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How do organizational characteristics influence teamwork and service delivery in lung cancer diagnostic assessment programs: a mixed methods study

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ABSTRACT

Objectives
Diagnostic assessment programs (DAPs) can reduce wait times for cancer diagnosis but optimal DAP design is unknown. This study explored how organizational 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 four lung cancer DAPs. Findings were analyzed with the Integrated Team Effectiveness Model.

Setting
Four DAPs at two teaching and two community hospitals in Canada

Participants
Twenty-two staff were interviewed about organizational 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 co-location, 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 co-location 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 organizational 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.

SUMMARY

Strengths and limitations of this study

- Data reflecting structures, processes and outcomes of diagnostic assessment programs 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 organizational characteristics, teamwork and service delivery, providing detailed insight on how diagnostic assessment program design could be optimized
- The study was conducted in Canada which features a publicly-funded health care system, and findings may not be transferrable to other settings
- Study findings pertain to lung cancer diagnosis, thus the organizational characteristics that influence teamwork and service delivery may differ in other health care contexts

INTRODUCTION

Multidisciplinary teamwork is essential for the optimal diagnosis of patients with cancer.[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 minimized delays in referral and diagnosis.[6,7] These centralized diagnostic services have been referred to as diagnostic assessment programs (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 both men and women, and is 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 lung cancer patients seen at a rapid outpatient diagnostic program, 87% were diagnosed within three weeks of referral, and 52.5% started curative treatment within two weeks of diagnosis.[12] Pre-post evaluation of a coordinated lung cancer program reduced the time from first abnormal image to initiation of treatment by 25 days.[13] In another study, implementation of a coordinated lung cancer program 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 optimizing 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 policy-makers 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 could influence DAP characteristics. A convergent mixed methods approach was used where qualitative and quantitative methods were prioritized 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 rigor 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. Participants were asked to describe teamwork processes, outcomes and determinants, and recommendations to enhance teamwork. Interviews were held from January 29 to October 15, 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 a research assistant (RA) determined thematic saturation was achieved. Themes were identified using constant comparative technique.[20] Transcribed interviews were read independently by the PI and RA to identify, define and organize 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 January 1, 2012 to December 31, 2012. Sampling was based on 2011 referral volumes which varied across sites. From site B, C and D, 80 patients (15% of patients at site with 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, 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), and those who 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 computed tomography of the chest; biopsy with fine needle aspiration, bronchoscopy or open biopsy; staging with positron emission tomography or magnetic resonance imaging); 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 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 Chi square test to compare proportions by site. The number of visits and wait times were compared by site using the Kruskal-Wallis non-parametric test, and we reported the Dunn's adjusted p values based on multiple comparisons between groups. Analyses were performed with IBM SPSS (*version 21, SPSS Statistics/IBM Corp, Chicago IL, USA*).

Qualitative and quantitative data were integrated by weaving the qualitative findings through the description of quantitative findings (narrative approach), and visually depicting potential associations between qualitative and quantitative findings (joint display).[15] Findings were further analyzed for concordance, discordance or expansion. Findings were also analyzed according to the Integrated Team Effectiveness Model (ITEM) which suggests that organizational characteristics (structures, resources, information systems) influence team communication and collaboration processes, leading to subjective outcomes such as perceived team effectiveness, and objective clinical outcomes.[22] 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

Organizational characteristics

Participating sites were similar in terms of regional access and most operational features (Table 1). Apart from sampling criteria (health region, urban versus 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. 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.

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
Service delivery model				
Scope of care diagnostic only	Yes	Yes	Yes	Yes
Single location	Yes	Yes	Yes	Yes
Single visit diagnosis	No	No	No	No
Patient risk level	All	All	All	All
Regional access				
Single point of entry	Yes	Yes	Yes	Yes
Accepts referral from all sources	Yes	Yes	Yes	Yes
Operational features				
Days per week	5	5	1 to 3	5
Referral and triage criteria	Yes	Yes	Yes	Yes
Protected booking slots	Yes	Yes	Yes	Yes
Dedicated governance structure	Yes	Yes	Yes	Yes

Characteristics	Participating site			
	A	B	C	D
Guidelines/service framework	Yes	Yes	Yes	Yes
Performance reporting	Yes	Yes	Yes	Yes
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 to 17 days	Within 7 to 14 days	Within 14 to 24 days	Within 14 to 21 days
Target time to consult*	7 to 28 days	14 to 21 days	Within 28 days	Within 28 days
Target number of total visits*	2 to 4	2 to 4	2 to 3	2 to 3 (1 to 2 in person, 1 via telehealth)

F full-time; P part-time

* Target refers to intended/planned according to goals/internal protocols

Multidisciplinary teamwork

Twenty-two individuals reflecting a variety of professionals were interviewed (Supplemental 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; in-person and asynchronous via shared medical records or telemedicine; and for patient care, strategic planning and quality improvement. Teamwork was said to be enabled by staff co-location and patient navigators. Many individual, team, organization and patient level benefits of teamwork were perceived 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 2. Exemplar quotes from interview participants

Themes	Sub-themes (specific to site)	Exemplar quote
MDT examples	Informal	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	Patients are triaged every day so there's planning rounds (Surgeon 20B)
	Asynchronous	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	Co-location 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)
	Optimize scope of practice	Clearly defining roles and maximizing the scope of practice for each of the disciplines that are involved (Clinical Director 7B)

Service delivery benchmarks

A total of 314 medical records were reviewed (Supplemental 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 lung cancer patients 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 (*organizational characteristics*) and site C which did not operate daily (*organizational characteristics*). Participants at both sites also reported insufficient human resources (*staffing*).

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, interquartile range)				Total
	A	B	C	D	
Diagnosis confirmed with CT	9 1.0 1.0 to 1.0	4 1.0 1.0 to 1.0	2 1.0 1.0 to 1.0	19 1.0 1.0 to 1.0	34 1.0 1.0 to 1.0
Diagnosis confirmed with PET, MRI	5 2.0 2.0 to 2.0	2 2.0 2.0 to 2.0	6 2.0 2.0 to 2.0	2 2.5 2.0 to 3.0	15 2.0 2.0 to 2.0
Diagnosis confirmed with biopsy	119 3.0* 2.0 to 4.0	52 2.0 2.0 to 3.0	43 3.0* 2.0 to 4.0	51 2.0 2.0 to 4.0	265 3.0 2.0 to 4.0
Consult	119 4.0 3.0 to 5.0	50 4.0 3.0 to 5.0	30 4.0 4.0 to 5.0	45 4.0 3.0 to 5.0	244 4.0 3.0 to 5.0
Target number of total visits from referral to consult (refer to Table 2)	2 to 4	2 to 4	2 to 3	2 to 3 (1 to 2 in person, 1 via telehealth)	

All associations significant at p<0.05

* Patients at site A and C had significantly more visits compared with sites B and D

The actual number of visits from referral to consult was higher than the benchmark target for site C which operated 1 to 3 days per week (*organizational 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 traveling 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 (*organizational characteristics*).

The median wait time 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, on-

site rather than telehealth consult for many patients, and challenges in scheduling locum radiologists and patients from remote communities (*rural-remote region, staffing, recently launched*).

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

The actual wait times from referral to diagnosis and to consult were higher than target benchmarks for all sites, likely reflecting insufficient number and complement of human resources, most of whom were not employed full-time by the DAP, had competing priorities and were not co-located (*staffing*) at all sites; high referral volume (*organizational characteristics*) at site A and B; operating a few days per week (*organizational 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, co-location, 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) were 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 to consult (quantitative data) were 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] to 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 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 improved information systems, more staff of all specialties, co-location of staff, and capitalizing 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 policy-makers 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 4,804 lung cancer patients 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 optimize DAP design. However, several factors limit the interpretation and application of these findings. Findings reflect services as 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 optimization of diagnostic service delivery. Data collected from DAPs were not compared with data from non-DAP patients. 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.

Several implications for policy-making, practice and ongoing research emerged from this study. 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 communicate tools may not be needed.[24] Instead, the organizational characteristics that challenge 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, all of which require the reallocation of, or additional resources. However, further research in a larger sample of DAPs could identify optimal staffing models to suit variable case volumes.

Participants recommended leveraging patient navigator roles to improve teamwork. Research on patient navigators,[25] change agents[26] or knowledge brokers[27] shows that their impact is enhanced when organizations recognize and support these roles. Hence, further research is needed to identify the specific roles of navigators that lead to improved diagnostic service delivery, and the characteristics of health care professionals who fulfill 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,[28] could be supplemented with measures of teamwork at the patient, staff, team and organizational levels, which reflect the benefits articulated by participants, and have also been suggested elsewhere.[29] 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.[30] 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.

AUTHOR CONTRIBUTIONS

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

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COMPETING INTERESTS

We have read and understood BMJ policy on declaration of interests and declare that we have no competing interests

DATA SHARING

Technical appendix, statistical code, and dataset available from the Dryad repository, DOI: [include DOI for dataset here]

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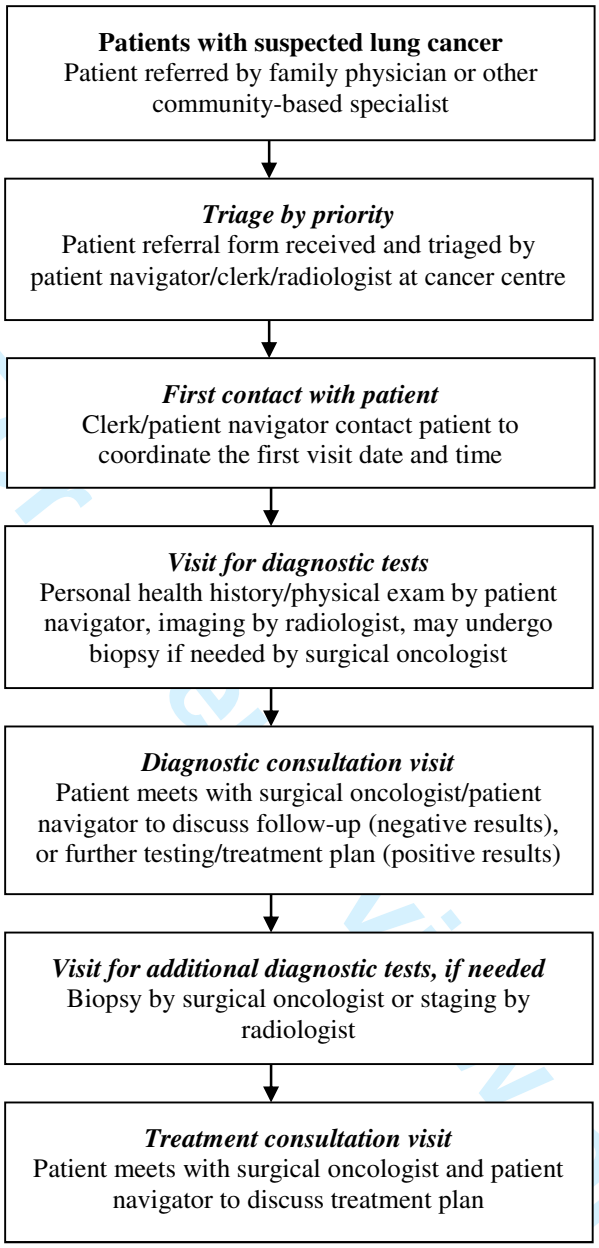
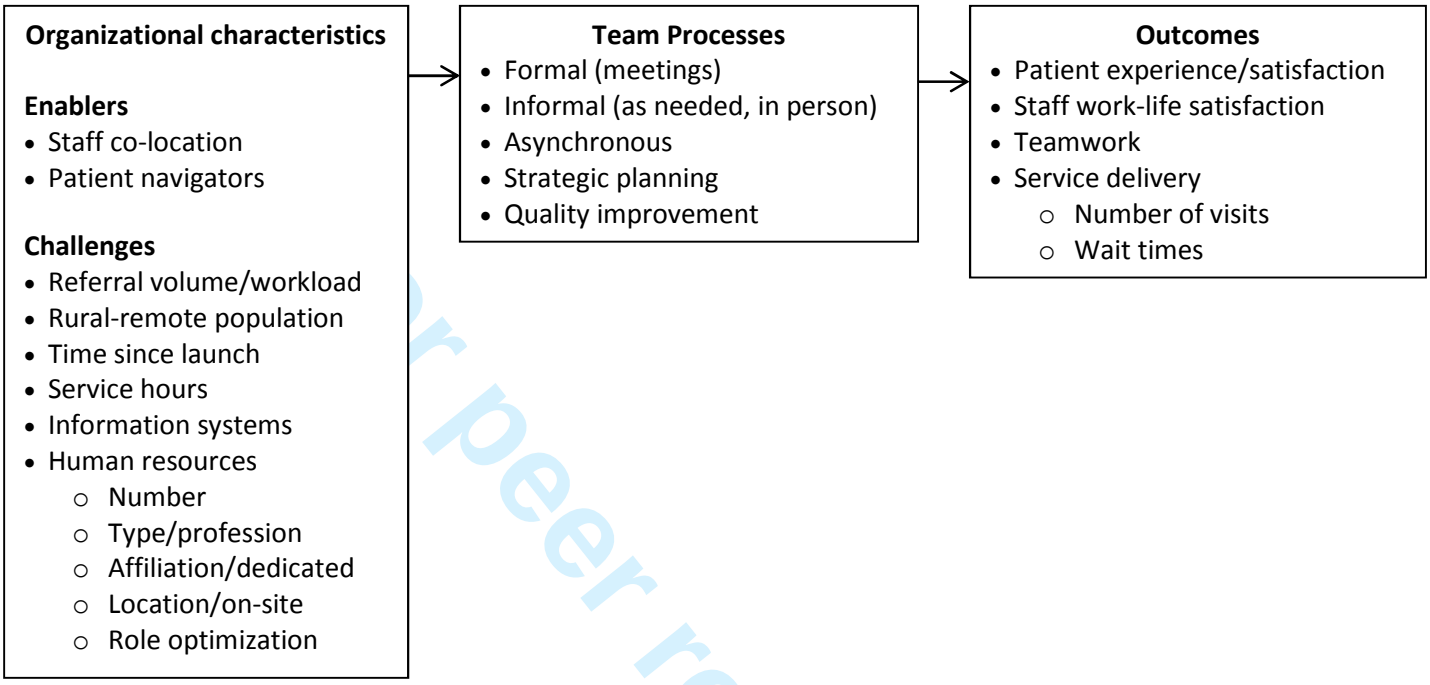
FIGURE LEGEND

Figure 1. Lung cancer diagnostic trajectory

Figure 2. Conceptual framework of teamwork determinants and outcomes





Supplmental File 1. Interview participants

Professional role	Participating site (unique ID)				Total
	A	B	C	D	
Medical Director	---	29 (surgeon)	---	---	1
Clinical Director	---	07 (APN)	---	25	2
Clinical Manager	---	34 (RN)	---	---	1
Patient Navigator	---	32 (RN)	14 (RN) 31 (RN)	26 (RN)	4
Surgeon	01	08 20	18	28	5
Nurse	---	22 (RN)	---	---	1
Radiologist	21	---	---	---	1
Respirologist	---	---	13	---	1
Social Worker	---	038	---	---	1
Clerk	03	015	---	39	3
Referring Family Physician	---	---	33	36	2
Total	3	9	5	5	22

APN advanced practice nurse; RN registered nurse

Supplemental File 2. Patient characteristics, diagnostic procedures and findings

Patient characteristics	Participating site n (%)				Total
	A	B	C	D	
Number participants	133	58	51	72	314
Mean age (years)	67.3	69.3	68.3	70.3	68.5
Sex					
Female	58 (43.6)	29 (50.0)	25 (49.0)	32 (44.4)	144 (45.9)
Male	75 (56.4)	29 (50.0)	26 (51.0)	40 (55.6)	170 (54.1)
Confirmatory procedure					
Imaging	14 (10.5)	6 (10.3)	8 (15.7)	21 (29.2)*	49 (15.6)
Biopsy	119 (89.5)	52 (89.7)	43 (84.3)	51 (70.8)	265 (84.4)
Diagnostic results					
Positive	96 (72.2)#	42 (72.4)#	33 (64.7)	34 (47.2)	205 (65.3)
Negative	8 (6.0)	4 (6.9)	2 (3.9)	5 (6.9)	19 (6.1)
Follow-up	29 (21.8)	12 (20.7)	16 (31.4)	33 (45.8)^	90 (28.7)

ns not significant at p = 0.05

* more patients at site D had imaging and fewer had biopsy as the confirmatory diagnosis

more patients at sites A and B were diagnosed with lung cancer compared with patients at site D

^ more patients at site D required follow-up compared with patients at sites A and B

Good Reporting of A Mixed Methods Study (GRAMMS)

O'Cathain A, Murphy E, Nicholl J. The quality of mixed methods studies in health services research. J Health Serv Res Policy 2008;13:92-8.

Domains and Items	Page in manuscript
Describe the justification for using a mixed methods approach to the research question	4
Describe the design in terms of the purpose, priority and sequence of methods	4
Describe each method in terms of sampling, data collection and analysis	4-5
Describe where integration has occurred, how it has occurred and who has participated in it	6
Describe any limitation of one method associated with the presentation of the other method	6
Describe any insights gained from mixing or integrating methods	10-11, Figure 1

Relevance, Appropriateness, Transparency and Soundness (RATS) principles for the reporting of qualitative research

Clark JP: *How to peer review a qualitative manuscript*. In *Peer Review in Health Sciences*. Second edition. Edited by Godlee F, Jefferson T. London: BMJ Books; 2003:219-235

RATS Domains and Items	Page in manuscript
R – relevance of study question	
Research question explicitly stated	4
Research question justified and linked to the existing knowledge base (empirical research, theory, policy)	4
A – appropriateness of qualitative method	
Study design described and justified i.e., why was a particular method (e.g., interviews) chosen	4
T – transparency of procedures	
Criteria for selecting the study sample justified and explained	4-5
Details of how recruitment was conducted and by whom	4-5
Details of who chose not to participate and why	4, Table 1, Supplemental Files 1 and 2
Data collection method outlined	5
Study group and setting clearly described	4-5, Table 1, Supplemental Files 1 and 2
End of data collection justified and described	5
Do the researchers occupy dual roles (clinician and researcher)? Are the ethics of this discussed	n/a
Ethics approval cited	4
Informed consent process explicitly and clearly detailed	5
S – soundness of interpretive approach	
Analytic approach described in depth and justified: Description of how themes were derived from the data (inductive or deductive); Evidence of alternative explanations being sought; Analysis and presentation of negative or deviant cases	5, Table 2
Description of the basis on which quotes were chosen. Illumination of context and/or meaning, richly detailed	Table 2, 6-11
Method of reliability check described and justified: e.g., was an audit trail, triangulation, or member checking employed? Did an independent analyst review data and contest themes? How were disagreements resolved?	6
Strengths and limitations explicitly described and discussed	11
Detail of methods or additional quotes contained in appendix	Supplemental Files 1,2

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any pre-specified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4-5
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	4-5
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	n/a
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-6
Bias	9	Describe any efforts to address potential sources of bias	5-6
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	5-6
		(*b*) Describe any methods used to examine subgroups and interactions	5-6
		(*c*) Explain how missing data were addressed	n/a
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	n/a
		(*e*) Describe any sensitivity analyses	n/a

Results			**Page**
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5, 8-10, Table 3,4, Supplemental Files 1 and 2
		(b) Give reasons for non-participation at each stage	5, 8-10, Table 3,4
		(c) Consider use of a flow diagram	n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8-9, Table 1, Supplemental Files 1 and 2
		(b) Indicate number of participants with missing data for each variable of interest	5, 8-10, Table 3,4,
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	n/a
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	8-10, Table 3,4,
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	n/a
		Cross-sectional study—Report numbers of outcome events or summary measures	n/a
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8-10, Table 3,4,
		(b) Report category boundaries when continuous variables were categorized	8-10, Table 3,4,
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	7-11
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11-12
Generalisability	21	Discuss the generalisability (external validity) of the study results	11
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	12

BMJ Open

How do organizational characteristics influence teamwork and service delivery in lung cancer diagnostic assessment programs?: a mixed methods study

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Primary Subject Heading:	Health services research
Secondary Subject Heading:	Communication, Health services research, Oncology, Patient-centred medicine, Qualitative research
Keywords:	lung neoplasms, diagnostic techniques and procedures, systems integration, patient care team, interprofessional relations

How do organizational characteristics influence teamwork and service delivery in lung cancer diagnostic assessment programs?: a mixed methods study

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ABSTRACT

Objectives

Diagnostic assessment programs (DAPs) can reduce wait times for cancer diagnosis but optimal DAP design is unknown. This study explored how organizational 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 four lung cancer DAPs. Findings were analyzed with the Integrated Team Effectiveness Model.

Setting

Four DAPs at two teaching and two community hospitals in Canada

Participants

Twenty-two staff were interviewed about organizational 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 co-location, 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 co-location 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 organizational 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.

SUMMARY

Strengths and limitations of this study

- Data reflecting structures, processes and outcomes of diagnostic assessment programs 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 organizational characteristics, teamwork and service delivery, providing detailed insight on how diagnostic assessment program design could be optimized
- The study was conducted in Canada which features a publicly-funded health care system, and findings may not be transferrable to other settings
- Study findings pertain to lung cancer diagnosis, thus the organizational characteristics that influence teamwork and service delivery may differ in other health care contexts

INTRODUCTION

Multidisciplinary teamwork is essential for the optimal diagnosis, management and outcomes of patients with cancer.[1] Multidisciplinary teamwork implies in-person or remote concurrent or asynchronous interaction among health care 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 minimized delays in referral and diagnosis.[6,7] These centralized diagnostic services have been referred to as diagnostic assessment programs (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 both men and women, and is 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 lung cancer patients seen at a rapid outpatient diagnostic program, 87% were diagnosed within three weeks of referral, and 52.5% started curative treatment within two weeks of diagnosis.[12] Pre-post evaluation of a coordinated lung cancer program reduced the time from first abnormal image to initiation of treatment by 25 days.[13] In another study, implementation of a coordinated lung cancer program 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 optimizing 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 policy-makers 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 prioritized 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 rigor 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. The semi-structured 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 January 29 to October 15, 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 a research assistant (RA) determined thematic saturation was achieved. Themes were identified using constant comparative technique.[20] Transcribed interviews were read independently by the PI and RA to identify, define and organize 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 January 1, 2012 to December 31, 2012. Sampling was based on 2011 referral volumes, which varied across sites. From site B, C and D, 80 patients (15% of patients at site with 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 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 computed tomography of the chest; biopsy with fine needle aspiration, bronchoscopy or open biopsy; staging with positron emission tomography or magnetic resonance imaging), 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 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 Chi square test was used to compare proportions by site. The number of visits and wait times were compared by site using the Kruskal-Wallis non-parametric test; the Dunn's adjusted p values based on multiple comparisons between groups were reported. Analyses were performed with IBM SPSS (*version 21, SPSS Statistics/IBM Corp, Chicago IL, 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 analyzed for concordance, discordance or expansion. To visually integrate and interpret findings, they were also analyzed according to the Integrated Team Effectiveness Model (ITEM), which emerged from a review of literature on health care 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 organizational characteristics (e.g. structures, resources, information systems) and team composition (i.e. size, tenure, diversity) influence team processes (i.e. communication, collaboration), leading to subjective outcomes (i.e. perceived team effectiveness) and objective outcomes (i.e. 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

Organizational 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 versus 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.

Table 1. Characteristics of participating DAPs

Characteristics	Participating site			
	A	B	C	D
Demographics				

Characteristics	Participating site			
	A	B	C	D
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 to 17 days	Within 7 to 14 days	Within 14 to 24 days	Within 14 to 21 days
Target time to consult*	7 to 28 days	14 to 21 days	Within 28 days	Within 28 days
Target number of total visits*	2 to 4	2 to 4	2 to 3	2 to 3 (1 to 2 in person, 1 via telehealth)

F full-time; P part-time

* Target refers to intended/planned according to goals/internal protocols

Multidisciplinary teamwork

Twenty-two individuals reflecting a variety of professionals were interviewed (Supplemental 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 in-person 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 co-location and patient navigators. Participants perceived many individual, team, organization 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 2. Exemplar quotes from interview participants

Themes	Sub-themes (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 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	Co-location 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)
	Optimize scope of practice	Clearly defining roles and maximizing the scope of practice for each of the disciplines that are involved (Clinical Director 7B)

Service delivery benchmarks

A total of 314 medical records were reviewed (Supplemental 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 lung cancer patients 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 (*organizational characteristics*), and site C, which did not operate daily (*organizational characteristics*). Participants at both sites also reported insufficient human resources (*staffing*).

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, interquartile range)				Total
	A	B	C	D	
Diagnosis confirmed with CT	9 1.0 1.0 to 1.0	4 1.0 1.0 to 1.0	2 1.0 1.0 to 1.0	19 1.0 1.0 to 1.0	34 1.0 1.0 to 1.0
Diagnosis confirmed with PET, MRI	5 2.0 2.0 to 2.0	2 2.0 2.0 to 2.0	6 2.0 2.0 to 2.0	2 2.5 2.0 to 3.0	15 2.0 2.0 to 2.0
Diagnosis confirmed with biopsy	119 3.0* 2.0 to 4.0	52 2.0 2.0 to 3.0	43 3.0* 2.0 to 4.0	51 2.0 2.0 to 4.0	265 3.0 2.0 to 4.0
Consult	119 4.0 3.0 to 5.0	50 4.0 3.0 to 5.0	30 4.0 4.0 to 5.0	45 4.0 3.0 to 5.0	244 4.0 3.0 to 5.0
Target number of total visits from referral to consult (refer to Table 2)	2 to 4	2 to 4	2 to 3	2 to 3 (1 to 2 in person, 1 via telehealth)	

All associations significant at $p<0.05$

* Patients at site A and C had significantly more visits compared with sites B and D

The actual number of visits from referral to consult was higher than the benchmark target for site C, which operated 1 to 3 days per week (*organizational 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 traveling 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 (*organizational characteristics*).

The median wait time 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 on-site 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*).

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

The actual wait times from referral to diagnosis and to consult were higher than target benchmarks for all sites, 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 co-located (*staffing*) at all sites; high referral volume (*organizational characteristics*) at site A and B; operating a few days per week (*organizational 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, co-location,

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, co-locating staff, and capitalizing 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 policy-makers 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 4,804 lung cancer patients 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 optimize DAP design. However, several factors limit the interpretation and application of these findings. Findings

reflect services as 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 optimization 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.

While several implications for policy-making 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 communicate tools may not be needed.[24] Instead, the organizational 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 optimize 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-recognized.[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 organizations recognize and support these roles. In a concept analysis, Birken et al. described how middle managers such as patient navigators, who straddle both leadership and front-line care delivery, support teamwork by functioning as the conduits of knowledge in health care organizations.[30] 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 health care professionals who fulfill 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 organizational 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 organizational support for teamwork with clinical outcomes.

AUTHOR CONTRIBUTIONS

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

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COMPETING INTERESTS

We have read and understood BMJ policy on declaration of interests and declare that we have no competing interests

DATA SHARING

Technical appendix, statistical code, and dataset available from the Dryad repository, DOI: [include DOI for dataset here]

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FIGURE LEGEND

Figure 1. Lung cancer diagnostic trajectory

Figure 2. Conceptual framework of teamwork determinants and outcomes

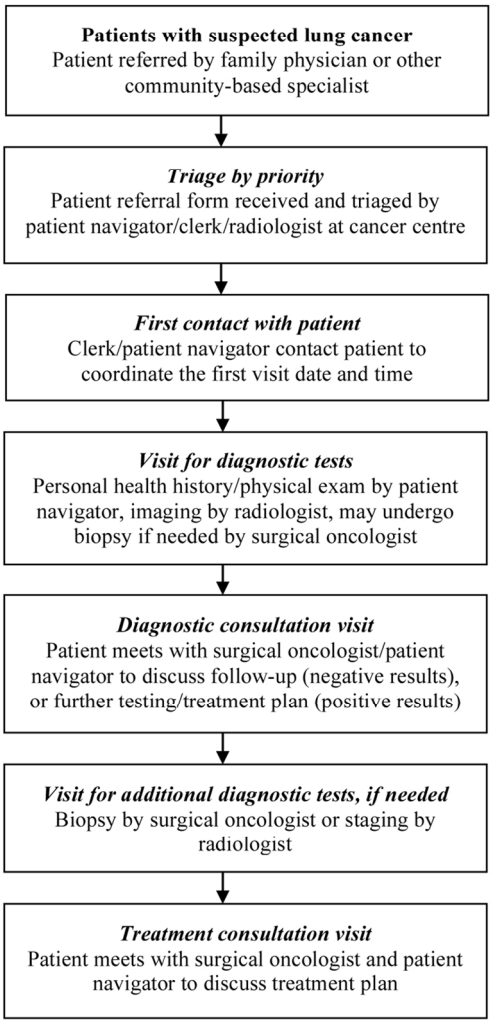

Figure 1. Lung cancer diagnostic trajectory

93x152mm (300 x 300 DPI)

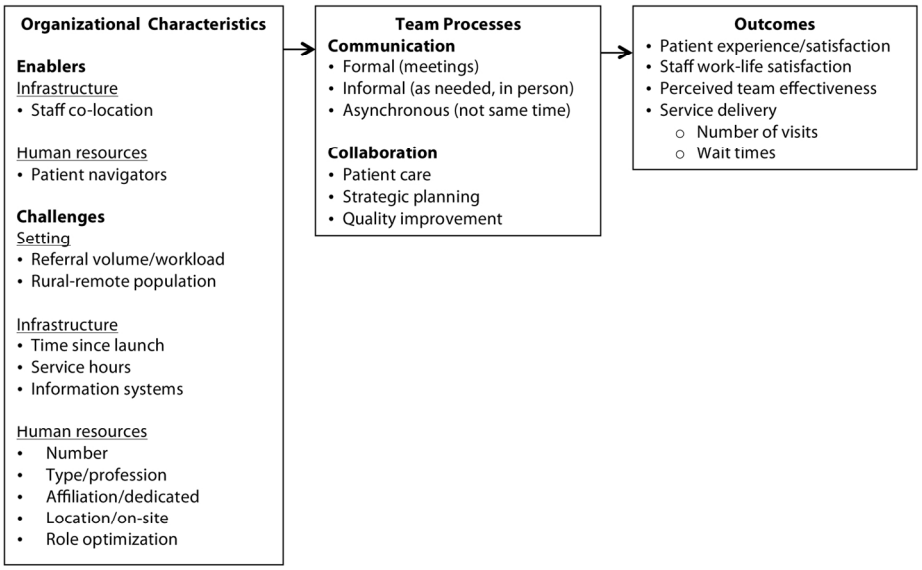

Figure 2. Conceptual framework of teamwork determinants and outcomes

152x99mm (300 x 300 DPI)

Supplmental File 1. Interview participants

Professional role	Participating site (unique ID)				Total
	A	B	C	D	
Medical Director	---	29 (surgeon)	---	---	1
Clinical Director	---	07 (APN)	---	25	2
Clinical Manager	---	34 (RN)	---	---	1
Patient Navigator	---	32 (RN)	14 (RN) 31 (RN)	26 (RN)	4
Surgeon	01	08 20	18	28	5
Nurse	---	22 (RN)	---	---	1
Radiologist	21	---	---	---	1
Respirologist	---	---	13	---	1
Social Worker	---	038	---	---	1
Clerk	03	015	---	39	3
Referring Family Physician	---	---	33	36	2
Total	3	9	5	5	22

APN advanced practice nurse; RN registered nurse

Supplemental File 2. Patient characteristics, diagnostic procedures and findings

Patient characteristics	Participating site n (%)				Total
	A	B	C	D	
Number participants	133	58	51	72	314
Mean age (years)	67.3	69.3	68.3	70.3	68.5
Sex					
Female	58 (43.6)	29 (50.0)	25 (49.0)	32 (44.4)	144 (45.9)
Male	75 (56.4)	29 (50.0)	26 (51.0)	40 (55.6)	170 (54.1)
Confirmatory procedure					
Imaging	14 (10.5)	6 (10.3)	8 (15.7)	21 (29.2)*	49 (15.6)
Biopsy	119 (89.5)	52 (89.7)	43 (84.3)	51 (70.8)	265 (84.4)
Diagnostic results					
Positive	96 (72.2)#	42 (72.4)#	33 (64.7)	34 (47.2)	205 (65.3)
Negative	8 (6.0)	4 (6.9)	2 (3.9)	5 (6.9)	19 (6.1)
Follow-up	29 (21.8)	12 (20.7)	16 (31.4)	33 (45.8)^	90 (28.7)

ns not significant at p = 0.05

* more patients at site D had imaging and fewer had biopsy as the confirmatory diagnosis

more patients at sites A and B were diagnosed with lung cancer compared with patients at site D

^ more patients at site D required follow-up compared with patients at sites A and B

Good Reporting of A Mixed Methods Study (GRAMMS)

O'Cathain A, Murphy E, Nicholl J. The quality of mixed methods studies in health services research. J Health Serv Res Policy 2008;13:92-8.

Domains and Items	Page in manuscript
Describe the justification for using a mixed methods approach to the research question	4
Describe the design in terms of the purpose, priority and sequence of methods	4
Describe each method in terms of sampling, data collection and analysis	4-5
Describe where integration has occurred, how it has occurred and who has participated in it	6
Describe any limitation of one method associated with the presentation of the other method	6
Describe any insights gained from mixing or integrating methods	10-11, Figure 1

Relevance, Appropriateness, Transparency and Soundness (RATS) principles for the reporting of qualitative research

Clark JP: *How to peer review a qualitative manuscript*. In *Peer Review in Health Sciences*. Second edition. Edited by Godlee F, Jefferson T. London: BMJ Books; 2003:219-235

RATS Domains and Items	Page in manuscript
R – relevance of study question	
Research question explicitly stated	4
Research question justified and linked to the existing knowledge base (empirical research, theory, policy)	4
A – appropriateness of qualitative method	
Study design described and justified i.e., why was a particular method (e.g., interviews) chosen	4
T – transparency of procedures	
Criteria for selecting the study sample justified and explained	4-5
Details of how recruitment was conducted and by whom	4-5
Details of who chose not to participate and why	4, Table 1, Supplemental Files 1 and 2
Data collection method outlined	5
Study group and setting clearly described	4-5, Table 1, Supplemental Files 1 and 2
End of data collection justified and described	5
Do the researchers occupy dual roles (clinician and researcher)? Are the ethics of this discussed	n/a
Ethics approval cited	4
Informed consent process explicitly and clearly detailed	5
S – soundness of interpretive approach	
Analytic approach described in depth and justified: Description of how themes were derived from the data (inductive or deductive); Evidence of alternative explanations being sought; Analysis and presentation of negative or deviant cases	5, Table 2
Description of the basis on which quotes were chosen. Illumination of context and/or meaning, richly detailed	Table 2, 6-11
Method of reliability check described and justified: e.g., was an audit trail, triangulation, or member checking employed? Did an independent analyst review data and contest themes? How were disagreements resolved?	6
Strengths and limitations explicitly described and discussed	11
Detail of methods or additional quotes contained in appendix	Supplemental Files 1,2

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any pre-specified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4-5
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	4-5
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	n/a
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-6
Bias	9	Describe any efforts to address potential sources of bias	5-6
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	5-6
		(*b*) Describe any methods used to examine subgroups and interactions	5-6
		(*c*) Explain how missing data were addressed	n/a
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	n/a
		(*e*) Describe any sensitivity analyses	n/a

Results			Page
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5, 8-10, Table 3,4, Supplemental Files 1 and 2
		(b) Give reasons for non-participation at each stage	5, 8-10, Table 3,4
		(c) Consider use of a flow diagram	n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8-9, Table 1, Supplemental Files 1 and 2
		(b) Indicate number of participants with missing data for each variable of interest	5, 8-10, Table 3,4,
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	n/a
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	8-10, Table 3,4,
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	n/a
		Cross-sectional study—Report numbers of outcome events or summary measures	n/a
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8-10, Table 3,4,
		(b) Report category boundaries when continuous variables were categorized	8-10, Table 3,4,
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	7-11
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11-12
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