental health service providers. It is the largest health and care partnership in the country. Clinical Commissioning Groups responsible for planning and buying health services for area	Serves over 2.4 million people within 8 boroughs. The population is culturally and socially diverse and is one of the most multicultural areas in the capital.	Focuses on integrated care systems to improve population health and social services across entire geographies and to deliver better outcomes for people. Whole population, outcomes based approaches require an extensive understanding an application of population segmentation modeling.

Table 2. Segmentation Approach for Case Studies

System	Segmentation Approach	Data Used in Segmentation	Segment Characteristics	Management Approach for Each Segment
Denver Health	Clinically acceptable risk tiering approach 3M clinical risk groups (CRG's) to produce strata of risk, each CRG is assigned to 1 of 4 tiers Secondary tiering rules used to promote individuals to higher tier based on specific clinical characteristics	Claims data, clinical data from EMR's and survey data	Tier 1: lowest risk Tier 2 Tier 3 Tier 4: highest risk	Tier 1: Panel management, e-touch programs Tier 2: chronic disease management Tier 3: Complex case management (high risk care coordination) Tier 4: High intensity treatment clinics
Gesundes Kinzigtal, Hamburg, State of Hessem Networks	Risk stratification to identify high-risk patients, predictively monitor and plan intervention programs; prevent health deterioration and progression to new risk levels	Diagnoses, health services, prescriptions, hospital admissions and other service partners	High-risk Risking-risk progressing Insured at-risk Healthy insured before getting into risk	High: Target poly-medication issues, intensive health coaching, enrollment into programmes with health care teams Rising: Multispecialty support through disease management, earlier access to psychotherapy, training for chronic disease self-management Insured at risk: Healthy weight programme, blood pressure monitoring program, setting health goals with health worker Health Insured: Health literacy training, health promotion in schools and companies, prevention efforts
North West London	Pragmatic approach taken to define risk groups; variables for segmentation selected based on public health, clinical opinion & NHS operations	Electronic patient records from acute, primary mental health, community and social care	Specialist/end of life High Risk Rising Risk Stable Risk Well	Specialist/end of life: Already receiving appropriate care High: Case management and care planning Rising: Proactive care Stable: Routine monitoring Well: Transactional care

Table 3. Practical Application of Segmentation for Case Studies

System	End users of information	Delivery of information on segmentation	Evaluation
Denver Health	Outpatient setting, those working in high intensity clinics	Banner within EMR which is used across healthcare organization (inpatient, outpatient pharmacy)	Pediatric asthma program associated with improved health outcomes for children
Gesundes Kinzigtal, Hamburg, State of Hessem Networks	Front line clinicians and intermediate users (care program managers, analysts)	Pop up in GP's electronic medical record	Improved cost effectiveness Health related quality of self, self management Improved health outcomes in those with osteoporosis
North West London	General partitioners, non-clinical GP staff, operational leaders	Dashboard separate from EMR	Integrated care programs evaluated but not segmentation approach itself

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Appendix

List of Interview Questions for Key System Informants

1. **Who are the end users of information on population segmentation?**
   - Is the information on the risk strata an individual is in communicated to someone to plan services for the future (e.g., clinician, case manager, public health official)?

2. **How are findings from population segmentation delivered to end-users?**
   - Is information on the risk strata an individual is in delivered via electronic medical record, report, etc?

3. **After a patient has been assigned to a segment, is there a clear action (or intervention) for that particular segment?**
   - How is an individual treated differently once they are assigned to a risk strata? Are they assigned to a unique care pathway? Can you give me an example of an intervention and how it is aligned to a patient with a particular risk strata?

4. **Is health equity considered in segmentation of your population or in the management approach following segmentation?**
   - How are factors such as race, gender, education, socioeconomic status and physical environment considered?

5. **Has the segmentation approach your organization is using been validated for its particular use?**
   - Have there been improvements in health outcomes, health equity or efficiency after the segmentation tool was applied?
   - Has cost effectiveness been measured?
   - Are the right resources mapped to the right patients?

6. **What are some challenges you've encountered in the application of population segmentation in your population health management approach?**