The Vancouver Community Analytics Tool (VCAT): Software Enabling Operationalization of the Building Blocks of High-Performing Primary Care at Community Health Centers in British Columbia, Canada

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ORIGINAL RESEARCH ARTICLE

ABSTRACT

**Background:** Community health centers (CHCs) in British Columbia, Canada, are using a data-driven approach to enable functions related to the design, organization, management, delivery, and evaluation of primary health care services for complex populations.

**Methods:** Descriptive study leveraging case studies from 4 CHCs in Vancouver, Canada, to provide an overview and examples of the functions and outputs of the Vancouver Community Analytics Tool (VCAT). Quantitative data were derived from electronic medical record data and regional emergency department data. Data were analyzed and reported by the VCAT software.

**Results:** VCAT is a health system modeling, analytics, and reporting application suite that enables operationalization of the Ten Building Blocks of High-Performing Primary Care framework via 1) creation of a virtual patient record, 2) modeling and measurement of epidemiological profiles, 3) population management and quality improvement, 4) measurement and assessment of biopsychosocial complexity, 5) empanelment, and 6) design and optimization of team-based care. The software captures data on patient pathways and service operations for over 300 service sites, including community health centers, detox centers, and emergency departments. The software integrates data on service utilization and myriad other variables for over 750,000 individuals.

**Discussion:** Using case studies, the article describes how the software helps solve practical clinical, organizational, and performance issues facing CHCs.

**Conclusions:** VCAT models, analyzes, and visualizes the complexity profiles and service utilization patterns of complex populations, thereby enabling system administrators and clinicians to improve system performance and quality of care. The software represents a significant advance for health services research and is transforming the organization, delivery, and evaluation of primary health care services.

INTRODUCTION

Vancouver Coastal Health (VCH) is 1 of 6 Regional Health Authorities in British Columbia (BC), serving approximately a quarter of the province’s population. Its community health centers (CHCs) are officially mandated to provide comprehensive primary care services to vulnerable patients with complex biopsychosocial needs who lack regular access to primary care providers. These services are critical within the context of poverty and homelessness in Vancouver, which includes the Downtown Eastside (DTES) neighborhood. DTES is Canada’s lowest income postal code that is at the epicenter of the national opioid crisis.

The DTES population of 18,500 includes some of the most complex (biopsychosocially), marginalized, and vulnerable people in Canada. More than 80% of DTES residents self-identify as illicit drug users, 50% are on social assistance, 10% are homeless, and many more are housing and food insecure. An estimated 2,181 people are homeless in the City of Vancouver (with a severe overrepresentation of Indigenous people), and over 7,000 people are housed in low-income, single-room-occupancy hotels.

The complex health needs of such vulnerable and marginalized populations present daunting challenges in relation to the delivery of appropriate, effective, efficient, and equitable CHC primary health care services. This paper describes how VCH is using a data-driven approach to operationalize the “Building Blocks of High-Performing Primary Care Framework,” which provides a useful heuristic enabling a systematic approach to the ongoing design, development, and evaluation of CHC primary care services.

The health authority uses innovative software named the “Vancouver Community Analytics Tool” (VCAT). The VCAT is a health system modeling, analytics, and reporting application suite that enables critical “building block” primary care system governance (organizational and clinical) and performance functions through a series of software modules. These functions include measurement and assessment of biopsychosocial complexity, empanelment, team-based care design, workload assessment, epidemiological analytics, performance assessment, and quality of care functions.

The VCAT is a unique and novel software program that captures masses of data on patient pathways and service...
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The VCAT software is well equipped with complex and sophisticated algorithms able to model the complexities of complex populations (eg, DTES) in ways that are not available otherwise. Data visualization and reports generated by this tool have been used to allocate services effectively and to ensure the right services are offered to the right client population at the right times. The reports generated by the software are used to provide feedback to staff to improve the way they provide care to their clients and encourage standardization of data entry. This is critical to improving the quality of the community databases that are ultimately used to inform decisions.

Using real examples from the health authority’s CHCs, this article describes how VCAT’s framework and software modules operationalize each of these functions. The practicality and functionality of VCAT’s respective modules manifest a “fit for purpose” design philosophy that was developed and implemented in response to solving real-world primary care system governance and performance problems facing CHCs.

METHODS

The descriptive study leverages case studies from VCH CHCs to provide an overview and examples of the functions and outputs of VCAT software modules. These functions operationalize Bodenheimer’s “Building Blocks of High-Performing Primary Care” framework, namely the domains of empanelment, team-based care, population management, and data-driven improvement.

The study settings are 4 VCH CHCs in Vancouver, BC: 1 urban CHC (3 multidisciplinary clinical teams at Raven Song CHC Primary Care) and 3 inner-city CHCs (2 integrated care teams working at each of Downtown CHC, Pender CHC, and Heatley CHC, respectively).

Quantitative data were derived from IntraHealth Profile EMR (Intrahealth Systems Ltd, Vancouver, BC, Canada), PARIS EMR (Primary Access Regional Information System), and VCH regional ED data.

Data were analyzed and reported by the VCAT software (VCAT created by Dr. Ron Joe and Dr. Gabriela Sincraian, Dept. Medical Affairs and Strategy Deployment VCH). The VCAT Complexity Module (VCAT-CM) generated patient biopsychosocial complexity scores using the root sum of squares method. A point-biserial correlation was conducted to assess whether there was any concordance between the patient complexity scores and clinician perceptions of patient complexity.

RESULTS

This section provides an overview of the conceptual underpinning of the VCAT software (Virtual Patient Record [VPR] Viewer), followed by descriptions of the functions and outputs of its key modules related to population management and data-driven improvement (ie, Co-morbidity Matrix module, Cascades of Care module, and Complexity module), empanelment, and team-based care (Empanelment Team Target Compiler module).

VCAT Framework

The VCAT software application is based on a person-oriented framework that models the health care system as it relates to individual patients. In technical terms, the software application was created in an industry standard development environment called Microsoft Visual Studio and is based on an extensible object-oriented model written in Visual Basic (VB.NET) that represents the health care system as an abstract object model. The VCAT framework consists of:

• The Health Care System Object model (structural components)
• The Core Analytical Engine (functional components)
• The Patient Object (the principal entity and unit of analysis)

The software foundation functions by aggregating data from multiple sources (eg, hospital ED, hospital inpatient, primary care, social services, and mental health, home health, and public health databases) at the individual client level by means of a data interface adapter. Therefore, for each client a VPR is created from all available data sources, which is then processed as a single unit of analysis. The VPR is the clinical record of a real patient assembled from information systems that are used by various clinical programs that the patient is connected to. Often, these information systems lack interoperability and do not communicate with one another.

The content of the VPR models the health care system from the unique perspective of each individual patient journey through the healthcare system. It contains all the clinical elements of an electronic health record taken from all services and programs that the clients touched within their journey (services requested or referred to, appointments, clinical encounters, clinical/functional assessments, prescriptions, lab tests, clinical forms, hospitalizations, diagnostics, etc.).

A patient’s VPR can be probed using the VCAT Viewer, which provides timeline views of health services utilization (ie, encounters with types of services and clinical disciplines) by individual patients. The VCAT also enables the creation of service entities and patient cohorts, which enables
tracking over time for monitoring, evaluation, research, and predictive purposes.

There are currently about 300 Services or Teams defined, representing the majority of VCH’s community-based services. New services can be added to the service panel as needed, and cohorts of patients can be created and maintained (currently, 40 cohorts are operationalized within the VCAT). Cohorts are usually created from a collection of service entities and are easily constructed at the user interface (Figure 1). The analysis is performed client by client using a custom Core Analytical Engine purpose-built to handle large volumes of complex health care data.

The VPR, in conjunction with the Core Analytical Engine, enables the VCAT to perform complex computations and analytics functions at patient, team/service, and cohort levels using available data sources. For any analysis to occur, the Core Analytical Engine binds to an indicator or a collection of indicators to render a dashboard. The execution of the indicators, along with the choice of indicators, occurs in a user-friendly interface. Each indicator has a graphics display, which is refreshed to display the progress of the execution. The output is diverse and can produce content such as client lists, descriptive summaries, data visualization, and the rendering of performance dashboards.

Over 200 indicators have been created and are ready to use, ranging from simple age-sex plots to complex clinical quality of care indicator cascades (e.g., opioid use, hepatitis C, HIV, chronic obstructive pulmonary disease [COPD]). VCAT indicators can all be used to construct dashboards for any service entity or patient cohort. Indicators are inherent in the VCAT framework, can be created relatively easy, and are limited only by the availability of data elements (see Figure S1 in the Supplemental Material at www.thepermanentejournal.org/files/2020/20.050supp.pdf).

The VCAT can perform complex analytics functions, each operationalized via specific modules equipped with sophisticated algorithms. In the following sections, the structure, function, and outputs of the VPR viewer and key VCAT modules are described (the Comorbidity Matrix Module, the Cascade of Care Module, the Complexity Module, and Empanelment Team Target Compiler Module).

VPR Viewer

The VCAT’s VPR Viewer provides a means to view and interrogate the VPR. The VPR Viewer provides a powerful timeline view of all services accessed and clinical encounters by any specific patient (as well as cohorts of patients) over defined time periods. The VPR Viewer visualizes the complexity of health care utilization patterns of VCH’s
mandated patient population, who are transient and often receive services from a multitude of fragmented service providers. These include hospital (ED and inpatient), mental health, public health, substance use, home and community, and primary care services. Accurate data regarding the content of health care utilization patterns is critical to enable the design and evaluation of intersectoral coordination mechanisms.

Visualizations of patient encounters proved to be especially useful for primary care empanelment and development of team-based care, where it is imperative to accurately understand primary care utilization patterns, specifically in terms of 1) which clinics the patient visited and when, 2) which clinicians saw the client and when, and 3) what services other than primary care the patient is connected to (see Figures S2-S4 in the Supplemental Material at www.thepermanentejournal.org/files/2020/20.050supp.pdf).

The timeline view has found particular utility in the youth addictions continuum of care by revealing services accessed over time and whether there are any gaps in or duplication of services. Ensuring that youth in need are longitudinally connected to appropriate services is crucial because this is a population that can easily fall through the cracks in the health system, despite the best intentions of health care providers.

Marginalized patients have a hard time keeping track of medical appointments and follow-up care. There is a wide range of sites that provide care and counseling for youth, and patients often access multiple clinics and outreach services. These various clinics and services are often poorly coordinated and do not effectively communicate with one another, which makes it difficult for providers to trace a client’s journey through the health system, finding out where they have been, and determining what their next step is.

The VCAT gathers information from the various health care sites in Vancouver—from detox centers to EDs—and builds a comprehensive list of all the services and supports a person has accessed. What separates the VCAT from other software is a focus on the patient rather than specific services. The VCAT can generate a list of checkpoints that clinicians and other providers can use for better follow-up and after care. For example, a patient cannot be released before the next step on a best-practice checklist is in place, whether that be the scheduling of the next appointment or a referral to another program. The VCAT goes to the heart of
the problem of inefficiencies and care gaps by tracking all the stops along a patient’s journey throughout the health care system.

**Comorbidity Matrix Module**

The complex multimorbidity profile of VCH’s CHC patient population presents significant challenges related to the organization, management, delivery, and evaluation of primary care.\(^3,8\) A prospective study of Vancouver’s single room occupancy occupants provided an indication of this particular population’s epidemiological profile and severe multimorbidity burden: 95.2% substance use prevalence (with 61.7% injection drug use), 47.4% psychosis, 45.8% neurological disorders, 18.4% HIV-positive serology, 70.3% hepatitis C virus–positive serology, and a median of 3 multimorbid illnesses per person.\(^8\)

The VCAT’s Core Analytical Engine is able to generate disease prevalence histograms and comorbidity matrices at CHC, team, service, cohort, and clinician levels (see Figure S5a and S5b in the Supplemental Material at www.thepermanentejournal.org/files/2020/20.050supp.pdf). The comorbidity matrix provides a visual heat map of the absolute numbers and frequencies of comorbid conditions, which enable functions related to resource planning, enhancing organization, and designing quality improvement initiatives (Figure 2).

The histogram and comorbidity matrix data are mainly derived from the problem list in the VPR (diagnosis list). However, the VCAT also has algorithms that enable inferences when diagnoses were missed or not recorded properly in the problem list by making use of other clinical elements present in the client’s record (eg, positive lab results). For instance, if the diagnosis is missing from the problem list but there is a lab test, prescription, or assessment clearly indicating the presence of the disease, it can be inferred that the patient has that particular disease. This ability is entirely possible due to data linkages within VCAT and makes the rendering of the comorbidity matrix more accurate.

**VCAT Cascades of Care Module**

The Cascade of Care framework has been adapted by VCH to evaluate the population-level performance and quality of primary health care delivery for priority communicable and noncommunicable chronic diseases, such as HIV, hepatitis C, COPD, opioid use disorder, and type 2 diabetes.\(^10-12\) The Cascade of Care provides a framework...
for policymakers, administrators, and health care providers to measure primary health care performance and to identify gaps in relation to the longitudinal delivery of evidence-based care (including prevention).

The content of VCH's cascades of care are developed through consultation with VCH clinical experts, who are mandated to align with the latest scientific evidence as well as national and provincial clinical standards and guidelines. Validated cascade of care indicator content is operationalized by the VCAT-Cascade of Care Module, which enables performance assessment in relation to the delivery of evidence-based prevention, treatment, and care. Cascades of Care at program level and similar regular reporting at client level are essential for all the chronic diseases.

The VCAT has a variety of prebuilt chronic disease cascades, which have been content validated by clinicians and specialists in their field within VCH. Cascades of care are particularly useful in representing the state of each treatment step and the proportion of individuals meeting the target outcome. It may reveal potential gaps in care for potential address in team quality improvement (QI) initiatives. This section describes the content, outputs, and QI application of the VCAT's cascades of care for HIV, hepatitis C, COPD, and opioid use disorder.

HIV Cascade of Care

The BC Centre for Excellence in HIV/AIDS publishes its HIV Cascade of Care (also referred to as the HIV Care Continuum) in its Provincial Quarterly Monitoring Report. The BC Centre for Excellence in HIV/AIDS Cascade of Care reports 4 key stages (HIV-diagnosed, linked to HIV care, on antiretroviral treatment, and achieving a suppressed viral load) and highlights differences in the care continuum by geographical location, sex, age, and transmission risk groups. The cascade depicts development toward HIV prevention and care goals and identifies significant gaps in patient care.

The content of VCAT's HIV Cascade of Care was developed and validated in collaboration with clinical experts working at VCH's Downtown Community Health Centre (Figure 3). Its content aligns with the BC Centre for Excellence in HIV/AIDS framework but is adapted to the realities of the local service delivery model and patient population context.

The VCAT HIV Cascade of Care was developed and validated in collaboration with clinicians actively delivering care; therefore, it was designed to be fit for purpose in relation to enabling performance assessment and QI functions. Each clinician can obtain a list of their clients in each of the cascade columns together with the most important elements or their clinical record (e.g., date of last HIV test and the viral load value). Furthermore, clinicians can obtain lists of clients who have HIV and are not linked to HIV care, which enables clinicians to follow up with patients and ensure they are appropriately connected to care.

<table>
<thead>
<tr>
<th>Complexity domain (Q)</th>
<th>Definition</th>
</tr>
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<tbody>
<tr>
<td>Q1: Attachment</td>
<td>Clients who are unattached or poorly attached to primary care clinic(s) and/or provider(s), reflecting poor continuity of care</td>
</tr>
<tr>
<td>Q2: Service density</td>
<td>Clients attached to primary care providers but who are experiencing a period of functional instability associated with use of multiple health and social care services, coupled with access challenges</td>
</tr>
<tr>
<td>Q3: Social and environmental factors</td>
<td>Clients with multiple social and environmental barriers</td>
</tr>
<tr>
<td>Q4: Psychosocial factors</td>
<td>Clients with significant cognitive, behavioral, and/or functional impairment</td>
</tr>
<tr>
<td>Q5: Relationships</td>
<td>Inability to maintain lasting personal or professional relationships</td>
</tr>
<tr>
<td>Q6: Activities of daily living</td>
<td>Clients with marked difficulties with activities of daily living without access to appropriate supports</td>
</tr>
<tr>
<td>Q7: Medical complexity</td>
<td>Clients with multimorbidity and/or medically complex conditions (i.e., chronic diseases, concurrent disorders, and/or communicable diseases) that are untreated or uncontrolled</td>
</tr>
<tr>
<td>Q8: Acute (hospital) utilization</td>
<td>High emergency department use for issues that could be addressed in the primary care setting and/or frequent acute care admission/readmission rates</td>
</tr>
<tr>
<td>Q9: Risk of harm to self or others</td>
<td>Risk of causing harm to self and/or others</td>
</tr>
</tbody>
</table>

Figure 4. Unweighted Composite Complexity Score (CCS) for patients at Raven Song CH.
The Supplemental Material to this paper illustrates other cascades of care developed in VCAT for hepatitis C, chronic obstructive pulmonary disease, and opioid use disorder.14-20

VCAT-CM

Understanding the biopsychosocial complexity profiles of patients and patient panels is critical to enable operationalization of fundamental “Building Block” functions, such as empanelment and team-based care.1 This is particularly important within the context of clinics mandated to serve marginalized and highly complex subpopulations (ie, homelessness, poverty, mental health, substance use, and addictions).1

To date, the measurement and assessment of biopsychosocial complexity has been performed manually by health authority clinicians using a survey tool called AMPS (Attachment, Medical conditions, Psychological/mental health/addictions challenges and Socio-economic status).1 It was hypothesized that the value of the manual AMPS tool could be strengthened if its use is complemented with computer-generated, person-oriented biopsychosocial complexity profiles that are automatically synthesized in real-time from existing databases.21

The VCAT-CM software module was therefore designed to calculate and report real-time, person-oriented biopsychosocial complexity profiles by linking multiple and often disparate data sources.21 A comprehensive description of the VCAT-CM’s conceptualization, underpinning algorithm, and scoring methodology has recently been published and is accessible online.21 This article describes the practical organizational and clinical functions enabled by the VCAT-CM, specifically in relation to 1) assessing whether patients meet the CHC’s primary care mandate, 2) optimizing and balancing the patient panels of health care providers, 3) optimizing the composition and organization of multidisciplinary teams, 4) enabling recognition of client needs and the tailoring of individualized care plans, and 5) monitoring and assessment of changes in individual and population complexity profiles.21

VCAT-CM Overview

The VCAT-CM is underpinned by a conceptualization of biopsychosocial complexity as being comprised of 9 domains (“Qs”), all of which are vectors (Table 1). Arrayed in parallel, the domain vectors form a profile of biopsychosocial complexity that are scored using a Likert-type scale (0-4).21
Complexity scores are calculated for each domain ("Q-Scores") using a Likert-type scale (0–4). The data sources and elements used to derive Q-Scores as well as the Q-Score calculation methodology are comprehensively described in an article published in the Community Mental Health Journal. The domain Q-Scores are used to calculate a composite complexity score (CCS). This was done by dividing each Q-Score by 4, resulting in an adjusted probability value (ie, a p value between 0 and 1). The CCS is calculated using the square root of the sum of squares method, yielding patient CCS values ranging between 0 and 3 (with a score of 3 indicating the highest possible level of biopsychosocial complexity):

\[
\text{Composite Complexity Score (CCS)} = \sqrt{Q_1^2 + Q_2^2 + Q_3^2 + Q_4^2 + Q_5^2 + Q_6^2 + Q_7^2 + Q_8^2 + Q_9^2}
\]

It is important to note that the CCS scoring approach was designed with the aim of ensuring that results are discriminatory and sensitive to change over time, thereby providing a meaningful spread of composite complexity scores. Furthermore, the VCAT-CM was developed using a “fit for purpose” design philosophy. Therefore, it is underpinned by 2 operational principles, relating to practicality and scientific rigour:

- The VCAT-CM must optimize use of available, relevant, timely, and valid data. Therefore, the content of each of the 9 complexity domains must be comprised of discrete data elements populating existing administrative and clinical databases. Data sources that could be leveraged to score each domain must therefore be identified according to their relevance, availability, and data quality.
- VCAT-CM data elements must reflect or bear some hypothetically plausible relationship to the processes, outputs, or outcomes of care. Therefore, where possible, data elements are derived from validated assessment tools, such as the HoNOS (Health of the Nation Outcome Scales) and RAI-MDS (Resident Assessment Instrument-Minimum Data Set). Other data elements must be subject to data entry organizational standards (eg, primary care electronic medical record data), which are the focus of quality improvement efforts.
Sample VCAT-CM outputs

The VCAT-CM was used to calculate and report CCS and disaggregated complexity scores (unweighted and weighted) for patients of VCH’s Raven Song CHC. Figure 4 illustrates the CCS for patients at Raven Song CHC. The x-axis is the CCS score, and the y-axis is the number of patients. Patients with a CCS < 1 are potentially of low biopsychosocial complexity and may therefore be more appropriately served by primary care clinics in their local neighborhoods. Patients with CCS scores > 1 are potentially complex and meet the service mandate of the CHC (with patients > 2 being potentially highly complex, warranting increased attention by the CHC). Figures 5 and 6 illustrate the disaggregated unweighted Q-score distribution for patients at Raven Song CHC. The figures show the breakdown of Q-scores (0, 1, 2, 3, and 4) by each of the 9 complexity domains as well as each domain’s contribution to the total complexity score.

VCAT-CM: Enabling Empanelment

Being able to characterize the biopsychosocial profiles of individuals that are part of the population served by the Health Authority has been a long-standing, crucial, and unaddressed necessity. As described above, the VCAT-CM has the ability to generate individual complexity scores based on a formula of each person’s medical condition, health status, and psychosocial factors. This enables critical functions related to assessing whether patients meet the CHCs’ primary care service delivery mandate, and, subsequently, enabling empanelment.

For example, VCH’s CHC primary care clinicians are provided with spreadsheets containing patient information, including CCS and disaggregated (“Q”) complexity scores and are asked to validate whether their patients indeed meet VCH’s primary care mandate:

A point-biserial correlation was run to determine the relationship between CCS and clinician perceived mandate status (n = 1865 patients). There was a positive correlation between CCS score and clinician-perceived mandate status that was statistically significant (r = 0.466, n = 1865, p = 0.01). The statistical analysis showed that there is virtually no significant overlap between the 2 groups (mandate and nonmandate), with a clear cutoff of CCS = 1.0 for mandate clients.

Patients deemed by clinicians to not meet VCH’s primary care complexity mandate are notified that their respective medical needs do not require the services of the CHC and are offered assistance in relation to finding an appropriate
primary care provider in their local community (eg, through patient attachment initiatives of local Divisions of Family Practice).

Enabling Team-Based Care and Balancing Caseloads: The VCAT Empanelment Team Target Compiler

It is critical to fairly and optimally balance the caseloads of multidisciplinary health care teams within and across VCH’s different CHC sites. The VCAT Empanelment Team Target Compiler (VCAT-ETTC) uses VCAT-CM complexity scores to create balanced caseloads for 6 Integrated Primary Care Teams across 3 CHCs (2 teams per site) in Vancouver’s DTES, with each team being assigned a balanced panel size of 775 patients (Figure 7). The compiler takes the source teams as input and produces the target teams (99% accuracy) as output in a completely automated way.

This was performed as part of VCH’s DTES service redesign work over a 5-month period in January 2018. A new model of care for clients that includes Integrated Care Teams with balanced caseloads provide residents of the DTES better access to coordinated, consistent health care. The model brings together existing programs and services, so clients get the care they need at 1 location. Primary care, mental health and substance use services, harm reduction, and specialized care are all available at 1 site. The 6 Integrated Care Teams support the new structure and provide clinic and outreach services at 3 DTES CHCs (Heatley, Pender, and Downtown CHCs).

The VCAT module was also used in the DTES redesign work to view the chronic disease prevalence case-mix distribution across the 6 Integrated Care Teams, which is important to ensure that teams are comprised of appropriate professional disciplines (see Figure S12 in the Supplemental Material at www.thepерmanentеjournal.org/files/2020/20.050supp.pdf).

Team Panel Analysis

The VCAT-ETTC was also used to generate balanced multidisciplinary team panels at the Raven Song CHC. The Primary Care Program at Raven Song CHC changed its model of care by going from a large multidisciplinary team caring for thousands of clients to a model based on 3 smaller team “pods,” with each pod comprised of physicians, nurse practitioners, and registered nurses. Physicians and nurse practitioners are “most responsible providers,” and each has a defined panel of clients.

The VCAT-ETTC was used to generate team panel analyses at Raven Song CHC (Figure 8). The panel generated for each most responsible provider shows the complexity scores (by 3 categories of scores ranging from 0 to 1, from 1 to 2, and 2+), as well as the number of clients per panel, adjusted by full time equivalency and the panel’s average complexity score.

Figure 8 shows the state at 2 points in time (as of January 2019 and as of January 2020) and indicates that panels were not well balanced in terms of client complexity as of January 2019. The team at Raven Song chose the ideal panel as the MD1 (i.e. Physician #1) panel, with more than 90% of the clients having a complexity score above 1 and approximately 45% of the clients having a complexity score of 2+. All the other panels had to be adjusted in order to resemble this ideal panel as much as possible. The complexity scores for each pod were continuously monitored (on a quarterly basis) to ensure the creation of teams based on an equitable case mix.

The situation in January 2020 is much closer to the desired one because most of the clinicians have panels with a client composition close to the chosen ideal one: all clients in the panels have been reviewed, and a certain number were discharged or transitioned to lower-intensity care settings.

Further description of VCAT’s functionalities enabling optimization of shared care and team-based task reallocation can be found in Supplemental Figures S13 and S14 at www.thepermanentejournal.org/files/2020/20.050supp.pdf.

DISCUSSION

The Canadian health care system is beset with uncoordinated service delivery and often functions in disconnected silos. Positively, the need for comprehensive solutions is gaining wider recognition. There is emerging policy and academic focus in BC and across Canada on the need for integrated, patient-centered primary health care to address chronically unmet needs and suffering in our cities. The system is stretched thin to cope with ED visits and hospitals stays that could be avoided through a stronger network of community-based primary health care services with the capacity to meet demand.

In Vancouver’s DTES, threats to health and well-being persist despite years of considerable investment in health care and social services. The Downtown Eastside 2nd Generation Strategy was developed by VCH to redesign the service delivery model, which has been in place since the public health crisis of the 1990s. There is a need for a primary health care system that is responsive to current predominant chronic health conditions. The strategy promotes operational excellence and synergistic partnerships “to support the evolution of local health services towards the provision of cost-effective, evidence-based care within a cohesive network of community based services.” The goal of the VCAT project is to support primary health care transformation in Vancouver through technological innovation.

Health care systems are among the largest producers of data; yet, compared with other industries, they invest
relatively little in harnessing the power in data to improve performance. System transformation is by definition a highly complex undertaking, and it is imperative that the best possible evidence informs that process. The VCAT project will use health informatics to gain insight from administrative and patient data to support system transformation and help achieve better health in our communities. The VCAT will help develop a decision-support platform to assist VCH clinicians, managers, operations directors, and policy makers in improving the health care system.

VCAT data will be used to generate real-time evidence to support short-term decision-making and medium-to-long-term planning of services for BC’s team-based Primary Care Networks. This will support the design and implementation of management strategies and enable the identification of targeted, high-value interventions. It will help generate evidence for the best health care for patients through the optimal allocation of resources and coordination across multiple service sites. Patient data will be integrated with operational analytics and simulation modeling in the development and management of team-based primary care services. The VCAT will be part of a comprehensive data-analytic decision support platform that aims to transform primary health care services for marginalized people in urban environments.

Conclusions

The VCAT represents a significant advance for the fields of health services research and primary care performance assessment. It is a powerful tool that enables the scientific operationalization of the “Building Blocks of High-Performing Primary Care” framework. It is a disruptive technology that has already begun to transform the design, organization, management, delivery, and evaluation of primary health care services for marginalized people in urban environments.

In particular, being able to model and characterize the biopsychosocial complexity of individuals who are part of the population served by the Health Authority has been a long-standing, crucial, and unaddressed necessity in health care. The VCAT complexity module has the ability to generate individual complexity scores based on a formula of each person’s medical condition, health status, and psychosocial factors. This enables tailoring care based on individual needs and also helps in assessing groups of individuals who meet the mandate of the CHCs. The VCAT makes information accessible to administrators and providers who have not...
Figure 8. VCAT team panel analysis.
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seen accurate data on their client population previously. They can now visualize and understand what gaps in care exist and assess utilization patterns and clinic capacity issues.

Thus far, the VCAT has been designed to model the Canadian health care system and was specifically developed for the province of British Columbia; however, the modularized software is flexible enough to be easily adapted to any national or international jurisdiction. The VCAT is able to perform well in any healthcare context because its patient-centered design and underpinning philosophy is to “follow the client journey,” with the patient being the fundamental unit of analysis. By modeling, analyzing, and visualizing the complexity profiles and service utilization patterns of patient populations, the VCAT enables system administrators and clinicians to meaningfully improve system performance and quality of care. The VCAT is being developed using an open-source software approach to encourage uptake of the tool in all jurisdictions interested in leveraging its person-oriented modeling, analytics, and reporting capabilities.

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Authors’ Contributions
The chapter was jointly conceived and drafted by the authors. The VCAT software suite was conceived, developed, and operationalized by R Joe and G Sincairan; A Shukor enabled operationalization of the VCAT at VCH’s Regional Primary Care Program level and contributed to the VCAT’s ongoing development through conceptual work, stakeholder engagement, and the design of validation studies.

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Abbreviations

- BOOST = Best Practices in Oral Opioid Agonist Therapy
- COPD = Chronic Obstructive Pulmonary Disease
- CHC = Community Health Centre
- VCAT-CM = Complexity Module
- CCS = Composite Complexity Score
- DTES = Downtown Eastside
- ED = Emergency Department
- OUD = Opioid Use Disorder
- VCH = Vancouver Coastal Health
- VCAT = Vancouver Community Analytics Tool
- VCAT-ETTC = VCAT Enamelpoint Team Target Compiler
- VPR = Virtual Patient Record

How to Cite this Article

References


