BMJ Open

How do organisational characteristics influence teamwork and service delivery in lung cancer diagnostic assessment programmes? A mixed-methods study

Gladys N Honein-AbouHaidar,[1] Terri Stuart-McEwan,[2] Tom Waddell,[3] Alexandra Salvarrey,[3] Jennifer Smylie,[4] Mark J Dobrow,[5] Melissa C Brouwers,[6] Anna R Gagliardi[1]

To cite: Honein-AbouHaidar GN, Stuart-McEwan T, Waddell T, *et al*. How do organisational characteristics influence teamwork and service delivery in lung cancer diagnostic assessment programmes? A mixed-methods study. *BMJ Open* 2017;**7**:e013965. doi:10.1136/bmjopen-2016-013965

► Prepublication history and additional material is available. To view please visit the journal (http://dx.doi.org/10.1136/bmjopen-2016-013965).

Received 22 August 2016
Revised 21 December 2016
Accepted 19 January 2017

For numbered affiliations see end of article.

Correspondence to
Anna R Gagliardi;
anna.gagliardi@uhnresearch.ca

ABSTRACT

Objectives: Diagnostic assessment programmes (DAPs) can reduce wait times for cancer diagnosis, but optimal DAP design is unknown. This study explored how organisational characteristics influenced multidisciplinary teamwork and diagnostic service delivery in lung cancer DAPs.

Design: A mixed-methods approach integrated data from descriptive qualitative interviews and medical record abstraction at 4 lung cancer DAPs. Findings were analysed with the Integrated Team Effectiveness Model.

Setting: 4 DAPs at 2 teaching and 2 community hospitals in Canada.

Participants: 22 staff were interviewed about organisational characteristics, target service benchmarks, and teamwork processes, determinants and outcomes; 314 medical records were reviewed for actual service benchmarks.

Results: Formal, informal and asynchronous team processes enabled service delivery and yielded many perceived benefits at the patient, staff and service levels. However, several DAP characteristics challenged teamwork and service delivery: referral volume/workload, time since launch, days per week of operation, rural–remote population, number and type of full-time/part-time human resources, staff colocation, information systems. As a result, all sites failed to meet target benchmarks (from referral to consultation median 4.0 visits, median wait time 35.0 days). Recommendations included improved information systems, more staff in all specialties, staff colocation and expanded roles for patient navigators. Findings were captured in a conceptual framework of lung cancer DAP teamwork determinants and outcomes.

Conclusions: This study identified several DAP characteristics that could be improved to facilitate teamwork and enhance service delivery, thereby contributing to knowledge of organisational determinants of teamwork and associated outcomes. Findings can be used to update existing DAP guidelines, and by managers to plan or evaluate lung cancer DAPs. Ongoing research is needed to identify ideal roles for navigators, and staffing models tailored to case volumes.

Strengths and limitations of this study

- Data reflecting structures, processes and outcomes of diagnostic assessment programmes were gathered and compared from multiple sites, unlike previous research that was based in single sites and reported wait times only.
- The mixed-methods approach integrated qualitative and quantitative data to reveal potential linkages between organisational characteristics, teamwork and service delivery, providing detailed insight on how diagnostic assessment programme design could be optimised.
- The study was conducted in Canada which features a publicly funded healthcare system, and findings may not be transferable to other settings.
- Study findings pertain to lung cancer diagnosis, and thus the organisational characteristics that influence teamwork and service delivery may differ in other healthcare contexts.

INTRODUCTION

Multidisciplinary teamwork is essential for the optimal diagnosis, management and outcomes of patients with cancer.[1] It implies inperson or remote concurrent or asynchronous interaction among healthcare professionals of differing specialties that allows for enhanced communication and coordination.[1] Many factors challenge teamwork during the diagnostic trajectory, contributing to delays that may influence stage at

diagnosis and prognosis and adding to patient confusion and anxiety.[2–4] Interventions implemented to improve referral such as education, audit and feedback, decision support software and diagnostic tools had little effect on reducing diagnostic delays.[5] Alternatively, facilities that provided access to multidisciplinary diagnostic services in a single location minimised delays in referral and diagnosis.[6 7] These centralised diagnostic services have been referred to as diagnostic assessment programmes (DAPs), and are meant to more efficiently achieve a diagnosis and link patients requiring treatment with those services.[7] DAP guidelines have been issued but provide largely consensus-based, rudimentary direction for planning and implementing DAPs.[7 8]

Lung cancer is the second most common cancer in men and women, as well as the leading cause of cancer death among men and women.[9] Multidisciplinary teamwork has been recommended to reduce delays in the diagnosis of lung cancer that have been observed in many countries.[10 11] Several studies evaluated the impact of implementing lung cancer DAPs on wait times. For example, among patients with lung cancer seen at a rapid outpatient diagnostic programme, 87% were diagnosed within 3 weeks of referral, and 52.5% started curative treatment within 2 weeks of diagnosis.[12] Pre–post evaluation of a coordinated lung cancer programme reduced the time from first abnormal image to initiation of treatment by 25 days.[13] In another study, implementation of a coordinated lung cancer programme reduced the median time from suspicion of lung cancer to diagnosis from 128 to 20 days.[14] While these results are promising, the studies were conducted in single sites and did not describe DAP or teamwork characteristics that contributed to reduced wait times such that they could be replicated elsewhere.

DAPs are a promising model for optimising teamwork, diagnostic service delivery and associated outcomes for patients with cancer. However, further evidence from comparative research in multiple sites is needed to identify the ideal characteristics of DAPs that promote teamwork and improve diagnostic service delivery. This knowledge could be used to update guidelines with specific recommendations for planning and implementing DAPs, which would provide policymakers and health system leaders with guidance to design, evaluate or improve lung cancer DAPs. The purpose of this study was to explore how DAP characteristics influence teamwork and diagnostic service delivery.

METHODS

Approach

A mixed-methods multiple case study design was used.[15 16] The study was based in Canada, where the health system is publicly funded. Cases were four lung cancer DAPs that differed by geographic region (urban, rural, remote), size of population served and launch date, factors that may have influenced DAP characteristics. A convergent mixed-methods approach was used where qualitative and quantitative methods were prioritised equally, data collection and analysis were concurrent and data were integrated and interpreted following analysis. Findings are reported based on Good Reporting of A Mixed Methods Study (GRAMMS) criteria.[17] Ethical review boards at participating sites approved the study.

Qualitative analysis of teamwork and determinants

Key informants at each site were interviewed to explore how DAP characteristics influenced teamwork and diagnostic service delivery. DAP characteristics were described according to those recommended in DAP guidelines, including operational features and human resources.[8] In the absence of evidence-based quality indicators, service delivery was described by key informants in terms of 'target' benchmarks set by each DAP for the number of visits and wait time required to achieve a diagnosis. Key informants also provided the names and contact information of other DAP staff for additional interviews. Basic qualitative description was employed along with strategies to enhance the rigour of sampling, data collection, analysis and reporting.[18 19] Purposive sampling was used to recruit participants from each site who varied by professional role. Individuals were invited by email, and asked to sign and return a consent form. Telephone interviews were conducted by a trained research assistant (RA). The semistructured interview guide was not based on a specific teamwork theory or model because interviews were exploratory in nature; instead, the meaning of teamwork was described to interview participants as multidisciplinary interaction for the purpose of clinical care. Participants were asked to describe teamwork processes, outcomes and determinants, and recommendations to enhance teamwork. Interviews were held from 29 January to 15 October 2013, audio-recorded and transcribed. An initial target of five individuals from each site was set for a minimum of 20 participants. Sampling proceeded until the principal investigator (PI) and an RA determined that thematic saturation was achieved. Themes were identified using a constant comparative technique.[20] Transcribed interviews were read independently by the PI and RA to identify, define and organise themes. The PI and another investigator checked all data. Quotes were assessed by theme, participating site and profession to identify similarities or differences, and to facilitate interpretation.

Quantitative analysis of diagnostic services

Data were collected to objectively assess the actual number of visits and wait time required to achieve a diagnosis. Eligible patients were aged 18 and older who were referred to participating DAPs for assessment of suspected primary lung cancer from 1 January 2012 to 31 December 2012. Sampling was based on 2011 referral volumes, which varied across sites. From sites B, C and

D, 80 patients (15% of patients at site with the highest 2011 referral volume) were randomly sampled. From site A, 200 patients were randomly sampled to accommodate another study of DAP services. This resulted in an initial sample of 440 patients from which patients were excluded if they were referred for a second opinion (74), consultation only (11), lung metastasis from a primary cancer (25), recurrent lung cancer (11); or had no record of any diagnostic tests (4), and follow-up from previous referral (1), leaving 314 patients eligible for analysis. Reporting complied with observational study standards.[21]

A data abstraction form was developed to collect data on the type and timing of diagnostic procedures performed after referral. Data included patient characteristics (date of birth, sex), type of procedure that confirmed the diagnostic result (imaging with CT of the chest; biopsy with fine needle aspiration, bronchoscopy or open biopsy; staging with positron emission tomography or MRI) and results (positive for cancer, negative for cancer, still suspicious requiring follow-up). Recorded dates included: *referral* (date when referral form received by DAP), *confirmatory procedure* (date when confirmatory diagnostic procedure performed), *diagnosis* (date when finding was recorded in patient record) and *consult* (date of meeting with patient to discuss treatment or follow-up plan). Four trained abstractors collected data from medical records at participating sites between June 2013 and August 2014. Summary statistics were used to assess the proportion of patients whose confirmatory procedure was imaging or biopsy; and the median number of DAP visits and wait time in days from referral date to confirmatory procedures, diagnosis and consultation. ANOVA was used to compare continuous variables, and the χ^2 test was used to compare proportions by site. The number of visits and wait times were compared by site using the Kruskal-Wallis nonparametric test; Dunn's adjusted p values based on multiple comparisons between groups were reported. Analyses were performed with IBM SPSS (V.21, SPSS Statistics/IBM Corp, Chicago, Illinois, USA).

Analysis of integrated findings

Qualitative and quantitative data were integrated by weaving the qualitative findings through the description of quantitative findings (narrative approach), and by visually depicting potential associations between qualitative and quantitative findings (joint display).[15] Findings were further analysed for concordance, discordance or expansion. To visually integrate and interpret findings, they were also analysed according to the Integrated Team Effectiveness Model (ITEM), which emerged from a review of literature on healthcare team effectiveness, offers an overarching framework by which to describe teamwork, and was meant by the authors to be adapted to different contexts.[22] ITEM suggests that organisational characteristics (eg, structures, resources, information systems) and team composition (ie, size, tenure, diversity) influence team processes (ie, communication, collaboration), leading to subjective outcomes (ie, perceived team effectiveness) and objective outcomes (ie, patient outcomes). We perused study findings to identify instances of ITEM constructs, and relevant constructs were included in a final conceptual framework. Integration of data was independently assessed by the PI and another investigator who met to discuss the findings and achieve consensus. The analysis was shared with, and then refined based on feedback from key informants at participating sites and from study investigators.

RESULTS

Organisational characteristics

Participating sites were similar in terms of service delivery model (scope of care diagnostic only, single location, single visit diagnosis, patient risk level), regional access (single point of entry, accepts referral from all sources) and most operational features (referral and triage criteria, protected booking slots, dedicated governance structure, guidelines/service framework and performance reporting). Apart from sampling criteria (health region, urban vs rural/remote, size of population served, launch date), sites differed in total volume of patients referred in 2012, days per week of operation and complement of human resources (table 1). Sites also differed in the timing and sequence of reported diagnostic processes; hence, 'target' service delivery benchmarks (total number of visits, time from referral to diagnosis/consult) varied across DAPs.

Multidisciplinary teamwork

Twenty-two individuals reflecting a variety of professionals were interviewed (see online supplementary file 1). They included directors, managers, patient navigators, nurses, clerks, surgeons, radiologists or respirologists, referring family physicians and a social worker. Themes were consistent across sites (table 2). Teamwork processes were formal and informal; communication was inperson and asynchronous via shared medical records or telemedicine; and addressed patient care, strategic planning and quality improvement. Teamwork was said to be enabled by staff colocation and patient navigators. Participants perceived many individual, team, organisation and patient level benefits of teamwork, including staff satisfaction, enhanced teamwork among staff and with referring physicians, good patient experience, service efficiency and reduced wait times. Reported challenges included high patient volumes and associated workload; insufficient human resources, including radiologists, pathologists and administrative clerks; limited interaction with dispersed staff; and competing priorities among physicians. To improve teamwork, participants recommended additional human resources, integrated information systems and enhanced scope of practice for navigators, who were typically nurses but in one case a radiologist.

Table 1 Characteristics of participating DAPs

Characteristics	Participating site A	B	C	D
Demographics				
Health region	Urban	Urban–rural	Urban–rural	Rural–remote
Population	1.2 million	1.2 million	775 000	236 000
DAP launch date	2009	2007	2007	2010
Total patients referred in 2012	523	676	360	169
Human resources				
Medical director	P	P	P	P
Clinical director	P	P	–	–
Clinical manager	–	P	P	P
Patient navigator	F	F	F	F
Reception/clerical/booking	P	F	F	P
Social worker	P	F	P	P
Other supportive care	P	P	P	P
Nurse practitioner	P	–	–	–
Registered nurse	–	P	–	–
Surgical oncologist	P	P	P	P
Medical oncologist	P	–	P	P
Radiologist	P	P	P	P
Radiology technician	P	P	P	P
Pathologist	P	P	P	P
Respirologist	–	P	P	–
Total full-time staff	1	3	2	1
Target time to diagnosis*	Within 7–17 days	Within 7–14 days	Within 14–24 days	Within 14–21 days
Target time to consult*	7–28 days	14–21 days	Within 28 days	Within 28 days
Target number of total visits*	2–4	2–4	2–3	2–3 (1–2 in person, 1 via telehealth)

*Target refers to intended/planned according to goals/internal protocols.
F, full time; P, part-time.

Service delivery benchmarks

A total of 314 medical records were reviewed (see online supplementary file 2). The mean age was 68.5 years. More patients at site D had imaging and fewer had biopsy as the confirmatory procedure (p=0.003) compared with other sites. The number of patients diagnosed with cancer was higher at sites A and B compared with other sites (p=0.01). The typical diagnostic trajectory of patients with lung cancer appears in figure 1.

Among patients with an image-confirmed diagnosis (49, 15.6%), the median number of visits from referral to diagnosis, and from referral to consult were similar across all sites (table 3). Among patients with a biopsy-confirmed diagnosis (265, 84.4%), the median number of visits from referral to diagnosis was significantly higher at site A, which had a high 2012 referral volume (*organisational characteristics*), and site C, which did not operate daily (*organisational characteristics*). Participants at both sites also reported insufficient human resources (*staffing*).

The actual number of visits from referral to consult was higher than the benchmark target for site C, which operated 1–3 days/week (*organisational characteristics, staffing*), and for site D, where staffing was particularly problematic because locum radiologists from elsewhere were often hired on a weekly basis to compensate for the lack of a local full-time radiologist (*staffing*), and scheduling had to accommodate locum radiologists and patients travelling by air from remote communities (*rural–remote region*). Pathology tests for site D patients were periodically sent to site A for a second opinion (*staffing*), and 45 (62.5%) site D patients had a DAP rather than a telehealth consult, potentially requiring patients to again travel a long distance (*rural–remote region*). Site D was most recently launched and still developing (*organisational characteristics*).

The median wait times from referral to confirmatory imaging (19 of 21 patients diagnosed by CT) and to consult were significantly higher at site D compared with other sites (table 4). Site D was notable for having been recently launched, acquiring a second opinion for pathology, offering onsite rather than telehealth consult for many patients, and experiencing challenges in scheduling locum radiologists and patients from remote communities (*rural–remote region, staffing, recently launched*).

The actual wait times from referral to diagnosis and to consult were higher than target benchmarks for all sites, most likely reflecting an insufficient number and complement of human resources, most of whom were not employed full time by the DAP, had competing priorities and were not colocated (*staffing*) at all sites; high referral volume (*organisational characteristics*) at sites A and B; operating a few days per week (*organisational*

Table 2 Exemplar quotes from interview participants

Themes	Subthemes (specific to site)	Exemplar quote
MDT examples	Informal (as-needed unscheduled interaction)	If there's a question as to who the patient needs to see she [nurse navigator] consults with the thoracic surgeon and the respirologist over the telephone. Sometimes she sits down and has face-to-face meetings with them to talk about how they can best serve the patients (Patient Navigator 31C)
	Formal (routinely scheduled interaction)	Patients are triaged every day so there's planning rounds (Surgeon 20B)
	Asynchronous (not at the same time)	You have a shared medical record so people are kept in the loop (Patient Navigator 31C)
	With referring physicians	We always contact the referring physician and let them know what the plan of care is (Clerk 15B)
	Planning/quality improvement	There's gonna be a formal process done on the whole flow to identify where we can further improve (Radiologist 21A)
MDT facilitators	Colocation of staff	The DAP brings all the key players into one physical location. We're physically co-located and able to have discussions that can sometimes be difficult (Clinical Director 7B)
	Patient navigators	The nurse navigators are key. I order all the stuff but the nurse navigators continuously check for the path reports, to make sure things are flowing (Surgeon 20B)
	Protocols or pathways	We have a DAP referral form and it outlines the whole process. Process mapping took place in the development of the guide (Patient Navigator 26D)
MDT challenges	Insufficient human resources	There was a little bit of funding but only for a nurse coordinator. There was no other funding. Patients still wait because of the availability of slots for biopsies, CT scan time so there's a limitation in resources (Radiologist 21A)
	Staff in different locations	Being in two different locations, communication is impacted. If the clinic was done together I could be introduced face-to-face and start working with them and walk through the steps with them (Patient Navigator 26D)
	Competing physician demands	Physician availability—there's multiple demands on their time. Another huge challenge, trying to ensure the physician is always there. We've changed appointments a lot around that (Clinical manager 34B)
	High volume or base of referrals	We are the only tertiary provider for quite a large population. So the problem is we have a high volume (Medical Director 29B)
	Increased workload	There's a lot of paperwork, trying to follow patients, making phone calls to physicians, charting (Patient Navigator 14C)
MDT benefits	Staff satisfaction	I like the variety of work, the database, the clinic, it's good for me (Clerk 03A)
	Enhanced teamwork	We were able to bring the team together. I don't think that would have flourished as well if we hadn't started the DAP. It's completely improved my interaction with other healthcare professionals. I have good, trusting working relationships with a big group of professionals (Patient Navigator 31C)
	Interaction with referring physicians	Interaction with the surgeons and the oncologists who are involved in the process is more immediate than it was previously (Referring physician 36D)
	Improved patient experience	The purpose is to expedite access and diagnostic work-up and to improve the quality of their experience. Our patients have a far better experience now because of the amount of support that's there (Medical Director 29B)
	More efficient service delivery	Before individual secretaries of the different specialist would try to coordinate all these tests. Now we have one person streamline and get everything ready for that first consultation (Radiologist 21A)
	Reduced wait times	It's reduced wait times and expedited the entire process. It's very important to be able to get to the intervention (Referring Physician 36D)
Suggestions to enhance MDT	Information systems integration	If requisitions for imaging or biopsies were electronic instead of paper, for example that would already save you a day and half (Radiologist 21A)
	Human resources	More radiologists and CT scanners (Surgeon 01A); You need to put money with the nurse navigators because they're the ones who are the liaisons, coordinating all the testing. They're really at the forefront (Surgeon 20B); If the system were to invest in more pathologists, more lab techs that would have an impact on the whole diagnostic journey (Surgeon 28D)
	Optimise scope of practice	Clearly defining roles and maximizing the scope of practice for each of the disciplines that are involved (Clinical Director 7B)

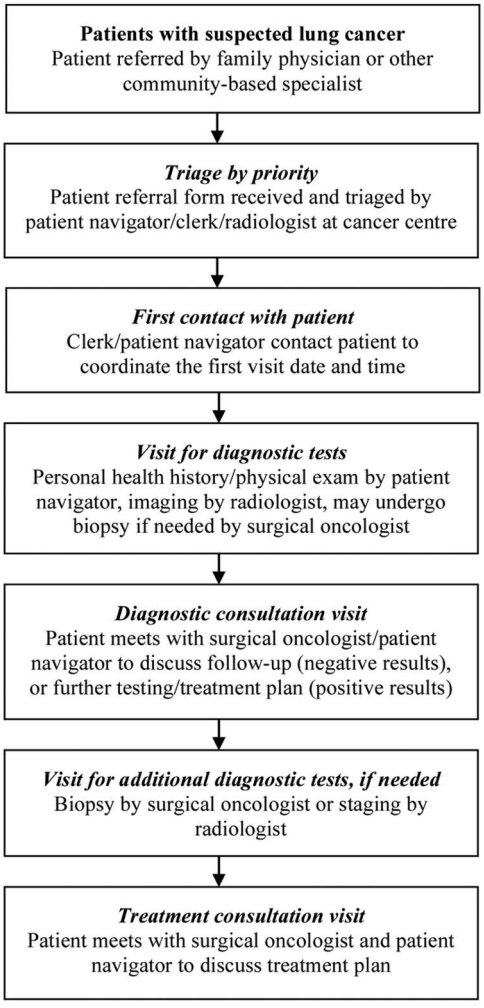

Figure 1 Lung cancer diagnostic trajectory.

characteristics) at site C; and scheduling issues at site D, which was most recently launched (*rural–remote region, recently launched*).

Integrated findings

Integration of data revealed *concordance* between qualitative and quantitative findings. Several DAP characteristics (referral volume/workload, time since launch, days per week of operation, rural–remote population, number and type of full-time/part-time human resources, colocation, information systems) challenged teamwork across all participating sites, and influenced service delivery (number of visits from referral to diagnosis and to consult; wait times from referral to imaging and to consult).

Instances of *discordance* were also identified. The actual number of visits (quantitative data) was higher than the target number of visits (qualitative data) for referral to consult at site C and site D, and the actual wait time from referral to diagnosis and referral to consult (quantitative data) was higher than the corresponding target wait times (qualitative data) at all sites. This suggests that sites were unable to adhere to service delivery targets, which further supports the potential relationship between the aforementioned DAP characteristics that challenged teamwork, and subsequently influenced diagnostic service delivery.

Integrated findings contribute to an *expansion* in the understanding of teamwork in the lung cancer diagnostic context compared with previous studies that did not describe determinants of reduced wait times.[12–14] Team processes were said to achieve several beneficial outcomes at the level of individual providers and teams which, in turn, enhanced the efficiency of service delivery and the patient experience, and reduced wait times and the number of visits needed to establish a diagnosis. Although perceived team effectiveness was high, it was hampered by a variety of more (days per week of operation, information systems, and number, type and location of full-time and part-time staff) and less actionable (referral volume, rural–remote region) DAP characteristics. Integrated findings were used to expand and tailor ITEM,[22] and generate a conceptual framework that visually displays how the characteristics of lung DAPs may influence teamwork and diagnostic service delivery (figure 2).

DISCUSSION

DAPs can reduce wait times for cancer diagnosis,[7 8] but evidence and guidance for optimal DAP design was lacking.[12–14] In this study, formal, informal and asynchronous team communication processes were perceived to achieve many benefits, yet several DAP characteristics reportedly challenged teamwork and the attainment of service delivery target benchmarks. Potentially actionable challenges relevant to all sites included the need for improving information systems, adding more staff of all specialties, colocating staff and capitalising on patient navigator roles. Findings were captured in a conceptual framework that confirms previous knowledge of teamwork determinants and outcomes as described in ITEM,[22] but is tailored to the lung cancer diagnostic context.[22] This can be used by policymakers and health system leaders to plan, implement, evaluate and improve lung cancer DAPs.

Several strengths of this study should be noted. Three single-site cohort studies found that DAPs reduced lung cancer diagnosis wait times but provided few details to link outcomes with DAP characteristics.[12–14] Another study, while not based on DAPs, evaluated service delivery among 4804 patients with lung cancer seen in 2007 at 131 Veterans Health Administration facilities, but also failed to identify facility-level attributes associated with better quality care.[23] Therefore, this study was unique because it generated knowledge from multiple sites on the DAP characteristics that can improve teamwork and diagnostic service delivery. Furthermore, it employed a rigorous mixed-methods approach that suggests linkages between DAP characteristics and service delivery to provide detailed insight on how to optimise DAP design. However, several factors limit the interpretation and application of these findings. Findings reflect services as

Table 3 Number of visits from referral to diagnosis and consult

End point	Participating site (n patients, median number of visits from referral to end point in days, IQR) A	B	C	D	Total
Diagnosis confirmed with CT	9	4	2	19	34
	1.0	1.0	1.0	1.0	1.0
	1.0–1.0	1.0–1.0	1.0–1.0	1.0–1.0	1.0–1.0
Diagnosis confirmed with PET, MRI	5	2	6	2	15
	2.0	2.0	2.0	2.5	2.0
	2.0–2.0	2.0–2.0	2.0–2.0	2.0–3.0	2.0–2.0
Diagnosis confirmed with biopsy	119	52	43	51	265
	3.0*	2.0	3.0*	2.0	3.0
	2.0–4.0	2.0–3.0	2.0–4.0	2.0–4.0	2.0–4.0
Consult	119	50	30	45	244
	4.0	4.0	4.0	4.0	4.0
	3.0–5.0	3.0–5.0	4.0–5.0	3.0–5.0	3.0–5.0
Target number of total visits from referral to consult (refer to table 2)	2–4	2–4	2–3	2–3 (1–2 in person, 1 via telehealth)	

All associations significant at p<0.05.
*Patients at sites A and C had significantly more visits compared with sites B and D.

Table 4 Wait time from referral to confirmatory procedure, diagnosis and consult

End point	Participating site (n patients, median wait time from referral to end point in business days, IQR) A	B	C	D	Total
Confirmatory imaging with CT	9	4	2	19	34
	8.0	12.0	3.0	14.0*	13.0
	7.0–13.0	9.5–16.5	2.0–4.0	12.0–21.0	7.5–18.5
Confirmatory imaging with PET, MRI	5	2	6	2	15
	14.0	34.0	29.5	31.5	28.0
	7.0–27.0	28.0–40.0	28.0–37.0	24.0–39.0	13.5–38.5
Confirmatory biopsy	119	52	43	51	265
	24.0	22.0	25.0	28.0	25.0
	15.0–36.0	15.0–29.0	19.0–36.0	21.0–54.0	16.0–36.0
Diagnosis	119	52	43	51	265
	27.0	26.0	28.0	32.0	27.0
	20.0–40.0	20.0–33.0	19.0–40.0	18.0–52.0	19.0–40.0
Consult	119	50	30	45	244
	33.0	29.0	33.0	55.0†	35.0
	21.0–45.0	22.0–43.0	24.0–86.0	42.0–74.0	23.0–50.0
Target wait time from referral to diagnosis (refer to table 2)	Within 7–17 days	Within 7–14 days	Within 14–24 days	Within 14–21 days	
Target wait time from referral to consult (refer to table 2)	7–28 days	14–21 days	Within 28 days	Within 28 days	

All associations significant at p<0.05.
*Median wait time significantly lower for sites A and C compared with site D.
†Median wait time significantly lower for sites A, B and C compared with site D.

they were delivered in 2012. Although we relied on published DAP guidelines,[8] we may not have identified and evaluated all DAP characteristics relevant to the optimisation of diagnostic service delivery. Data collected from DAPs were not compared with data from non-DAP patients. Recruitment of interview participants was challenging; as a result, the complement of professional roles was not consistent across sites, and site A was represented by only a surgeon, a radiologist and a clerk. Teamwork was assessed based on participant perceptions and may not reflect actual teamwork. The findings, based on four sites in Canada that diagnosed one type of cancer, may not be transferrable to other settings. Similar research among a larger sample of lung DAPs in other jurisdictions could confirm and expand on these findings.

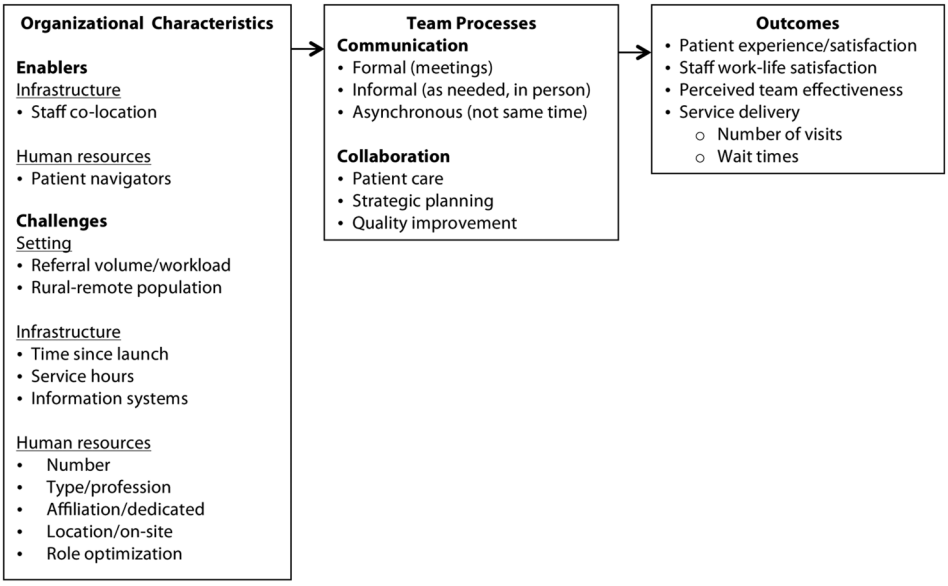

Figure 2 Conceptual framework of teamwork determinants and outcomes.

While several implications for policymaking and care delivery emerged from this study, it also identified several issues that warrant further research. Participants described various formal, informal and asynchronous teamwork processes for communication and collaboration, and numerous associated benefits. Therefore, perceived team effectiveness was high, despite the fact that service delivery targets were not achieved. Thus, interventions to improve team collaboration such as team training, checklists or structured communication tools may not be needed.[24] Instead, the organisational characteristics that challenged the work that teams do must be addressed. These included days per week of operation, information systems and the number, type and location of full-time and part-time staff. The reallocation of, or additional, resources are needed to achieve these improvements. Information is also needed on how to optimise the integration of information systems, and the number and complement of staff in DAPS. The imperative for stronger information systems to improve the quality of cancer care is well recognised.[25] By systematic review, we identified that models of teamwork or multidisciplinary collaboration have not been applied or evaluated in cancer care.[26] Thus, further research in a larger sample of DAPs could potentially identify exemplar strategies to integrate information systems and staffing models to suit variable case volumes.

Participants recommended leveraging patient navigator roles to improve teamwork. Research on patient navigators,[27] change agents[28] or knowledge brokers[29] shows that their impact is enhanced when organisations recognise and support these roles. In a concept analysis, Birken *et al*[30] described how middle managers such as patient navigators, who straddle leadership and front-line care delivery, support teamwork by functioning as the conduits of knowledge in healthcare organisations. However, Birken *et al* recommended further research to understand how to support and strengthen their role. Hence, further research is needed to identify the specific roles of navigators that lead to improved diagnostic service delivery, and the characteristics of healthcare professionals who fulfil this role. This study suggests that quality indicators of lung cancer management based on the number of visits or wait times, or on other clinical measures,[31] could be supplemented with measures of teamwork at the patient, staff, team and organisational levels, which reflect the benefits articulated by participants, and have also been suggested elsewhere.[26] These measures could be compiled to update and expand existing DAP guidelines.[8 9] Another essential issue that should be examined is the perspective of patients, which is currently absent from the published literature on DAPs, despite the fact that patient engagement is a health system priority internationally.[32] Such research might compare the views of those diagnosed in a DAP compared with usual diagnosis as a means of further distinguishing the optimal design of DAPs based on patient preferences. Finally, in this study, participants self-reported teamwork processes, determinants and benefits. To build on these findings, future research should objectively measure teamwork in DAPs using available theoretical frameworks[33] and validated instruments[34] to more definitively associate specific characteristics of teamwork and organisational support for teamwork with clinical outcomes.

Author affiliations
[1]Toronto General Hospital Research Institute, University Health Network, Toronto, Ontario, Canada
[2]Gattuso Rapid Diagnosis Centre, University Health Network, Toronto, Ontario, Canada
[3]Division of Thoracic Surgery, University Health Network, Toronto, Ontario, Canada
[4]Ages Cancer Assessment Clinic, Ottawa Hospital, Ottawa, Canada
[5]Institute for Health Policy, Management and Evaluation, University of Toronto, Toronto, Ontario, Canada

[6]Department of Clinical Epidemiology and Biostatistics, McMaster University, Hamilton, Ontario, Canada

Acknowledgements The authors thank NH who assisted with qualitative interviews; and contacts at participating sites who facilitated data collection, who are not named so that participating sites remain anonymous.

Contributors The study was conceived by ARG, TS-M, MJD, MCB and TW. Funding was acquired by ARG. All authors contributed to study planning and monitoring. Data were collected, analysed and interpreted by all authors. The manuscript was drafted and edited by all authors.

Funding This work was supported by the Canadian Breast Cancer Foundation—Ontario Chapter.

Competing interests None declared.

Ethics approval University Health Network Research Ethics Board.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement Extra data can be accessed via the Dryad data repository at http://datadryad.org/ with the doi:10.5061/dryad.tq106.

REFERENCES

1. Brar SS, Hong NL, Wright FC. Multidisciplinary cancer care: does it improve outcomes? *J Surg Oncol* 2014;110:494–9.
2. Gagliardi AR, Wright FC, Davis D, *et al*. Challenges in multidisciplinary cancer care among general surgeons in Canada. *BMC Med Inform Decis Mak* 2008;8:59.
3. Macleod U, Mitchell ED, Burgess C, *et al*. Risk factors for delayed presentation and referral of symptomatic cancer: evidence for common cancers. *Br J Cancer* 2009;101(Suppl 2):92–101.
4. Pedersen AF, Olesen F, Hansen RP, *et al*. Coping strategies and patient delay in patients with cancer. *J Psychosoc Oncol* 2013;31:204–18.
5. Mansell G, Shapley M, Jordan JL, *et al*. Interventions to reduce primary care delay in cancer referral. *Br J Gen Pract* 2011;61:e821–35.
6. Brown S, Castelli M, Hunter DJ, *et al*. How might healthcare systems influence speed of cancer diagnosis: a narrative review. *Soc Sci Med* 2014;116:56–63.
7. Brouwers M, Oliver TK, Crawford J, *et al*. Cancer diagnostic assessment programs: standards for the organization of care in Ontario. *Curr Oncol* 2009;16:29–41.
8. Wilson AR, Marotti L, Bianchi S, *et al*. The requirements of a specialist breast centre. *Eur J Cancer* 2013;49:3579–87.
9. Chudgar NP, Bucciarelli PR, Jeffries EM, *et al*. Results of the National Lung Cancer Screening Trial: where are we now? *Thorac Surg Clin* 2015;25:145–53.
10. Ost DE, Yeung SC, Tanoue LT, *et al*. Clinical and organizational factors in the initial evaluation of patients with lung cancer. *Chest* 2013;143(5 Suppl):121–41.
11. Olsson JK, Schultz EM, Gould MK. Timeliness of care in patients with lung cancer: a systematic review. *Thorax* 2009;64:749–56.
12. Brocken P, Kiers BA, Looijen-Salamon MG, *et al*. Timeliness of lung diagnosis and treatment in a rapid outpatient diagnostic program with combined 18FDG-PET and contrast enhanced CT scanning. *Lung Cancer* 2012;75:336–41.
13. Alsamarai S, Yao X, Cain HC, *et al*. The effect of a lung cancer coordination program on timeliness of care. *Clin Lung Cancer* 2013;14:527–54.
14. Lo DS, Zeldin RA, Skrastins R, *et al*. Time to treat: a system redesign focusing on decreasing the time from suspicion of lung cancer to diagnosis. *J Thorac Oncol* 2007;2:1001–6.
15. Fetters MD, Curry LA, Creswell JW. Achieving integration in mixed methods designs—principles and practices. *Health Serv Res* 2013;48(Pt 2):2134–55.
16. Yin RK. Enhancing the quality of case studies in health services research. *Health Serv Res* 1999;34(Pt 2):1209–24.
17. OCathain A, Murphy E, Nicholl J. The quality of mixed methods studies in health services research. *J Health Serv Res Policy* 2008;13:92–8.
18. Sandelowski M. Whatever happened to qualitative description? *Res Nurs Health* 2000;23:334–40.
19. Clark JP. How to peer review a qualitative manuscript. In: Godlee F, Jefferson T, eds. *Peer review in health sciences*. 2nd edn. London: BMJ Books, 2003:219–35.
20. Auerbach CF Silverstein LB., *Qualitative data: an introduction to coding and analysis*. New York: New York University Press, 2003.
21. von Elm E, Altman DG, Egger M, *et al*. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *J Clin Epidemiol* 2008;61:344–9.
22. Lemieux-Charles L, McGuire WL. What do we know about health care team effectiveness: a review of the literature. *Med Care Res Rev* 2006;63:263–300.
23. Ryoo JJ, Malin JL, Ordin DL, *et al*. Facility characteristics and quality of lung cancer care in an integrated health care system. *J Thorac Oncol* 2014;9:447–55.
24. Weaver SJ, Dy SM, Rosen MA. Team-training in healthcare: a narrative synthesis of the literature. *BMJ Qual Saf* 2014;23:359–72.
25. Feeley TW, Sledge GW, Levit L, *et al*. Improving the quality of cancer care in America through health information technology. *J Am Med Inform Assoc* 2014;21:772–5.
26. Gagliardi AR, Dobrow MJ, Wright FC. How can we improve cancer care? A review of interprofessional collaboration models and their use in clinical management. *Surg Oncol* 2011;20:146–54.
27. Cook S, Fillion L, Fitch M, *et al*. Core areas of practice and associated competencies for nurses working as professional cancer navigators. *Can Oncol Nurs J* 2013;23:44–62.
28. McCormack B, Rycroft-Malone J, Decorby K, *et al*. A realist review of interventions and strategies to promote evidence-informed healthcare: a focus on change agency. *Implement Sci* 2013;8:107.
29. Traynor R, DeCorby K, Dobbins M. Knowledge brokering in public health: a tale of two studies. *Public Health* 2014;128:533–44.
30. Birken SA, Lee SYD, Weiner BJ. Uncovering middle managers' role in healthcare innovation implementation. *Implement Sci* 2012;7:28.
31. Darling G, Malthaner R, Dickie J, *et al*. Quality indicators for non-small cell lung cancer operations with use of a modified Delphi consensus process. *Ann Thorac Surg* 2014;98:183–90.
32. Carman KL, Dardess P, Maurer M, *et al*. Patient and family engagement: a framework for understanding the elements and developing interventions and policies. *Health Aff* 2013;32:223–31.
33. Rousseau V, Aube C, Savoie A. Teamwork behaviors. A review and an integration of frameworks. *Small Group Res* 2006;37:540–70.
34. Valentine MA, Nembhard IM, Edmondson AC. Measuring teamwork in health care settings: a review of survey instruments. *Med Care* 2015;53:e16–30.