


RESEARCH REPORT

Using the consolidated framework for implementation research (CFIR) to guide implementation of cardio-oncology services

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Abstract

Introduction: Cardio-oncology focuses on diagnosing and preventing adverse cardiovascular outcomes in cancer patients. Interdisciplinary cardio-oncology services address the spectrum of prevention, detection, monitoring, and treatment of cancer patients at risk of cardio-toxicity and aim to improve the continuum of cardiac care for oncology patients. The goal of this study was to engage clinician and administrative stakeholders to assess multilevel needs, barriers, and expectations regarding cardio oncology services.

Methods: We interviewed clinicians and administrators at an academic medical center using the Consolidated Framework for Implementation Research (CFIR) to understand multilevel determinants influencing cardio-oncology service implementation. We also conducted a web-based survey to assess the knowledge, attitude, and perceptions of cardio-oncology services held by local and regional clinicians who may refer cardio-oncology patients to the study site.

Results: Multiple facilitators to cardio-oncology service implementation emerged. Interview participants believed cardio-oncology services could benefit patients and the organization by providing a competitive advantage. A majority (74%) of clinicians surveyed thought a cardio-oncology service would significantly improve cancer patients' prognoses. Implementation barriers discussed included costs and a siloed organizational structure that complicated cross-service collaboration. In the clinician survey, differences in the views toward cardio-oncology services held by cardiology versus oncology providers would need to be negotiated in future cardio-oncology service development. For example, while most providers accepted similar risk of cardio-toxicity when consenting patients for cancer therapy in a curative setting, cardiologists accepted significantly higher levels of risk than oncologists in an incurable setting: 75% of oncologists accepted 1-5% risk; 77% of cardiologists accepted $\geq 5\%$ risk).

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Conclusions: Participants supported implementation and development of cardio-oncology services. Respondents also noted multi-level barriers that could be addressed to maximize the potential for success. Engaging administrators and clinicians from cardiology and oncology disciplines in the future development of such services can help ensure maximal relevance and uptake.

KEYWORDS

cancer, cardio-oncology, cardiovascular disease, implementation science, survivorship

1 | INTRODUCTION

Due to improved diagnostic testing and treatment, the number of cancer survivors in the United States had reached nearly 16.9 million by 2019 and is expected to increase to 22.2 million by 2030.^{1,2} With longer survival, managing adverse effects of treatment and promoting healthy lifestyles is increasingly important. Unfortunately, cardiovascular diseases (CVDs) such as cardiomyopathy, heart failure, coronary artery disease, thrombosis, and hypertension can manifest during or after therapy due to cancer treatment-related toxicities. Compared with the general population, adult lymphoma, and breast cancer survivors have a higher risk of CVD^{3,4} and epidemiologic data suggest that common CV risk factors are more strongly associated with CVD risk in cancer survivors compared with noncancer controls.⁴⁻⁹ CV toxicities from chemotherapy, immunotherapy, radiation, and targeted or hormonal therapies can interfere with optimal cancer management; and CVD represents a leading cause of morbidity and mortality in cancer survivors^{10,11} and is among the leading causes of death in older (≥ 66 years old) breast and colorectal (>60 years old) cancer survivors 10 years after cancer diagnosis.^{8,12} Consequently, understanding how to improve the prevention, recognition, and treatment of CVD is a priority for the health of cancer survivors.^{13,14}

1.1 | Questions of interest

As evidence grows regarding the specific agents and circumstances that increase the risk of adverse cardiac events in cancer survivors, the field of cardio-oncology has also advanced, aiming to address the spectrum of prevention, detection, monitoring, and treatment of cancer patients at risk of cardio-toxicity and to improve cancer patient care, well-being, and long-term outcomes.¹⁵⁻²⁰ A well-designed cardio-oncology program typically consists of several key components designed to provide specialized care for cancer patients at risk of or experiencing cardiovascular complications due to cancer treatment. These components may vary from one program to another, but typically include interdisciplinary team, cardiovascular risk assessment and stratification, preventive strategies (eg treatment plan adjustment), monitoring and surveillance, management of cardiovascular complications, personalized care plan, and education and support. These services require sophisticated, cross-disciplinary collaboration and organization to address the complex clinical problems of the growing population with

these conditions. Such collaborations may be helped or hindered by multilevel determinants, such as organizational characteristics; leadership perspectives; and individual-level attitudes, opinions toward and knowledge of cardio-oncology services and patient risk factors.

The field of implementation science provides tools and frameworks for identifying barriers and facilitators to implementing cardio-oncology services. Using the consolidated framework for implementation research (CFIR),²¹ the present study aimed to engage an urban, safety-net, National Cancer Institute-designated academic medical center (AMC) to assess multilevel needs, barriers, and facilitators to cardio-oncology service implementation.

2 | METHODS

2.1 | CFIR framework

We used CFIR²¹—a multilevel, planning framework commonly used to guide the design and evaluation of strategies employed for the implementation of interventions or innovations—to guide our data collection and analysis (Figure 1). One study focal construct, knowledge, and beliefs under the individual characteristics domain, was assessed by survey as there was no more suitable approach to collect this specific data, while other focal constructs were assessed through qualitative interviews. A completed COREQ checklist for qualitative research methodology is available as Additional file 1.

2.2 | Data collection

2.2.1 | In-depth interviews and focus group

All focus group and interview participants were recruited from the single study site, an urban, safety-net AMC. Informed by CFIR, we developed a semi-structured interview guide to collect physicians' perspectives of multilevel determinants (eg the required infrastructure requirements, care coordination, implementation barriers, and perceived solutions) that may influence the implementation of cardio-oncology services at their institution. Cardiologists, hematologists, and oncologists were invited to participate in a one-hour focus group interview via an email invitation from the PI using a purposive sampling approach. (Provider interview guide is available as Additional

INNOVATION CHARACTERISTICS	OUTER SETTING	INNER SETTING	INDIVIDUAL CHARACTERISTICS	PROCESS
A. Innovation Source	A. Needs & Resources of Those Served by the Organization	A. Structural Characteristics	A. Knowledge & Beliefs	A. Planning
B. Evidence Strength & Quality	B. Cosmopolitanism	B. Networks & Communications	B. Self-efficacy	B. Engaging
C. Relative Advantage	C. Peer Pressure	C. Culture	C. Individual Stage of Change	1. Opinion Leaders
D. Adaptability	D. External Policy & Incentives	D. Implementation Climate	D. Individual Identification with Organization	2. Formally Appointed Implementation Leader
E. Trialability		1. Tension for Change	E. Other Personal Attributes	3. Champion
F. Complexity		2. Compatibility		4. External Change Agent
G. Design Quality & Packaging		3. Relative Priority		5. Key Stakeholders
H. Cost		4. Organizational Incentives & Rewards		6. Innovation Participants
		5. Goals and Feedback		C. Executing
		6. Learning Climate		E. Reflecting & Evaluating
		E. Readiness for Implementation		
		1. Leadership Engagement		
		2. Available Resources		
		3. Access to Knowledge and Information		

FIGURE 1 CFIR constructs highlighted in study. Shaded domains and constructs indicate study focal points. Individual characteristics were captured through the provider survey; Innovation Characteristics, Inner Setting, and Process were explored through individual and focus group stakeholder interviews. CFIR, consolidated framework for implementation research.

file 2). Due to COVID-19 precautions, the focus group was conducted remotely via Zoom. Participants verbally consented to participate prior to interview conduct and were informed of the study's purpose and goals. The physician focus group was facilitated by the PI (JL), a female, MD/DrPH researcher with extensive experience in implementation science and health services research focus group facilitation; other members of the team (JMC and CM) attended and took notes.

The team then recruited cancer and cardiovascular services administrators from the same healthcare system to participate in a separate focus group, also using purposive sampling. Due to scheduling difficulties, we ultimately conducted individual, hour-long interviews, following a modified version of the aforementioned interview guide to fit the administrator perspective (ie decision-making factors, short- and long-term goals to establishing cardio-oncology services) (administrator interview guide is available as Additional file 3). We used completeness in stakeholders represented, rather than saturation in data or themes emerging as a cue for when to cease recruitment. In other words, once we conducted interviews with physicians and operational administrators in each of cardiology, oncology, and general internal medicine, we ended participant recruitment. Due to the PI's involvement in study site's practice and operation and knowledge of service lines, to ensure the interview questions were asked in an unbiased approach, the administrator focus groups were facilitated by either of two female members of the research team (JMC and CM), each of whom had training and experience in focus group facilitation and familiarity with the CFIR model. The PI attended all interviews for any needed clarification on the study.

2.2.2 | Survey

The targeted population of survey included healthcare professionals who are the referrers to the cardio-oncology services, including cardiologists, oncologists, and primary care providers. We selected

36 questions from a 45-question survey developed by Peng et al²² to assess the knowledge, attitudes, perceptions, and needs regarding cardio-oncology services (Additional file 4) of these clinicians. The Peng survey targeted providers internationally; therefore, six demographic and organizational questions and three clinical case study questions were excluded from our study. Due to the study site's role as a safety net hospital, its patient base—and thus its network of outreach and affiliate programs—expands across the state. The study site also is engaged in setting standards of care and jointly approved clinical pathways and protocols, with the ultimate goal of developing statewide standards of care and statewide appropriate measures of quality and efficiency. Therefore, using the convenience sampling approach, invitations to complete the survey were sent from the PI and/or project administrators to relevant, statewide professional associations for distribution to the targeted healthcare professionals. The web-based survey was administered via REDCap, a secure, online platform from December 2020 to March 2021. Survey link was re-sent to enhance response every 2 weeks. Participants were consented prior to completing the survey.

The University of Kentucky Institutional Review Board approved this study's protocol (#63082). All participants provided informed consent prior to participation.

2.3 | Analysis

Interviews were recorded, transcribed verbatim and quality checked to prepare for directed content analysis²³ in NVivo 12 (QSR International, Melbourne, Australia). After reading all transcripts and noting key concepts, one coder independently coded transcripts utilizing a codebook based on the CFIR framework, including all domains and constructs.²¹ After the first round of coding, the research team, including qualitative experts and researchers experienced in Implementation Science and cardio-oncology, met to review the codes,

re-read transcripts for confirmation when indicated, discuss the initial schema and reflective quotes, and suggested refinements to better fit the data. Analytical memos were discussed as a group over study meetings with the goal of refining and finalizing themes and categories.

Some CFIR constructs did not emerge in the data, and overlap was common among others. In the second phase of analysis, we consolidated and reorganized themes and codes to reflect a more parsimonious structure that captured key elements and reduced redundancies and recoded the data. For example, as many themes related to Outer Setting constructs (eg attaining National Cancer Institute status) are mediated through Inner Setting Constructs (eg relative priority), we focused on the Inner Setting. See Figure 1.

Provider survey data were analyzed through item-level descriptive statistics using IBM SPSS Statistics, Version 27 (IBM Corp, Armonk, New York). Bivariate analyses were conducted to assess associations between respondent characteristics (eg specialty) and their knowledge of and attitudes toward cardio-oncology services.

3 | FINDINGS

3.1 | Participants

3.1.1 | Individual and focus group interviews

A total of nine providers and four administrators participated in focus group or individual interviews. Nine clinicians participated in the provider focus group, representing medical oncology, radiology, hematology, cardiology, and cardio-oncology. Four cancer service line, cardiovascular service line, and/or college of medicine administrators (leadership and operations) participated in individual interviews.

3.1.2 | Survey

Due to the use of partners' listservs to disseminate the survey invitation, we do not have a denominator for the number of individuals who ultimately received an invitation to participate; as a result, we cannot calculate a response rate. Ultimately, 48 survey responses were received. After omitting 14 surveys due to incompleteness, 33 were analyzed. Participants included cardiologists (14, 42.4%), oncologists (12, 36.4%), and primary care or other (7, 21.2%). The majority of respondents practiced at an AMC (21, 63.6%); most were attending physicians (27, 93.1%) (Table 1).

3.2 | Innovation

Cardio-oncology services involve risk stratification, prevention, surveillance, early diagnosis, and treatment of cancer patients at risk of CVD from exposure to cardiotoxic cancer therapies and their underlying risk factors.²⁴ In the present study, we did not present participants with an operational definition of what services were included in

TABLE 1 Demographics of study respondents.

	N	Percent
Specialty		
Cardiology	14	42.4
Oncology	12	36.4
Primary care or other	7	21.2
Practice location		
Academic Medical Center	21	63.6
Community Teaching Hospital	5	15.2
Community Non-Teaching Hospital	2	6.1
Community Clinic/Practice	4	12.1
Other	1	3.0
Position		
Attending physician	27	93.1
Clinical fellow	2	6.9

“cardio-oncology services” in part because we sought to understand from participants what the term and field meant to them and how services could be envisioned by multidisciplinary stakeholders.

3.3 | State of implementation

After two initial champions—a cardiologist and a medical oncologist—began collaborating on cardiology consults for oncology patients undergoing cardio-toxic therapies, the organization's Cardiology division hired a specialized cardio-oncologist. At the time of the interviews (April 2021), the cardio-oncologist had been practicing for 5 months and a full-time support staff had been hired; most cardio-oncology services were delivered to breast cancer patients due to two initial champions' area of expertise and the physical location of CV imaging (eg echocardiogram) equipment.

3.4 | CFIR model

Below, we outline facilitators and barriers to implementing cardio-oncology services as described by participants. Sections reporting results from qualitative interviews reflect these CFIR domains: Innovation Characteristics, Inner Setting, and Process. Provider survey results reflect the CFIR domain of Individual Characteristics. See Figure 2 for an illustration of overall findings.

3.5 | Qualitative interview findings

3.5.1 | Innovation characteristics domain

See Table 2 for innovation characteristics constructs, themes, and quotes.

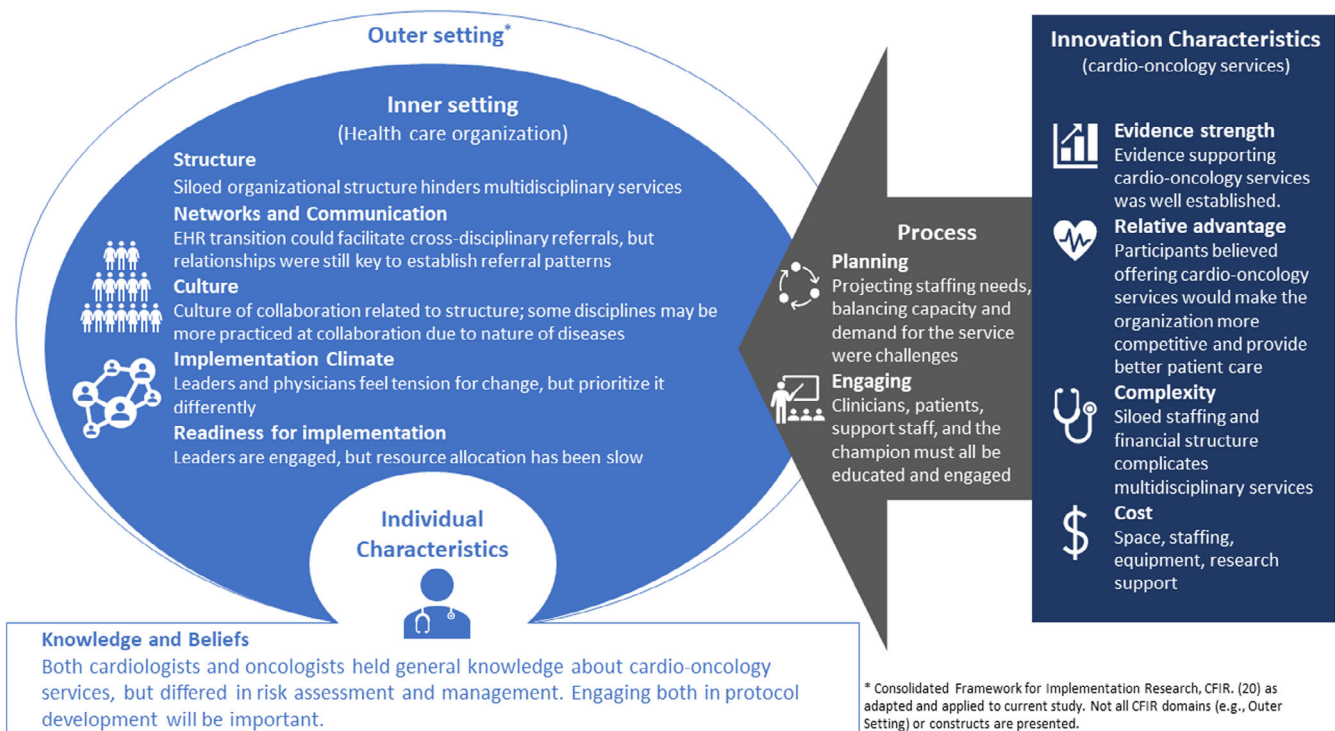


FIGURE 2 Application of CFIR to guide cardio-oncology service implementation. We conducted individual and focus group interviews with clinical and administrative stakeholders and a statewide survey of potentially referring providers to assess multilevel determinants that may influence the implementation of cardio-oncology services at an academic medical center. Most survey respondents thought it important for oncologists to consider cardio-toxicity planning in current treatment plans; interview participants noted multilevel determinants to maximize the potential for successful cardio-oncology service implementation. CFIR, consolidated framework for implementation research.

Evidence strength (facilitator)

Most participants were aware that some cancer therapies had adverse cardiac effects and believed that the evidence base supported cardio-oncology service provision. As one physician administrator noted, “it’s very established that many chemo agents have adverse metabolic effects, including cardiac.”

Relative advantage (facilitator)

Participants viewed cardio-oncology services as advantageous for comprehensive patient care, enhancing patient satisfaction and experience. In addition, both provider and administrator participants referenced the benefit of integrated cardio-oncology services as helpful in maintaining or advancing the organization’s current National Cancer Institute (NCI) status. As a physician administrator noted: “anything that would help in the NCI comprehensive status...that would be a huge advantage.”

Cost (barrier)

Participants widely acknowledged the costs associated with implementing cardio-oncology services, including capital (eg imaging equipment), research infrastructure (eg research support staff), and marketing to physicians and patients. The most common and critical costs discussed were space and personnel, or, as one administrator noted, “who quote unquote owns it.” However, with plans for an integrated, comprehensive cancer center within the coming years, some

participants viewed space a short-term obstacle rather than a long-term barrier.

Complexity (barrier)

Personnel was not only a cost associated with cardio-oncology service development, but also a chief complexity stemming from the cross-disciplinary nature of the service line in a financially, geographically, and operationally siloed organization. While participants tended to agree that oncology was a sensible site for services (eg patient visits and imaging), they also generally agreed that cardiology clinicians and support staff should perform specialized services due to their knowledge and training (eg operating an echo machine). Nonetheless, one administrator noted that “visitor” staff risked being unfamiliar with the unit and its workflows, which may impact patient experience: “I think what’s best for patients is that staff that lives on that unit be the staff that care for the patient ... they’re comfortable with the unit. They know the flow of the unit. They know where things are. They know how to direct patients.” However, co-locating cardiology/cardio-oncology technicians and clinicians in the cancer space again was complex when the demand for full-time effort was not yet present. Finally, parsing out billing of non-technical services (eg registration) that supported the multidisciplinary effort was also complex, given cardiology and oncology’s separate financial streams. As one physician administrator noted, “So, let’s say there’s a multidisciplinary cardio-onc clinic, all day

TABLE 2 Innovation characteristics' themes and supporting quotes.

CFIR construct	Reflective quotes
Evidence Strength and Quality (facilitator)	<i>There is a goal, as people are surviving their malignancies, to make sure we're not killing them with heart disease subsequently. (Clinician administrator)</i> <i>It's very established that many chemo agents have adverse metabolic effects, including cardiac. (Clinician administrator)</i>
Relative Advantage (facilitator)	<i>If it's anything that would help in the NCI comprehensive status... that would be a huge advantage. Everything we can do to get the next status. (Clinician administrator)</i> <i>In terms of just sort of [the hospital] marketing itself, broadly to the public... "The place to get your best care." (Administrator)</i>
Cost (barrier)	Space and Staff <i>That's going to be our biggest issue is space. In regards to physical aspects of, you know, where do we grow the program, where's the best location? ... We're still early and figuring that out. But I think really kind of our big thing will be ... you know, who quote unquote owns it. (Administrator)</i> Other costs: marketing, capital equipment, research infrastructure <i>I would think that there will be minimal cost at this point, because the [imaging] machine is here. (Administrator)</i>
Complexity (barrier)	Cross disciplinary nature of the service in a siloed organization <i>It's really hard to do... I'll give you an example we do that right now with ophthalmology. So ophthalmology has a space in our emergency department. And there are specific tests that have to be done in that space. And it oftentimes requires them to bring someone from across the street. And so, it's, it takes more time when you have to get that person, make sure that they're freed up from taking care of a patient that's already in the clinic, walk across the street, do whatever it is you're doing. (Clinician Administrator)</i> The need to gradually scale up the service <i>So, let's say there's a multidisciplinary cardio-onc clinic, all day Monday. That's fine. What will the respective staff do on the rest of the week? And, that's where I think the financials get difficult. Because it then becomes, "Well no, this is a cardiology pharmacist, and they go back to cardiology. This is an oncology nurse who goes back to oncology." ... if it's a full-time thing then I think it's much easier to overcome some of the infrastructure challenges. (Clinician administrator)</i> <i>I think what's best for the patients is that the staff that lives on that unit be the staff that care for the patient ... because they're comfortable with the unit. They know the flow of the unit. They know where things are. They know how to direct patients. (Administrator)</i>

Monday...What will the respective staff do on the rest of the week? And, that's where I think the financials get difficult."

3.5.2 | Inner setting domain

See Table 3 for inner setting constructs, themes, and quotes.

Structural characteristics (barrier)

Separate leadership and financials for service lines. Cardiology and oncology are organizationally distinct services in their structure, financing, leadership, and personnel. As one administrator noted, some of the technical challenges of the siloed structure, "I think it's the way we're set up in terms of our financial structure ... [it's] too siloed... "Who's paying for this support staff? ... Can this support staff check-in for that service?" As a result, comingled services such as cardio-oncology, require negotiation of differences in the two systems (eg billing, revenue, and staffing) and buy-in from both sets of leadership who are independently accountable for financial viability and productivity.

Need for standardization. Physician participants discussed how cardio-oncology referrals must become more standardized and less dependent on the specific knowledge or relationships among providers. As one physician noted, "On the

imaging side of things, we tried to have a standardization, but we don't." A formal process was needed to identify, refer, and communicate information about patients who could benefit from the service.

Slow process onboarding new providers and services. Participants described a stepwise process for onboarding new physicians that precluded operational support prior to their arrival. As a result, clinicians' early tenure at the healthcare facility was often consumed with navigating operational barriers (eg securing support staff, phone numbers, etc) at the expense of delivering direct patient care. As one physician commented, and others agreed:

You know when we hire new faculty...we basically say we don't expect you to do anything for the first couple of years...Which is such an old-fashioned model...If you actually grease the slicks ahead of time with people come in ready to run, you actually have a business model that works as well in a better manner.

Such practices also extended to establishing new services. Consequently, no prior structure was established to facilitate cardio-oncology service delivery (eg referral pathways, mechanisms, and tracking systems) prior to the cardio-oncologist's arrival, leading to operational inefficiencies.

TABLE 3 Inner setting themes and supporting quotes.

CFIR construct	Reflective quotes
Structural Characteristics (barrier)	<p>Separate leadership and financials for service lines</p> <p><i>It's working well now but there was a lot of people involved with a lot of high-powered positions just to put one echo tech and one machine over [in the breast cancer center]. (Administrator)</i></p> <p><i>Trying to organize some of these co-located services, it's our system makes that very challenging. I think it's the way we're set up in terms of our financial structure ... too siloed... "Who's paying for this support staff? ... Can this support staff check-in for that service?" (Clinician administrator)</i></p> <p><i>...At the end of the day we both have to produce for [leadership], right? (Administrator)</i></p> <p>Need for Standardization</p> <p><i>Unfortunately, I do not believe that it really is that standard, standing protocol to automatically consult cardiology oncology. (Clinician)</i></p> <p><i>On the imaging side of things, we tried to have a standardization, but we don't. (Clinician)</i></p> <p>Process for initiating new service/new physician is slow</p> <p><i>You know when we hire new faculty...we basically say you don't expect you to do anything for the first couple of years... Which is such an old-fashioned model...If you actually grease the slicks ahead of time with people come in ready to run, you actually have a business model that works as well in a better manner. So, I do think it's really an innovative approach, but it's not something that we do in academics and university practices as much as people do in private practice. (Clinician)</i></p>
Culture (facilitator and barrier)	<p>Different cultures of collaboration across disciplines</p> <p><i>[Cardio-oncology] is not just a referral-based practice that we're used to. It is much more collaborative than just, "Hey, here's a referral for this problem. Help me address this problem, and move on," because these are ongoing continuums of care... that need to be managed collaboratively. (Clinician)</i></p>
Networks and Communication (barrier and facilitator)	<p>Relationships</p> <p><i>Most of the time I'm just getting those ECHOs and following them up myself ... in the past, that was always just me emailing or calling [Cardiologist] to get those patients seen... But sometimes that was difficult to coordinate.) (Clinician)</i></p> <p><i>My plan, is really push [Cardio-Oncologist] hard in regards to that relationship building. To make sure that he's got that trust. (Administrator)</i></p> <p>Electronic Health Record Integration</p> <p><i>Given that we're moving to Epic...I actually am hopeful that actually could facilitate....because it won't be two separate systems. (Clinician administrator)</i></p>
Implementation Climate (facilitator and barrier)	<p>Tension for change</p> <p><i>We need to get out of a primary gender-specific service area [breast cancer center] getting into a more gender-neutral area. (Administrator)</i></p> <p><i>As a new specialty, it's probably been around for about 10 years in some of the leading centers, and we're way behind. (Clinician)</i></p> <p>Relative Priority</p> <p><i>These are the types of things that I think are barriers from an organizational standpoint. It's a recognition that not only do we value it, but we're willing to commit to the resources necessary to build it and support it, even if we recognize that it won't ...directly result in a financial reward from it, but recognizing that with better care delivery, these patients will have better outcomes. (Clinician)</i></p> <p><i>One of the challenges that we struggle with is that we're...not that good at sort of stepping back and saying really strategically: "Here's where we want to go, and here is not where we want to go." It's still department chair, center directors, individual faculty coming up with an idea and the proposal and taking it. (Clinician administrator)</i></p>
Readiness for Implementation (facilitator and barrier)	<p>Leadership engagement</p> <p><i>[The challenge] has been the physician leadership as its evolving and understanding what their desired state is going to be. (Administrator)</i></p> <p><i>I think conceptually people are very, very interested in novel approaches to care delivery. But there is a certain commitment that needs to happen in helping providers provide structure and a construct around it. (Clinician)</i></p> <p>Available Resources</p> <p><i>There's nothing that we can do for a provider before they get here. I've put together business proposals on the front-end, say, "Hey, listen, we're hiring these five people on. This is what they are going to be doing. Can we get them set up with the support staff?" And, we will get a fraction of that. (Clinician)</i></p> <p><i>One of the biggest frustrations for us has always been identifying data points, manually pulling data points, ...in terms of panel size, how many patients do we see, and what is our empanelment. So that way I can project for our next five attendings coming on...So that way we can staff appropriately. (Clinician)</i></p>

Culture (facilitator and barrier)

Some participants noted that the culture of collaborative care varied across specialties, with clinicians managing chronic diseases (with their often-concomitant comorbidities) being more practiced in cross-disciplinary collaboration than those managing acute conditions. As one provider noted, cardio-oncology “is much more collaborative than just, ‘Hey, here’s a referral for this problem. Help me address this problem, and move on,’ because these are ongoing continuums of care... that need to be managed collaboratively.”

Networks and communication (facilitator and barrier)

At present, individual relationships are the basis for referrals. One provider noted, “most of the time I’m just getting those ECHOs (echocardiograms) and following them up myself.” Similarly, a cardiology administrator acknowledged that forging relationships and trust among providers was critical to facilitate referrals. Participants suggested that provider education and electronic health record (EHR) prompts could help standardize referrals, especially given the enterprise’s recent transition to a system-wide EHR.

Implementation Climate (facilitator and barrier)

Tension for change. Cardio-oncology services were already being implemented at the time of the interviews, with the recent hiring of a cardio-oncologist. However, their scope was limited, including imagining within the breast cancer center and patient consults with the cardio-oncologist. Both physician and administrator participants were eager to move out of the breast cancer center to a more gender-neutral space. Further, physicians expressed tension for standardization of the organization’s cardio-oncology services given the relative maturity of the specialty elsewhere: “it’s probably been around for about 10 years in some of the leading centers, and we’re way behind.”

Relative priority. Most participants viewed the development of cardio-oncology services as a priority, but to varying degrees. One administrator noted, “we are in the business of putting out fires and [cardio-oncology] is not a fire”. While the comment was positive—cardio-oncology services did not present a threat or crisis—it did not reflect the proactive strategic investment that was desired by clinical participants. As one administrator noted:

We are not that good at sort of stepping back and saying really strategically, “Here’s where we want to go, and here is not where we want to go.” It’s still department chair, center directors, individual faculty coming up with an idea, and the proposal and taking it.

Readiness for implementation (facilitator and barrier)

Leadership engagement. Early leadership support was expressed through Cardiology’s hiring of a dedicated cardio-oncologist, however, providers spoke to the importance of leadership buy-in to strategically build the program. As one provider noted, “I think conceptually people are very, very interested in novel approaches to care delivery. But there is a certain commitment that needs to happen in helping

providers provide structure and a construct around it.” Simultaneously, administration noted that a challenge to service integration included transitions in physician leaders “and understanding what their desired state is going to be,” given the importance of the clinical champion in shaping the program.

Available resources. Participants decried that resource allocation to support new services was slow. New providers were not offered operational support prior to arrival; as a result, there is a degree of “tripping through it” as new services are established. In addition, other resources—that is, data to forecast needs and justify resource allocations—were difficult to obtain.

3.5.3 | Process

See Table 4 for Process constructs, themes, and quotes.

Planning

Financial planning. Participants highlighted that when planning for comingled services, the organization’s siloed financial structure should remain invisible to the patient who “should be able to come in, be roomed by a CST [certified surgical technologist] without it mattering whether the CST belongs to oncology versus cardiology.” While financial stratification vexed other multidisciplinary programs, the organization’s multidisciplinary cancer clinic and hospital-based clinics with centralized costs were cited as potential examples.

Projecting staff needs. Related to financial planning, understanding and sufficiently allocating clinical and support staff effort was paramount to ensuring sufficient resources were allocated to the service.

Balancing capacity and demand. Similarly, balancing the allocation and capacity of cardio-oncology staff with the clinical demand for those services was difficult given their mutual dependency. Participants did not want to oversell the program beyond their capacity to deliver; however, to justify capacity-building investments (ie clinician and support roles), demand must be demonstrated.

Engaging

Champion. The recently hired cardio-oncologist served as the program’s logical Champion. However, provider participants cautioned that the Champion must have institutional support or risk failure. One physician contended that building new programs, “falls on us as individual providers way too often... if there is an interest from an organizational standpoint to build these services, there has to be a blueprint.”

Key stakeholders. Both administrators and physicians vocalized the importance of engaging and educating institutional stakeholders in cardio-oncology service development. Potential “referrers” (eg hematologists, medical oncologists, and radiologists) need training on referral indicators and processes to establish appropriate referral patterns. Likewise, support staff should be cross-trained on patients’ needs and context in the multidisciplinary setting. As one participant noted, “you can’t just assume people could wear multiple hats, you have to actually train them.”

TABLE 4 Process themes and supporting quotes.

CFIR construct	Reflective quotes
Planning	<p>Financial Planning</p> <p><i>[I]f the appropriate costs and the appropriate revenues can be allocated on the back-end and not have to be so parcelled out at the front-end—the patient-facing experience—then it should be able to work. You know, the patient should be able to come in, be roomed by a CST without it mattering whether the CST belongs to oncology versus cardiology. (Clinician administrator)</i></p>
	<p>Projecting Staffing Needs</p> <p><i>...A clinician seeing patients in the outpatient space...an Advanced Imaging Cardiographer that will have some time needed in the advanced imaging space; One of the things that we will have to just fundamentally understand and navigate is how much time is allocated to each one of those activities. (Clinician)</i></p>
	<p>Balancing Capacity and Demand</p> <p><i>One of the problems that we often have...we think that things are a good idea and we try to implement them and then they either grow really, really quickly really fast, and we don't have the necessary resources, or we market them well enough. (Administrator)</i></p> <p><i>We actually have a tendency to oversell very quickly and then we're not able to deliver because we're at capacity. (Administrator)</i></p>
Engaging	<p>Champion</p> <p><i>If it's up to me to always build the program, when there's a slip, a patient is not satisfied because they were having trouble finding a location... that falls on us as individual providers way too often. It's our job to find the problem, solve the problem, and prevent it from happening again when the problem wasn't ours to begin with. So I think that if there is an interest from an organizational standpoint to build these services, there has to be a blueprint. (Clinician)</i></p>
	<p>Key Stakeholders: Clinicians and Staff</p> <p><i>Working across disciplines, to some extent, there's a big learning curve...you cannot just assume people could wear multiple hats, you have to actually train them. (Clinician administrator)</i></p> <p><i>The blueprint on how to create a supportive service and integrating it in a multi-clinic, multi-specialty platform...is active participation in tumor boards, active participation in departmental meetings, and collectively just making sure that the program is visual...And coming up with in-clinic, physician workspace signage that speaks to referral patterns and referral process and where the service is located. (Administrator)</i></p>
	<p>Implementation Participants: Patients</p> <p><i>Every patient that we have encountered is so focused on the cancer diagnosis that...it's kind of been our job to really guide them to make sure that we are taking care of their whole body and particularly their heart...there's a lot of patient education that has to occur. (Administrator)</i></p>

Participants suggested various approaches to inform clinicians about new referral protocols, including Grand Rounds, organizational publications, meetings, signage, and participation in departmental meetings and boards.

Innovation participants. Participants also noted that patients needed education about the benefit of cardio-oncology services, or the long-term effects of cardio-toxic drugs on their heart health. One administrator noted their patients are “so focused on the oncology cancer diagnosis that ...it's kind of been our job to really guide them to make sure that we're taking care of their whole body, and particularly their heart.”

3.5.4 | Individual characteristics domain

The individuals' knowledge and beliefs regarding the potential design and delivery of cardio-oncology services were captured through the survey. (Additional file 5 for detailed results).

Knowledge and beliefs

Perception of cardio-toxicity risk. Cardiologists and oncologists' cardio-toxicity risk tolerance in a curative setting was similar, with most

(84.4%) perceiving $\leq 5\%$ risk of cardio-toxicity as acceptable. However, in an incurable setting, cardiologists accepted significantly higher risk of cardio-toxicity than oncologists with the majority (77%) accepting higher than 1-5% risk levels ($P < .05$). Participants held similar opinions about cardio-toxicity risk from trastuzumab with over half (53.8% cardiologists and 58.3% oncologists) believing patients' greatest risk was during cancer treatment. However, perceptions of chemotherapy with anthracyclines differed. The majority of cardiologists (53.8%) believed the greatest risk was 1-year post-therapy, followed by active treatment (30.8%), while a plurality of oncologists believed the risk was greatest 1- to 5-year post-therapy (41.7%); a quarter (25%) believed the highest risk was over 5-year post-therapy.

Opinions toward cardio-oncology services. A majority of both specialties believed (66.7% cardiologists; 83.3% oncologists) that access to a cardio-oncology service will significantly improve prognosis for cancer patients, though a full third of cardiologists were unsure.

A majority of both specialties felt it was very important to consider cardio-toxic side effects during and after cancer treatment with oncologists generally finding initial treatment (66.7%) and cardiologists finding active treatment (66.7%) as most important. The majority of oncologists (58.3%) indicated that standard of care should include a cardiology/cardio-oncology assessment, while cardiologists' responses

were mixed: a third preferred cardiology/cardio-oncology consult as standard of care, a third preferred cardiac monitoring regardless of symptomology, and a third preferred cardiology intervention only when cardio-toxicity symptoms arose.

Comfort with cardiovascular implications of cancer therapies. A majority of cardiologists reported being knowledgeable about cardiovascular (CV) complications of cancer therapy and were comfortable with managing them. In contrast, only a third of oncologists thought cardiologists were knowledgeable and fewer reported that cardiologists were comfortable managing them. When asked about their own knowledge and comfort with CV complications of cancer therapies, half of the oncologists agreed they were knowledgeable, though fewer were comfortable with managing them. In contrast, over half of cardiologists agreed that oncologists were knowledgeable about cardiovascular complications of cancer therapy, though the majority disagreed that oncologists were comfortable with managing them.

4 | DISCUSSION

4.1 | Key findings

4.1.1 | Key facilitators

Participants widely viewed investments in cardio-oncology services as advantageous for the organization to deliver excellent, patient-centered health care, and maintain its NCI status. Similarly, provider survey participants noted the importance of considering cardiotoxic side effects of cancer treatments with a majority of both oncologists (83.3%) and cardiologists (66.7%) believing that access to cardio-oncology services would improve cancer patients' prognoses. These responses reflect greater optimism toward cardio-oncology services among oncologists in our survey and more tepid optimism among cardiologists compared to an international sample which found that 45.8% of oncologists and 88.3% of cardiologists shared this view.²² However, cardiologists' views in our survey aligned with those in a national survey of cardiologists about cardio-oncology services, in which 65% thought access to consultants with specialized training would provide an advantage for patients with CV complications undergoing cancer treatment.²⁵ Indeed, support for the development of cardio-oncology services and guidelines is growing, with expectations that cardio-oncology services can aid in informed decision-making about appropriate therapies, completion of cancer treatments, prevention of CV conditions, and more.^{24,26-28}

Leadership's early support of cardio-oncology service implementation—evidenced by the hiring of a cardio-oncologist and providing space and equipment—was another important facilitator. Further, recent investments in the communications infrastructure (ie EHR) will likely facilitate cross-disciplinary referrals, as both oncology and cardiology providers can access and edit patients' medical records.

4.1.2 | Key barriers

Structural barriers arose as the most common and significant obstacles influencing cardio-oncology service implementation, with separate funding streams and systems most frequently discussed.

Negotiating the inclusion of both physician and administrative leaders in strategic visioning was a challenge, with administrators looking to physicians for guidance and physicians looking to administrators for resources. However, while leaders expressed their support of the program, this support was reactive and lacked proactive visioning and strategic investment in services supporting the enterprise's values (ie superior patient care).

Despite initial personnel and capital investments, few resources were allocated to support the infrastructure of a cardio-oncology service (eg protocols and processes). However, provider participants noted they were hampered in their ability to forecast clinical demand to advocate for service investments by little support for ongoing data collection and evaluation to demonstrate the program's value, need, and/or implementation gaps. Of note, the slower pace of resource allocation and onboarding—owing perhaps to the organization's designation as an AMC, with dual goals of service and scholarship²⁹—further slowed new service development and integration.

Importantly, administrators in our study looked to clinicians for guidance on the most clinically appropriate protocols for the management of cardio-oncology services. However, our provider survey found discrepancies in the attitudes and opinions that clinicians from different disciplines (ie cardiologists and oncologists) held toward cardiovascular risk assessment and patient management. For example, while a majority of providers agreed that cardio-oncology services were important, cardiologists accepted significantly higher cardio-toxicity risk in a metastatic setting compared to oncologists, findings that mirrored those of an international survey of clinicians.²² Similarly, though not statistically significant, more oncologists in our study believed patients receiving anthracyclines were at greatest risk of cardio-toxicity beyond 1 year of cancer therapy compared to cardiologists, who believed patients were at greatest risk within 1 year or less of active treatment. Such discrepancies in perspective would need to be negotiated.

Finally, both specialties generally expressed higher levels of confidence in their own ability to manage complications arising from cardio-toxic cancer therapies compared to their counterparts, which could pose a barrier to cross-disciplinary collaboration. Our findings, however, mirror responses from physicians internationally²² and supports others' calls for improved education and collaboration across the cardiology and oncology disciplines to build trust and knowledge to ensure optimal patient care.^{30,31} To ensure maximal relevance and uptake of any cardio-oncology program, both disciplines should be engaged to ensure consensus on protocols and processes for patient management.

4.2 | Implementation recommendations

Importantly, this study did not seek to interrogate the facilitators and barriers to a specific structure or operationalization of

cardio-oncology services given that standardized recommendation and structural requirements for cardio-oncology services are still limited. We aimed to assess the context regarding a general concept of integrated cardio-oncology services. Cardio-oncology services can play a vital role within the concept of learning health systems by contributing to the generation of knowledge, continuous improvement/refinement on care protocols, guidelines, and treatment strategies, interdisciplinary collaboration, and personalized patient care. The final scope of cardio-oncology services at the study site is not presently defined or fixed but is also meant to be collaboratively developed through the involvement of key stakeholders. This study sought to contribute to that process. Results showed that the formation of efficient cooperation and workflows within the involved departments would be a critical factor. The recommendations toward future implementation include:

- Standardized referral and management processes—leveraging the new integrated EHR to develop standardized processes for referring and managing patients to cardio-oncology services, such as screening or consultations, as well as engaging and training relevant clinicians and staff in developing those processes.
- EHR-embedded clinical decision-making tool - A clinical decision-making tool embedded in the EHR is a promising approach for specialized care, and may be facilitated by the organization's recent EHR transition. Such activities may occur within the enterprise, but also regionally, given the geographic breadth of the organization's patient base.
- Educational campaign—Given the *relative* newness of the discipline,³² patient and population-level educational campaigns could help inform patients and families about the potential long-term cardiotoxic effects of certain cancer therapies, which could, in turn, enhance demand for the services.
- Streamlined financial structure—Integrating interdepartmental financial streams, including interdisciplinary staffing, arose repeatedly as a major barrier. Participants noted that few successful local examples existed from which to learn; however, clinics with centralized costs could provide a blueprint. Ultimately, some unified approach will be necessary to overcome the challenges associated with sharing costs and revenues of a multidisciplinary service. However, it is possible that this, too, will be remedied as the organization transitions to a comprehensive, co-located cancer center.

4.3 | Ongoing evaluation

Regularly evaluating changes and improvements in cardio-oncology services is a fundamental aspect of maintaining and enhancing the quality of care for cancer patients with cardiovascular concerns. With recommended changes, the evaluation of impact should focus on the areas including reduction of cardiovascular complications, patient quality of life improvements, enhanced collaboration among healthcare teams, healthcare provider feedback, and cost and resource efficiency. The learning health systems cycle will guide data collection

and analysis for integration of data, research, practice, and education to adapt strategies and processes based on new findings.

4.4 | Strengths and limitations

We believe the multi-method nature of this study, its inclusion of diverse multidisciplinary stakeholders, and its grounding in the CFIR framework are strengths that render it valuable for informing a cardio-oncology implementation strategy at an AMC. However, its limitations should be considered.

As this study focuses on one state, and one AMC, its results may not be generalizable to other institutions. However, through their multidisciplinary nature and focus on developing new knowledge, AMCs have served an important role in the cardio-oncology discipline,³⁰ and we hope our findings may help similar institutions implement collaborative, integrated practices.

The sample size for each study component is small ($n = 13$ for the qualitative component and $n = 33$ for the survey) and also limits our study's generalizability and power. Nonetheless, each study component includes diverse perspectives from multidisciplinary stakeholders (eg oncology, hematology, cardiology, and primary care), which is a strength.

Finally, “cardio-oncology services” were not expressly defined as part of our data collection approaches. We did this in part because the cardio-oncology service line was in its initial stages of development at the institution and we sought a collaborative process for further defining and developing the service. However, it is possible that survey participants held diverging views of what was meant by terms such as “cardiology or cardio-oncology assessment,” with some potentially interpreting “assessment” as an in-person consultation with a cardio-oncologist and others as a screening procedure (eg echocardiogram). Such potential differences would need to be explored in subsequent stages of implementation strategy development as they have meaningful differences in the resources to be dedicated.

5 | CONCLUSIONS

Cardio-oncology is an emerging field to address the potential for cancer therapies to influence patients' long-term cardiovascular health. However, standardized protocols for the provision of cardio-oncology services are not routinely embedded into many healthcare systems, and clinicians' and administrators' views toward the provision of cardio-oncology services vary. Using CFIR, multilevel implementation barriers were revealed, including a siloed organizational structure and discrepancies in the views toward cardiovascular risk assessment and management held by cardiologists and oncologists. Leaders and administrators in healthcare organizations can use the findings from this study to develop a detailed implementation strategy to increase the likelihood of successful implementation of interdisciplinary services, specifically, cardio-oncology services.

AUTHOR CONTRIBUTIONS

JMC facilitated individual interviews, analyzed the data, and was a major contributor in writing the manuscript; AKA conducted the quantitative survey analysis and contributed to the corresponding results section; CM helped co-facilitate individual interviews and contributed to editing the manuscript; AA contributed to the selection of questions to include on the provider survey, helped validate the provider focus group findings, and reviewed and edited the manuscript; GW helped select the questions for both the provider survey and the focus group/individual interview protocols and edited the manuscript. JL provided overall guidance on the study design, facilitated/co-facilitated focus group and individual interviews, and contributed to the editing and framing of the manuscript.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data sets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

ETHICS STATEMENT

The University of Kentucky Institutional Review Board approved this study's protocol (#63082). All participants provided informed consent prior to participation.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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