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

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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.

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.\textsuperscript{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.\textsuperscript{5} Alternatively, facilities that provided access to multidisciplinary diagnostic services in a single location minimised delays in referral and diagnosis.\textsuperscript{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.\textsuperscript{2} DAP guidelines have been issued but provide largely consensus-based, rudimentary direction for planning and implementing DAPs.\textsuperscript{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.\textsuperscript{9} Multidisciplinary teamwork has been recommended to reduce delays in the diagnosis of lung cancer that have been observed in many countries.\textsuperscript{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.\textsuperscript{12} Pre–post evaluation of a coordinated lung cancer programme reduced the time from first abnormal image to initiation of treatment by 25 days.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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 χ² 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; 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 organizational 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 pursued 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 respiratoryists, referring family physicians and a social worker. Themes were consistent across sites (table 2). Teamwork processes were formal and informal; communication was impersonal 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.
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 characteristics) at site D.

| 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 | – | – | – | – |
| 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.
| 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 the 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      | 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)                                                                 |
| enhance MDT         | 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)                                                                           |
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. 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, 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, but evidence and guidance for optimal DAP design was lacking. 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, but is tailored to the lung cancer diagnostic context. 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. 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. 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...
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.

### 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) | Total |
|----------------------------------------|-------------------------------------------------------------------------------------------------|-------|
|                                        | A | B | C | D |                                |       |
| 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 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) | Total |
|----------------------------------------|-------------------------------------------------------------------------------------------------|-------|
|                                        | A | B | C | D |                                |       |
| 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† |                                | 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.
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. 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. By systematic review, we identified that models of teamwork or multidisciplinary collaboration have not been applied or evaluated in cancer care. 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, change agents or knowledge brokers shows that their impact is enhanced when organisations recognise and support these roles. In a concept analysis, Birken et al. described how middle managers such as patient navigators, who straddle leadership and frontline 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, 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. These measures could be compiled to update and expand existing DAP guidelines. 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. 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 and validated instruments to more definitively associate specific characteristics of teamwork and organisational support for teamwork with clinical outcomes.

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Figure 2 Conceptual framework of teamwork determinants and outcomes.
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