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The Spoke-Hub-and-Node model of integrated heart failure care

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BRIEF SUMMARY

Heart failure (HF) is a significant public health concern. HF clinics provide the optimal environment to address the needs of these patients and improve outcomes. The growing population of HF patients outstrip the ability of these clinics to deliver care. The spoke-hub-and-node model represents an organization of care working collaboratively with the primary care sector and is highly integrated with community-based multidisciplinary teams of health care professionals and specialty care.

Abstract

Heart failure (HF) is a significant public health concern. Specialized HF clinics provide the optimal environment to address the complex needs of these patients and improve outcomes. The current and growing population of HF patients outstrip the ability of these clinics to deliver care. Integrated care is defined as health services that are managed and delivered so that people receive a seamless continuum of health promotion, disease prevention, diagnosis, treatment, disease-management, rehabilitation and palliative care services. This approach requires coordination across different levels and sites of care within and beyond the health sector, according to changing patient needs throughout their life. The spoke-hub-and-node (SHN) model represents an organization of care that works collaboratively with the primary care sector and is highly integrated with community-based multidisciplinary teams of health care professionals and specialty care. The purpose of the present paper is to analyze the requirements for successful implementation of SHN models. We consider the respective roles of HF Clinics, HF nurse specialists, pharmacists, palliative care teams, telemonitoring, and solo practitioners. We also discuss levels of care delivery and the importance of patient stratification and patient flow. The SHN approach has the potential to build on and improve the chronic care model (CCM) to deliver centralized services to preserve quality, patient-centered care at an affordable cost.

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INTRODUCTION

Heart failure (HF) is a significant public health concern affecting more than 500,000 Canadians. HF cases have increased 13% from 2010 to 2016, with a continued expected rise, greatly due to the aging population^{1,2} HF prevalence is approximately 3.5%, increasing with age to about 23% for those over age 85.¹ Annual mortality is approximately 12% overall, approaching 25% among those over age 85.¹ There are over 75,000 new cases each year and over 60,000 patients die each year¹. Despite present management 50% of patients die within five years of diagnosis.³⁻⁵

HF represents the second leading cause of hospital admissions for Canadians over the age of 65, and the fifth cause of medical admissions.⁶ Compared to admissions for other medical conditions, HF patients have more comorbidities (3.9 versus 2.3), in hospital mortality (13.3% versus 4.4%) and longer length of stay (12 days versus 6.4 days).⁷ Following discharge these patients experience a 30-day mortality rate of 16% and 1-year mortality rate of 25%.⁸

Approximately 25-50% of patients return to hospital within 30-days of discharge.⁹ HF re-hospitalizations strongly predict poor outcomes.¹⁰ As a result the costs are more than 2.8 billion dollars annually, or around 1% of Canada's GDP.^{9,11,12} System planning for HF management must consider patient complexity and increasing prevalence. This review examines the concept of chronic disease management (CDM), the effect of HF management programs and a systems approach to HF.

INTEGRATED CARE IN HF

HF is a complex chronic condition requiring system integration. Integrated care is defined as health services that are managed and delivered so that people receive a seamless continuum of health promotion, disease prevention, diagnosis, treatment, disease-management, rehabilitation and palliative care services. These are coordinated across different levels and sites of care within and beyond the health sector and according to their needs throughout the life course.^{13,14} Integrated care is demonstrated by two principle characteristics. First is the requirement to bring together key aspects in the design and delivery of fragmented systems. Second, there must be care delivered to those in need. The Chronic Care Model (CCM) is consistent with the integrated care concept.¹⁵ The Canadian Heart Health Strategy Action Committee recommended the CCM for cardiovascular disease.¹⁶ The CCM elements include healthcare organization, community resources, self-management support, delivery system design, decision support and clinical information systems.^{17,18} The CCM strength is patient-centered care incorporating timely access and a strategy for self-care management, leading to improved outcomes including improved quality of life (QOL).¹⁹⁻²¹ There are various independent, integrated care models aiming to achieve these goals, including Canadian examples.²¹⁻²⁹ The Alberta Cardiac Access initiative improved collaborative care through expansion of Heart Failure Clinics (HFC) and training primary care physicians (PCP), pharmacists and nurses resulting in improved post-discharge 30-day mortality and readmissions.³⁰

British Columbia Cardiac Services also developed an integrative system based on the “hub and spoke” model to create collaboration with regional teams.³¹ Thus, with respect to HF care in Canada, the status quo is unsustainable and system redesign is required. The CCS HF guidelines identify the features of an integrated health care system (Table 1) supporting a spoke-hub-and-node (SHN) model.³²

SPOKE-HUB-AND-NODE (SHN) MODEL OF CARE

A SHN model has been promoted as a possible solution encompassing evidence-based recommendations for integrated care.^{2,3} This represents a systems approach to care guided by patient risk and complexity, including beneficial HF management components, with healthcare professionals working collaboratively for optimal management.^{33,34}

Heart Failure Clinic

Studies demonstrate HFCs improve outcomes including mortality, hospital readmissions, prescribing patterns, QOL and system costs.^{18,19,23,26,33,34} The Canadian, American and European HF Guidelines all recommend multidisciplinary HFCs.^{32,38,39} Recently a review confirmed a lower incidence of HF hospitalizations and all-cause mortality associated with specialized HFCs.³⁵ However, only patients with a minimum of 3 months follow-up benefit (OR 0.52; P=0.0009), while those followed less than 3 months do not (OR 0.91; P=0.70). Patients with recent hospitalization benefited (OR 0.51; P=0.0001), those without did not (OR 0.95; P=0.70). This suggests more prolonged follow-up is required, as well as the need to target higher risk, recently hospitalized patients for HFCs. Sochalski et al., reanalyzed data from 10 trials of HF case management programs assessing if delivery methods influence program effectiveness.²⁸ They found a multidisciplinary team more effective than a program with a single HF expert. Meeting with the patient in-person was more effective than telephone communication. A combination of a multidisciplinary team and in-person communication was most effective to reduce readmissions. Although HFCs are effective the number of clinics in any geographical area is limited.^{2,35} Currently, most HF patients are cared for by PCPs and generalists. In part, the limited number of clinics is due to lack of designated government funding. However, variable clinic structures pose difficulties for developing an appropriate funding model.^{2,35} A consistent funding structure is required.

HF Nurse Specialist

Nurses play a valuable role in the CCM. A meta-analysis of HFC RCTs suggested clinics have a key role for specialist nurses.²⁶ Two studies demonstrated nurse practitioner (NP) led clinics decrease HF and all-cause admissions, are cost effective, improve patient satisfaction, and lower one-year mortality.^{36,37} NPs managing HF independently as primary care providers is one way to deal with the shortage of PCPs and increasing burden of patients.⁴⁰ For

younger (mean age 79.82 ± 7.39 vs. 81.56 ± 7.34) patients with fewer comorbidities, they demonstrated similar safety data for emergency room visits and increased likelihood of achieving guideline-recommended medications compared to PCPs.³⁸ Specialized HF nurse involvement reduces hospital readmission rates versus generic nurses (30% vs 13%).⁴⁴ A meta-analysis further emphasizes nursing involvement for HF management.³⁹ Nurse home visits (RR 0.78; 95% CI 0.62-0.98) and disease management clinics (RR 0.80; 95% CI 0.67-0.97) resulted in reductions of all-cause mortality. All-cause readmissions were reduced by nurse home visits (incident rate ratio 0.65; 95% CI 0.49-0.86), nurse case management (incident rate ratio 0.77; 95% CI 0.63-0.95) and disease management clinics (incident rate ratio 0.80; 95% CI 0.66-0.97).

Pharmacist Support

Meta-analyses demonstrated pharmacists have a beneficial role for inpatient and outpatient HF management.⁴⁰⁻⁴³ Roles include patient education, resource within the HF team and collaborative medication management.⁴¹ A review showed pharmacist intervention decreased all-cause hospitalization (OR 0.74; 95% CI 0.58-0.94).⁴² There was a higher prescription rate of ACE inhibitor (OR 1.43; 95% CI 1.07 to 1.91) and beta-blocker (OR 1.92; 95% CI 1.24 to 2.96) in the intervention group.⁴⁰ Another review demonstrated reduction of HF hospitalizations (OR, 0.69; 95% CI, 0.51-0.94); pharmacist collaborative care reduced HF hospitalizations (OR, 0.42; 95%CI, 0.24-0.74) more than pharmacist-directed care (OR, 0.89; 95% CI, 0.68-1.17).⁴⁴ With the recent USA FDA approval of a drug with a digital ingestion tracking system, the pharmacist role could expand in the future.

Palliative Care Support

Despite the variable illness trajectory and uncertain prognosis of HF patients, much is to be gained from early inclusion of palliative specialists. Provision of palliative services should be based on assessment of need and symptom management rather than focusing on an individual's life expectancy.¹⁸ Accumulating evidence demonstrates palliative care should be delivered in an integrated manner.^{18,45-48} According to a recent review palliative care should add value through expert symptom management, facilitation of advance care planning, optimizing transitions and end-of-life care.⁴⁷ Studies demonstrate improvement in QOL, symptom management and reduction in use of medical services.^{53,54,56,57} A review demonstrated reduction in hospital visits, overall admissions and length of stay.⁴⁸ A meta-analysis of home-based palliative care found it lowered the risk of rehospitalization (RR 0.58; 95% CI 0.44, 0.77).⁴⁸ The Palliative Care in Heart Failure (PAL-HF) study examined a longitudinal palliative care interdisciplinary intervention in advanced HF patients.⁴⁶ Programs were delivered by specialty nurses and improvements in QOL were observed over a six-month period. No differences were observed between the intervention group and usual care group for hospitalizations or mortality.⁴⁶

Role of Telemonitoring

There is inconsistent evidence regarding the benefit of telemonitoring and telehealth in the HF population. Some of the difficulty in comparison comes from heterogeneous models without detailed descriptions, varying levels of clinical support and differences in response to monitored parameters. Meta-analyses tend to show reductions in hospitalizations, mortality and economic benefit but have been criticized for including single-center, non-randomized and predominantly positive studies.^{49,50} Three of the largest multi-center RCTs did not show clinical benefit.^{51–53} Telehealth trials seem to show greater benefit when the usual care arm is suboptimal. Consistently in those trials showing benefit, patients in the telemonitoring arm were on higher doses of disease-modifying agents.⁵⁰ Many reviews acknowledge the confusion surrounding the role of telehealth in HF, however multiple ongoing studies will better define the role of this technology.^{49,54}

Role of Solo Practitioners

PCPs and specialists play important roles in HF management. Patients with a cardiologist involved in their care experience improved outcomes in acute and outpatient settings.^{26,55,56} Boom et al., demonstrated patients hospitalized with HF cared for solely by a generalist were at increased risk of 30-day mortality (OR 1.50; 95% CI 1.18–1.91).⁵⁷ In the outpatient setting, it has been demonstrated combined PCP and specialist care results in lower one year mortality compared to PCP care alone.^{20,41} Collaborative care increases use of drug therapies and cardiovascular tests.⁵⁸ Continuity of care is an important issue to recognize when considering care delivery, as we know providing follow-up soon after hospital discharge, with a familiar physician, portends better patient outcomes.⁵⁹ Furthermore, sole cardiology care confers a trend to increased mortality compared to collaborative care (HR 1.41; 95% CI 0.98-2.03; P=0.067), emphasizing the role of collaborative care.⁴¹ Given these data, collaborative care in HF is the current standard for achieving best patient outcomes.

Levels of Care Delivery

At present, management strategies essentially work in isolation. The SHN model organizes care along a continuum where patients are triaged, among three levels of care, based on complexity and risk at any given time.

Low risk or complexity patients can be cared for in a spoke, close to home, generally by PCPs. These patients will have well-controlled risk factors or fully diagnosed causes of HF and require medication optimization. It must be recognized that HF patients are never completely stable, so ongoing monitoring and care are essential in the spoke to detect early findings of decompensation. There should be patient and caregiver education with regular follow-up as required.

Intermediate risk or complexity patients require more complex care provided by a hub. A specialist (an internist, cardiologist or in some cases a PCP with HF training) in a multidisciplinary team within a community clinic or hospital would provide care. This level of care may often be delivered close to the patient's home. Patients will generally require stabilization and investigations for

reversible causes of HF. Appropriate management at this level includes review of available evidence-based therapies, medication optimization and ongoing patient and caregiver education.

High risk or complex patients require the most complex care delivered in a node. The node provides specialized multidisciplinary programs to stabilize and support patients. HF physicians would have access to the full range of cardiac diagnostics and therapeutics, utilizing these to pursue sophisticated diagnostic modalities, implement complex medication regimens including device implementation.² The strengths of this system would be established communication among the three levels with shared electronic medical records and providing optimal care as close as possible to the patient's home.

Patient Stratification

The intensity of patient care will fluctuate over time based on changing complexity and risk. Inherent in the system is a pre-arranged set of criteria for referral and risk stratification. Initial assessment and continued reassessment of longer term prognosis and risk, should be assessed using standardized risk scores for mortality such as those suggested in the 2017 CCS HF guidelines.³² Risk stratification, including frailty, should be the basis of reallocation between levels. Using assessments such as New York Heart Association (NYHA) functional classification, could serve to assess patient symptom severity and eligibility for care at each level. For example, patients with NYHA class I-II symptoms could be managed at a spoke, NYHA class II-III at a hub, and NYHA class III-IV at a node. NYHA classification is often used in this capacity and has been shown to be a valid measure of functional status and important in prognosticating HF.⁶⁰ Despite this, there are questions regarding its reproducibility as there is no consistent method of assessment and there is difficulty distinguishing NYHA class II and III symptoms objectively.⁶⁰⁻⁶³ Concerns regarding NYHA class assessment in the elderly population stems from the inability to characterize co-morbid cardiac and non-cardiac conditions which may contribute to frailty and complexity of patients. Given the increasing prevalence of elderly HF patients this is an issue which warrants special consideration. The international Resident Assessment Instrument (interRAI) assessment system was developed by a large, multinational network of researchers to specifically address the care of complex and frail seniors. Within interRAI systems, the Changes in Health, End-stage disease, Signs and Symptoms (CHESS) scale was developed and has well-established reliability and validity.⁶⁴ It takes into consideration six items including weight gain, dietary intake, dyspnea, change in cognition, unstable patterns of cognition, function or behavior. When combined with determination of need for assistance when ambulating, these items have been shown to be a more powerful prognostic indicator than NYHA class in elderly HF patients.⁶² InterRAI assessment systems are mandated in home and long-term care across most of Canada. Since HF patients with concomitant co-morbidities are at increased risk of poor outcomes this is an important system to consider when stratifying patients.⁶⁵ HF patients are more likely to be diagnosed as frail, which has impacts on healthcare utilization and should inform ongoing

discussions regarding patient goals of care and facilitate appropriate risk stratification.⁶⁵

Patient Flow

In chronic diseases, generally 70-80% of patients can be managed in low acuity settings.⁶⁶ HFCs in a primary care setting, with appropriate training and support, can manage the majority of low acuity patients with a less intense program for ongoing monitoring, with an aim to accommodate the needs of the growing population.^{3,27,28,33} This would also allow for continuity of care, at a vulnerable period of transition.⁶⁷ A patient may have NYHA class II symptoms and be started on medication in the community where their chronic needs are managed in the spoke with availability for support and consultation from the hub for medication optimization and possibly the node for more sophisticated diagnostic testing. At some point in time, they may destabilize during an acute HF exacerbation requiring immediate care in the hub due to proximity and increased acuity; with transfer to the node, as required, for more advanced cardiac management. The same process could happen in reverse upon discharge, where the patient may initially require frequent visits for management in the hub, but when stabilized may access the spoke. This is important because the patient's home environment provides a sense of community that facilitates re-enablement after hospital discharge.⁶⁸ Utilization of this model would shift care to the community, minimizing acute care bed usage and cost to the system while maintaining optimal care.⁶⁹⁻⁷¹

Implementation

This proposed system allows shared patient care among healthcare providers within the SHN network, ensuring timely access depending on the patient's needs and preferences. This may involve direct patient care or accessible consultation and/or capacity building provided by the team at the node. Actualization of this model would necessitate the development of trained professionals, likely in primary care settings, to support spoke and hub care. This would adapt current care settings, where PCPs and generalists follow most patients, to work within the model for ongoing continuity of care. Adaptations from other functioning clinic models of multidisciplinary care, such as the memory clinic model, offer suggestions regarding capacity building in primary care.⁷² The memory clinic team typically consists of a PCP, 2-3 nurses and a social worker. A geriatric specialist is linked to each clinic and provides consultation support. Team members use standard assessments to determine patient and caregiver needs and work collaboratively to optimize medication and disease specific issues.⁷³ This initiative, shows high levels of patient and caregiver satisfaction, high-quality care and decreased need for direct specialist consultation.⁷²⁻⁷⁶ Education, ongoing support and opportunity for professionals to maintain competencies through professional development are required. Building this relationship will establish close working connections and opportunities to develop trust, which is necessary to enact system change.^{37,77}

Implementation of a SHN model of care will take several system, program and provider level initiatives (and full discussion is beyond the scope of this paper). For example, system redesign requires capacity planning that identifies opportunities to make better use of current healthcare resources through realignment and reallocation, while recognizing that new services and system policies also will be required. We know that delivery of care for HF in a HFC would optimize outcomes for high risk patients. We have also acknowledged the limitations to this model including distribution, healthcare provision and access to appropriate care personnel. Taking healthcare out of the current brick-and-mortar structures we are accustomed to, may help us to bridge some of these barriers. In a meta-analysis by McAlister et al. looking at HFCs, a secondary analysis showed no difference between clinic and home-based programs in reducing mortality and hospitalizations.²¹ This is consistent with a number of reviews that have echoed these results.⁷⁸ Nurse home visits were also shown in a recent systematic review and network meta-analysis to decrease all-cause mortality and all-cause readmissions.³⁹ Examining the Geriatric Assessment for Acute Care of Elders (ACE) model, we can start to extrapolate from RCT data, that a model of integrated and home-based care is plausibly accomplished providing excellent patient care and changing system utilization.⁷⁹ Telemonitoring (discussed above) may also find its niche in assisting to develop integrated care delivery systems as it appears to have benefit when used in these environments. Funding models for health care provider remuneration have been identified as ongoing barriers to integrative care.^{72,80} Organizing care around a patient's primary medical condition and providing bundled funding rather than fee-for-service models may encourage collaboration across care environments and within multidisciplinary teams.⁸⁰ It is important to evaluate variability and share learnings among systems to improve care. The difficulty lies in obtaining data across the various jurisdictions in Canada.^{23,24,30,31,33,68,81-83} In fact only the 30-day hospital readmission HF quality indicator can be measured across Canada, emphasizing need for standardized evaluation of care.⁸⁴ System capacity planning for HF will require accurate data, complex analytics and modeling, jurisdictional scans, and extensive stakeholder consultation to ensure that appropriate structures, processes, and resources are in place to meet regional and provincial needs.

SUMMARY

As the baby boomer generation ages, seniors will account for an increasingly larger percentage of the population in Canada. This reality is the primary driver for the growing HF population and the increased demands on the healthcare system.

The substantial burden demands a systems approach for organizing HF care that includes key principles of the CCM, encourages a multidisciplinary team approach, and integrates care between primary and specialty care services. The SHN model aims to improve outpatient HF care through its foundation in proven concepts of integrated care while accounting for the unpredictable trajectory of the illness. This model, which has been used successfully in other chronic diseases such as renal disease in Ontario, has the potential to unify regional HF care across the country. This would eliminate the need for isolated initiatives of CCM and centralize services in the hopes of preserving quality, patient-centered care at an affordable cost to the Canadian public.

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Table 1: Necessary features of successful health system integration.

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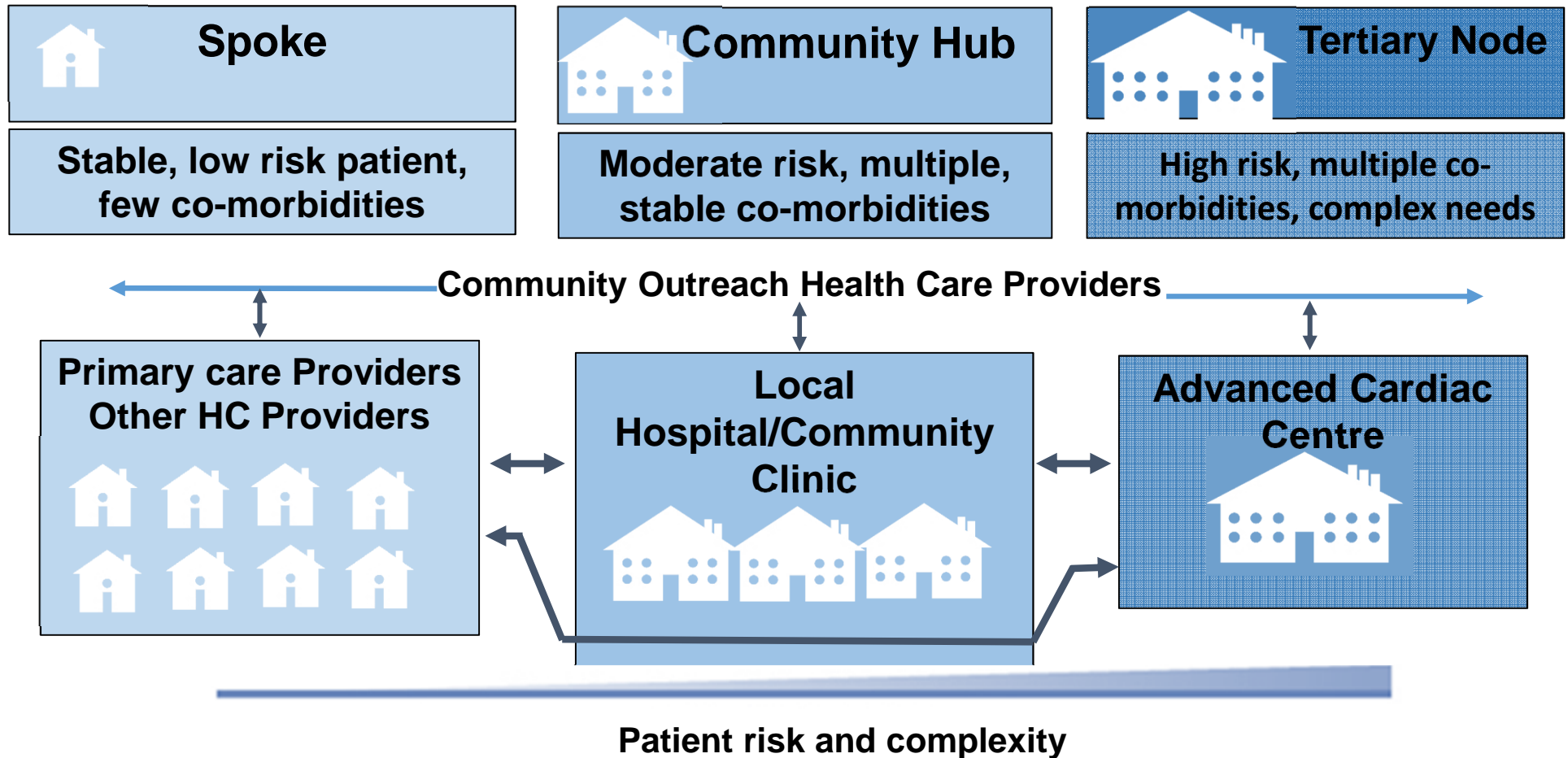
Feature	Description
Program integration and care coordination	<p>Shared and standardized information system accessible from any point in the care network</p> <p>Shared care plan with clearly defined patient-centred goals of care, and mutually understood and agreed-upon provider (formal and informal) responsibilities</p> <p>An organizational framework clearly specifying the linkages between constituents of the care network and community-based services</p> <p>Clearly defined protocols to facilitate seamless transitions and navigation for patients and providers between levels and sites of care, and are anchored in primary care</p>
Human resource elements	<p>In addition to clinical staff, additional resources should include</p> <ul style="list-style-type: none"> • Program to support coordination, commensurate with its size and scope;

	<ul style="list-style-type: none"> • Access to continuing medical education to support knowledge translation
Access to care	<p>Standardized risk stratification criteria to ensure timely referral and access to appropriate care;</p> <p>Access to other services:</p> <ul style="list-style-type: none"> • Specialists: cardiology, geriatrics, psychiatry, internal medicine, rehabilitation; • Palliative care, spiritual care; and • Home care and community support services
Quality improvement and outcome measurement	<p>Measurement and submission of mandated quality measures to appropriate authority;</p> <p>Measurement of Quality Indicators, as defined according to the Canadian Cardiovascular Society Quality Indicators Working Group for Heart Failure</p> <p>(http://ccs.ca/images/Health_Policy/Quality-Project/Definition_HF.pdf)</p>

FIGURE LEGEND

Figure 1: Conceptual design of the spoke-hub-and-node model of integrated heart failure care.

ACCEPTED MANUSCRIPT



Two way **communication** between Levels of care: Face-to-face visits, phone, e-consult