



Incidental pulmonary nodule management in Canada: exploring current state through a narrative literature review and expert interviews

Geneviève C. Digby¹, Jeffrey Habert², Jyoti Sahota³, Lucía Zhu⁴, Daria Manos⁵

¹Department of Medicine, Division of Respiriology, Queen's University, Kingston, ON, Canada; ²Department of Family and Community Medicine, University of Toronto, Toronto, ON, Canada; ³Health Economics and Market Access, Amaris Consulting, Toronto, ON, Canada; ⁴Health Economics and Market Access, Amaris Consulting, Barcelona, Spain; ⁵Department of Diagnostic Radiology, Dalhousie University, Halifax, NS, Canada

Contributions: (I) Conception and design: All authors; (II) Administrative support: J Sahota, L Zhu; (III) Provision of study materials or patients: All authors; (IV) Collection and assembly of data: All authors; (V) Data analysis and interpretation: All authors; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Daria Manos, MD, FRCPC. Department of Diagnostic Radiology, Dalhousie University, Victoria Building, 3rd Floor, North Wing, 1276 South Park Street, PO BOX 9000, Halifax, NS B3H 2Y9, Canada. Email: daria.manos@nshealth.ca.

Background and Objective: Incidental pulmonary nodules (IPNs) are common and increasingly detected with the overall rise of radiologic imaging. Effective IPN management is necessary to ensure lung cancer is not missed. This study aims to describe the current landscape of IPN management in Canada, understand barriers to optimal IPN management, and identify opportunities for improvement.

Methods: We performed a narrative literature review by searching biomedical electronic databases for relevant articles published between January 1, 2010, and November 22, 2023. To validate and complement the identified literature, we conducted structured interviews with multidisciplinary experts involved in the pathway of patients with IPNs across Canada. Interviews between December 2021 and May 2022 were audiovisual recorded, transcribed, and thematically analyzed.

Key Content and Findings: A total of 1,299 records were identified, of which 37 studies were included for analysis. Most studies were conducted in Canada and the United States and highlighted variability in radiology reporting of IPNs and patient management, and limited adherence to recommended follow-up imaging. Twenty experts were interviewed, including radiologists, respirologists, thoracic surgeons, primary care physicians, medical oncologists, and an epidemiologist. Three themes emerged from the interviews, supported by the literature, including: variability in radiology reporting of IPNs, suboptimal communication, and variability in guideline adherence and patient management.

Conclusions: Despite general awareness of guidelines, there is inconsistency and lack of standardization in the management of patients with IPNs in Canada. Multidisciplinary expert consensus is recommended to help overcome the communication and operational barriers to a safe and cost-effective approach to this common clinical issue.

Keywords: Incidental pulmonary nodule (IPN); radiology; patient management; literature review; expert interviews

Submitted Oct 03, 2023. Accepted for publication Dec 21, 2023. Published online Feb 27, 2024.

doi: 10.21037/jtd-23-1453

View this article at: <https://dx.doi.org/10.21037/jtd-23-1453>

Introduction

Background

Pulmonary nodules are well-circumscribed opacities in the lung, measuring under 3 cm in diameter (1,2). Incidental pulmonary nodules (IPNs) are asymptomatic nodules detected by imaging performed to investigate unrelated symptoms or conditions and are detected outside of a lung cancer screening program. IPNs are found in approximately one-third of all chest computed tomography (CT) scans (3).

Rationale and knowledge gap

Many IPNs are benign and do not require further investigation (4,5). However, approximately 4% of IPNs progress to early-stage lung cancer within two years (3). IPNs are responsible for more early-stage lung cancer diagnoses than CT screening, even in jurisdictions with well-established lung cancer screening (6,7). Prompt IPN diagnosis is critical to detect lung cancer early and improve survival (5,8-11). While biopsies can evaluate larger IPNs, many IPNs are too small to accurately characterize radiographically and are not amenable to invasive testing (4,11). In these cases, surveillance with serial imaging is required to assess for malignancy (4,12,13). However, there is currently no available evidence on the current state of IPN management across Canada.

Objective

The recent increase in CT imaging in Canada (14) has led to additional IPN detection, highlighting the importance of ensuring standardized, equitable IPN management processes (15). We sought to describe the current state of IPN management in Canada through a narrative literature review and interviews with Canadian key opinion leaders (KOLs) with IPN expertise to identify barriers to optimal management and opportunities for improvement. We present this article in accordance with the Narrative Review and COREQ reporting checklists (available at <https://jtd.amegroups.com/article/view/10.21037/jtd-23-1453/rc>).

Methods

Narrative literature review

The primary research question of this review was “What are the current IPN management standards, processes, and

practices in Canada and internationally?”. This question was defined using the Population, Intervention, Comparator, Outcomes, and Study type (PICOS) framework (Table 1).

A structured search strategy (Appendix 1, Table S1) was developed to find articles published from January 1, 2010 to November 22, 2023 in Embase, MEDLINE, and MEDLINE In-Process using combinations of the following search terms, including but not limited to: incidental pulmonary nodule, incidental findings, lung parenchyma nodule, computed tomography, clinical pathway, consensus development, treatment, management, patient care, and patient outcome (Table 2). The search was originally conducted on August 6, 2021, and was updated on November 22, 2023 (Table 2). The search was limited to full-text articles in English language. Observational studies, real-world data studies, case studies and reports, diagnostic and treatment guidelines, reviews, expert opinion pieces, and government or KOL-led whitepapers were examined. For unpublished studies, manual searches of conference proceedings and registries were performed (Appendix 1, Table S2). Three KOLs also shared additional relevant studies (Figure 1) (16).

Data analysis

Two researchers extracted data in parallel. To ensure the accuracy and reliability of the extracted data, an independent reviewer quality-checked the data by reviewing 20% of extractions. Any discrepancies were resolved through discussion and consensus among the reviewers. The results of the review were summarized descriptively and presented as a narrative review.

KOL interviews

Canadian KOLs were interviewed to further understand current IPN identification and management pathways in Canada and identify opportunities for improvement. Targeted specialists included radiologists, respirologists, thoracic surgeons, epidemiologists, medical oncologists, radiation oncologists, and primary care physicians (PCPs) given their involvement in the care pathway of patients with IPNs. Potential participants were identified by professional networks and snowball sampling was used for recruitment, starting with leaders within the Canadian Association of Thoracic Surgeons, the Canadian Society of Thoracic Radiology, the Canadian Thoracic Society, and Lung Cancer Canada. Participants were invited to participate in the study

Table 1 PICOS framework

Criteria	Description
Population	IPN identified patients (outside of a lung cancer screening program) and/or patients diagnosed with lung cancer having had IPNs as the initial finding (discovered outside of a lung cancer screening program)
Intervention/comparator	Not applicable
Outcomes	<p>Patient pathway:</p> <ul style="list-style-type: none"> • Incidence/prevalence/rate of IPN discovery • Patient demographics and clinical characteristics at time of IPN discovery (including risk factors) • Source of IPN detection (when/how/where/who) • Diagnostic tests at time of detection of IPN • Time between first scan and potential diagnosis of IPN • Time to treatment and type of treatments for IPN • Rates and types of subsequent testing/investigations • Route of follow-up • Follow-up responsibility (i.e., who is accountable/most responsible provider) • Rates of loss to follow-up <p>Definition/IPN classification:</p> <ul style="list-style-type: none"> • IPN definition/classification (i.e., nodule size, appearance) <p>Guidelines and systems used in Canada:</p> <ul style="list-style-type: none"> • List of guidelines and systems used in Canada (local and international) for IPN management • Provider understanding or awareness of IPN management guidelines and adherence to guidelines/systems <p>Patient clinical and economic outcomes as a result delayed/inadequate IPN management:</p> <ul style="list-style-type: none"> • Incidence of lung cancer development • Lung cancer staging (proportion of stage I–IV cancer diagnoses) • Survival rate • Time to lung cancer progression • Lung cancer mortality rates and all-cause mortality • Cost of IPN management (per patient) and cost of follow-up (per patient) • Other relevant clinical and economic outcomes <p>Reported unmet needs for IPN management in Canada:</p> <ul style="list-style-type: none"> • Barriers to patient follow-up in Canada and reasons for inappropriate IPN management • Other IPN management obstacles and (if reported) recommendations for patient management in Canada <p>Initiatives/activities launched outside of Canada:</p> <ul style="list-style-type: none"> • Recommendations, methods used, and lessons learned
Study type	Observational studies of any type, real-world data studies, diagnostic/treatment guidelines, reviews, expert opinion pieces, government, or KOL-led whitepapers

PICOS, Population, Intervention, Comparator, Outcome, and Study type; IPN, incidental pulmonary nodule; KOL, key opinion leader.

Table 2 The search strategy summary

Items	Specification
Date of search	Originally on 6 August 2021 and updated search on 22 November 2023
Databases and other sources searched	Embase, MEDLINE, MEDLINE In-Process, conference proceedings, and registries
Search terms used	<p>Incidental finding or incidental findings</p> <p>Lung or pulmonary or incidental lung nodule or incidental pulmonary nodule or incidental nodule</p> <p>Lung nodule or lung parenchyma nodule or pulmonary nodule</p> <p>Multiple or solitary</p> <p>Lung nodule or pulmonary nodule or pulmonary nodule or pulmonary nodules or lung nodule or lung nodules</p> <p>CT or computed tomography or computer assisted tomography or scan or CT scan</p> <p>Clinical pathway</p> <p>Clinical pathway or clinical protocol</p> <p>Clinical protocol or consensus</p> <p>Consensus or consensus development</p> <p>Consensus development or consensus workshop or clinical practice</p> <p>Practice or treatment or management or clinical or current practice guideline or recommendation or standard or algorithm</p> <p>Patient or care or current</p> <p>Pathway or journey or algorithm or management or practice</p> <p>Standard or integrated or multidisciplinary or streamlined</p> <p>Care or patient care or pathway or journey or algorithm or treatment or management</p> <p>Process or method or quality or patient outcome</p> <p>Optimization or improvement or management or control or healthcare quality</p> <p>Animal/exp not human/exp</p>
Timeframe	2010–2023
Inclusion and exclusion criteria	<p>Inclusion criteria: observational studies of any type, real-world data studies, case studies/reports, diagnostic/treatment guidelines, reviews, expert opinion pieces, government or KOL-led whitepapers, English language</p> <p>Exclusion criteria: randomized controlled trials, non-randomized controlled trials, single arm trials, letters/editorials, other languages</p>
Selection process	J.S. and L.Z. conducted the study selection and obtained consensus

CT, computed tomography; KOL, key opinion leader.

via email (up to four emails were sent to one person over 10 weeks). KOLs were contacted until the following conditions were met: at least 20 participants; at least one participant from each of Western Canada, Central Canada, Quebec, and Atlantic Canada and at least two participants from each of the following specialties: radiology, respirology, thoracic surgery, oncology, and primary care. A discussion guide

based on the literature review results facilitated an open-ended discussion ([Appendix 1](#)). This was pilot tested with the first two participants. Audiovisual recording, field notes, and transcription of the 1.5-hour qualitative interviews were conducted between December 2021 and May 2022. No repeat interviews were conducted, and transcripts were not returned to interviewees. *Figure 2* presents the steps for

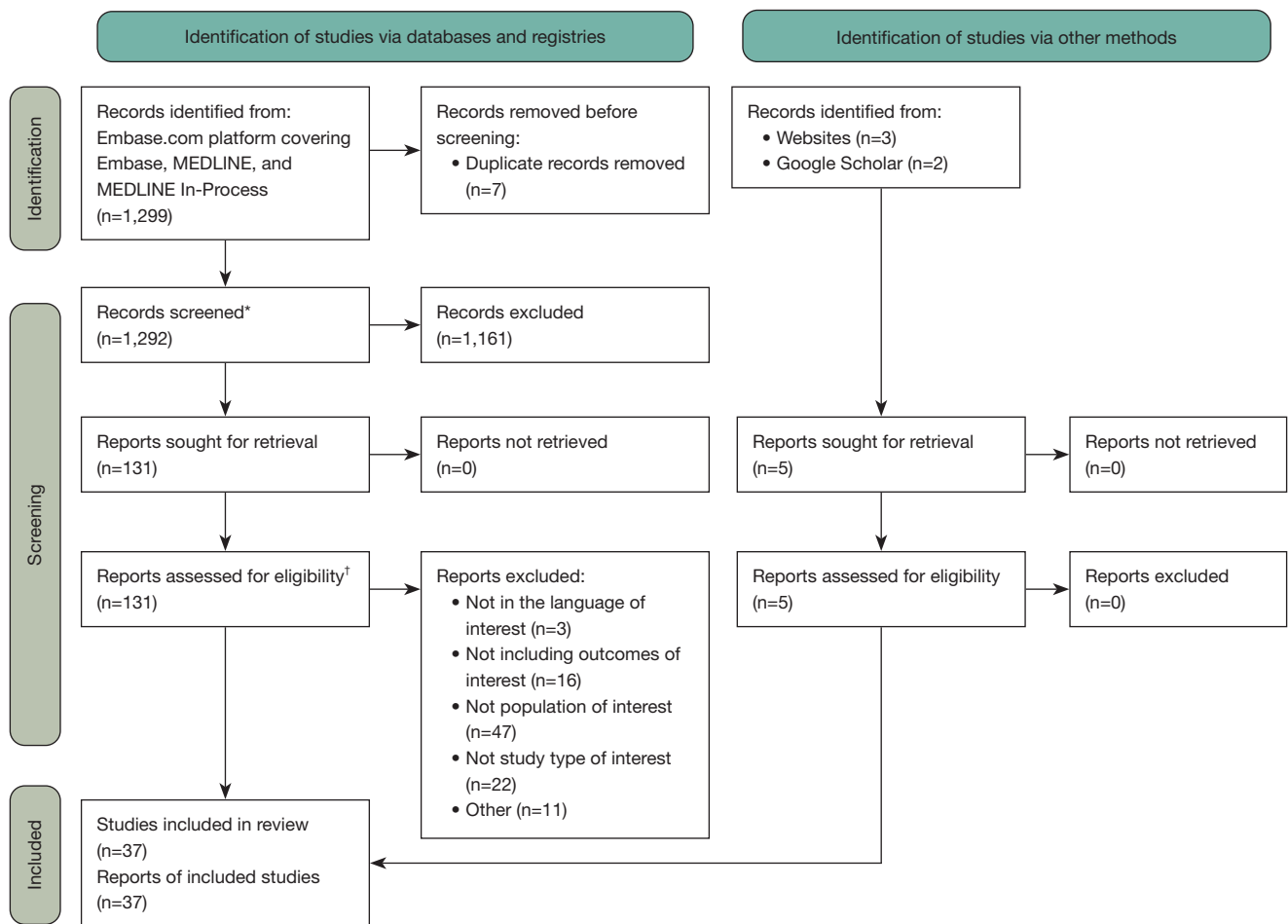


Figure 1 PRISMA flow diagram. *, records were independently screened by two reviewers based on titles and abstracts and according to pre-specified inclusion and exclusion criteria (Appendix 1, Table S3), with conflicts resolved by discussion. †, eligibility was assessed by one reviewer according to pre-specified inclusion/exclusion criteria (Appendix 1, Table S3). A second reviewer screened the full text of the included studies for quality control. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analysis.

participant selection, interview process, and analysis.

Data analysis

The literature review provided a theoretical foundation for the analysis of interview data. A qualitative thematic analysis was conducted based on a priori concepts highlighted in the literature review (17). This method was chosen as it is most suitable for describing, analyzing, and reporting themes and patterns in data (18). In line with the methods set out by Braun and Clarke [2006], three researchers identified relevant themes, or patterned responses within the interview transcripts, that captured important elements of the research question (19). The thematic analysis was

conducted manually, without relying on digital coding or data management software. As an initial step, all interviews were recorded and transcribed for analysis. Each interview was summarized, consolidating and streamlining the key conceptual findings to facilitate subsequent analysis. This also allowed analysts to familiarize themselves with the dataset and begin to identify potential themes (17).

Initial themes were identified, primarily based on the literature review results. Researchers were instructed to remain open to emergent concepts and novel perspectives that arose directly from the interview data, enhancing the richness and depth of the analysis. To enhance credibility and reliability of results, three KOLs critically reflected on the data analysis to identify potential discrepancies or

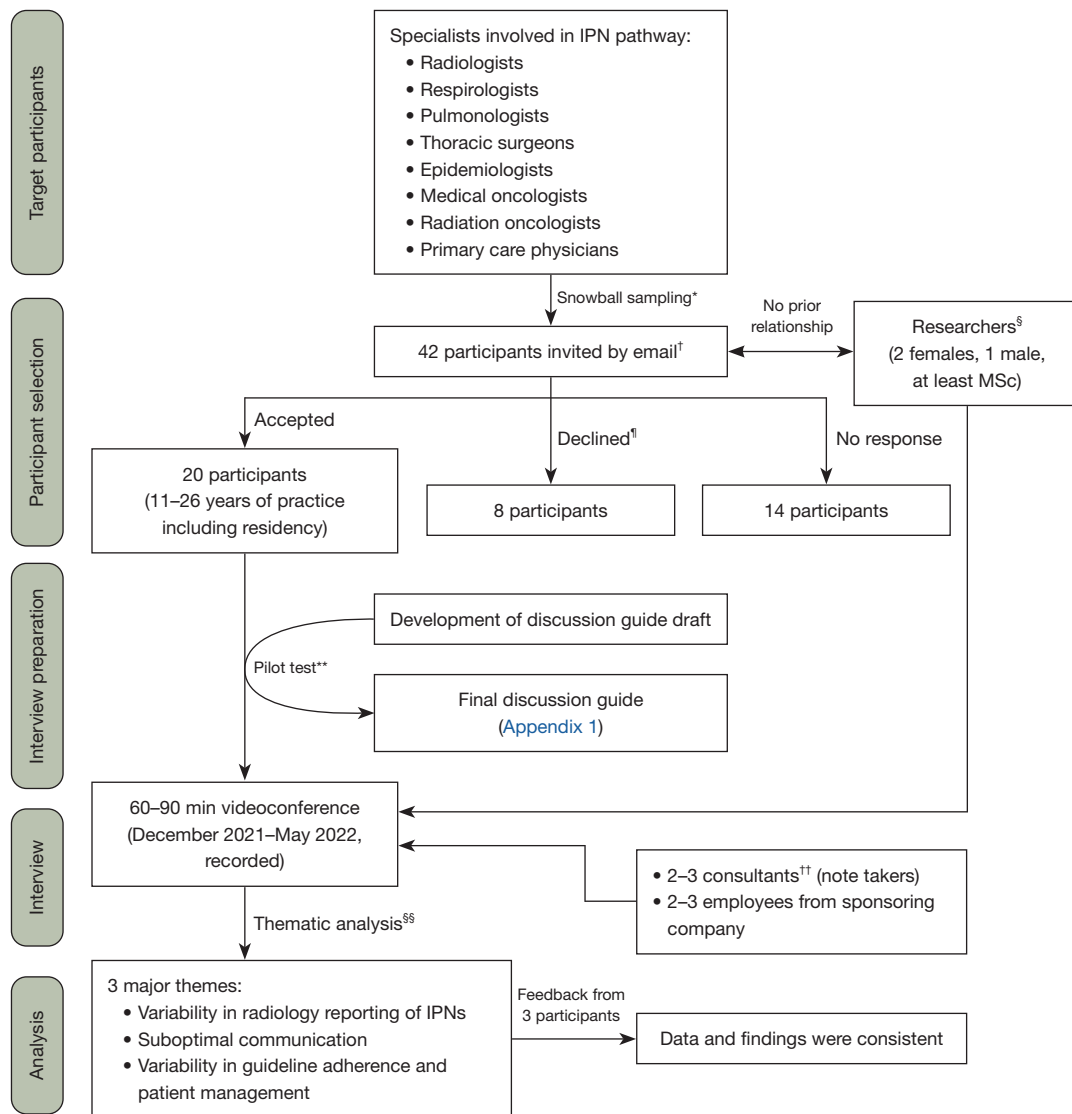


Figure 2 Participant selection and interview process and analysis. *, snowball sampling started with participants belonging to the specialties of interest and who had extensive experience managing lung nodules. [†], participants were informed about the researchers' names, occupation, their relationship with the sponsoring company, and their interest in obtaining the participant's perspectives on IPN management practices in Canada. [§], researchers were affiliated to a consulting firm collaborating with the sponsoring company, and had prior experience in KOL research, had developed pre-interview/advisory board materials (screener and discussion guide), completed multiple individual interviews, and worked on primary research data analyses. [¶], declined to participate due to reasons related to the COVID-19 pandemic and clinic work overload derived from it. **, pilot tested with the two participants with the earliest availability to conduct the interview. ^{††}, from the same consulting firm as the researchers. ^{§§}, Thematic analysis was conducted by three researchers using the literature review as a conceptual guide. Major themes initially identified included patient journey, IPN management, unmet need, and challenges. This initial analysis was validated by three KOLs, and no new themes emerged, indicating data saturation. Initial emergent themes were then condensed into three major themes following further discussion with KOLs. We report general statements that summarize the themes in the manuscript and specific participant quotations supporting each theme is presented in [Appendix 1](#). COVID-19, coronavirus disease 2019; IPN, incidental pulmonary nodule; KOL, key opinion leader; MSc, Master of Science.

alternative interpretations (20). Following their validation of the analysis for consistency with data, no new themes emerged, indicating that data saturation was reached (*Figure 2*) (21). Further discussions with KOLs provided an opportunity to refine and condense the initially emergent themes into the major themes identified.

Narrative literature review

Our search identified 1,299 publications via databases and registries and 5 records from manual search. After deduplication and eligibility assessment, 37 studies were included (*Figure 1*). Most publications were observational studies (n=28) and conducted in the United States (US) (n=33). The search identified only four studies (22-25) conducted in Canada. Given the paucity of relevant Canadian literature, we included studies from both the US and Canada to provide contextually relevant findings for North American healthcare settings, and to draw on the available US literature evidence where most of the relevant research has been conducted.

Summary of review findings

IPN detection rates vary based on index diagnostic imaging, which can include chest, abdominal, whole-body CTs, or coronary CT angiography and can be ordered by various specialists for a range of patient presentations (22,23,26-33). Variability in IPN reporting exists. Radiology reports may be incomplete (26), resulting in diagnostic delays due to requests for additional review or misinterpretation (34,35).

When an IPN is identified, patient management is affected by guideline awareness and clinical judgement. In Canada, the Fleischner Society guidelines are well recognized by radiologists and used extensively for IPN management. These guidelines utilize the initial probability of malignancy (determined by factors such as nodule size, patient age, and smoking history or other risk factors) to establish appropriate schedules and duration for radiographic follow-up (36). However, varying degrees of guideline conformance exist amongst radiologists, and conformance is higher in academic settings and in group practices that include a subspecialist thoracic radiologist (37-39). Compared to those who received guideline-concordant care, the median time to lung cancer diagnosis in the US was longer in patients with less intensive evaluation of IPN (40). Conversely, more intensive evaluation has been associated with greater expenditures,

higher radiation exposure, and more procedure-related adverse events (40,41).

US studies have shown that many patients with IPNs did not receive appropriate imaging and clinical follow-up (29,30,42-47). Similarly, up to two thirds of patients in Canada did not receive follow-up imaging in the recommended time frame, even when radiologists adhered to the Fleischner Society guidelines (22-24,30). Factors associated with timely follow-up imaging for IPNs include explicit mention in a hospital discharge summary, attending an outpatient follow-up visit, younger patient age, and inclusion of the nodule in the impression section (not just the findings section) of the radiology report (23,30).

In addition to suboptimal follow-up of nodules, studies also identified a lack of adherence to guidelines. Reduced adherence to guidelines may occur due to lack of continuity or coordination in care and information overload (24). To overcome this issue and improve patient management, some centers have implemented clinical decision support tools (48), electronic consultation systems (25), and patient risk questionnaires administered at the time of CT (49).

KOL interviews

Twenty KOLs from five Canadian provinces agreed to participate (*Figures 2,3*). Three major themes emerged from the interviews including variability in radiology reporting of IPNs, suboptimal communication, and variability in guideline adherence and patient management. Supporting quotations from the KOLs are presented in *Table 3*.

Theme one: variability in radiology reporting of IPNs

The experts agreed that there is a lack of radiology report standardization in Canada for the documentation and description of IPNs, such that there is significant variability even within institutions. Due to this heterogeneity, thoracic surgeons and respirologists noted that they personally review images to guide decision-making while considering the radiologist report. The experts also noted barriers to widespread implementation of standardized reporting. One radiologist felt that their senior department members are less likely to change the way they report findings and would not comply with a standardized form.

PCPs and respirologists expressed that radiology reports often lack appropriate guidance on recommended follow-up intervals, and medical oncologists stated that there is often a lack of guideline adherence in the reports. A non-

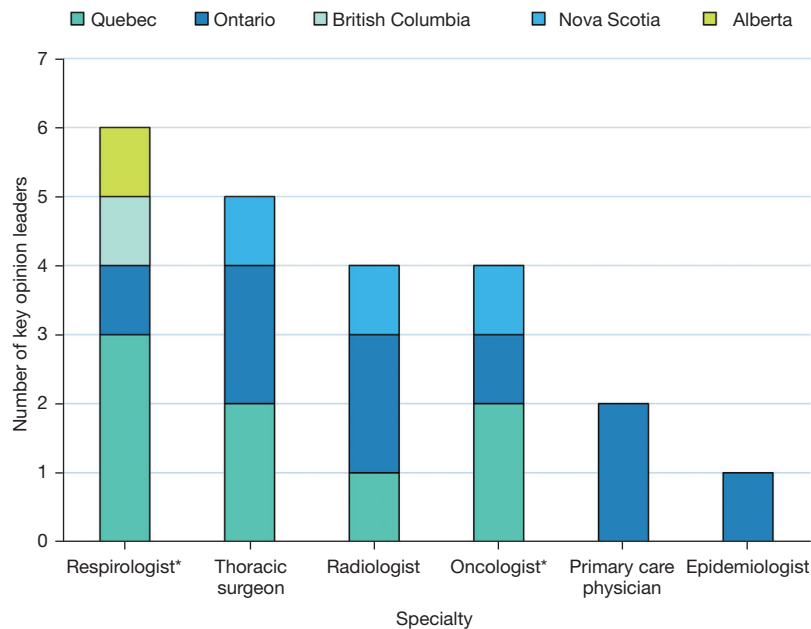


Figure 3 Key opinion leader participants by specialty and province. *, n=2 pulmonary oncologists from Quebec were considered as both respirologists and oncologists.

radiologist, who also has extensive research in lung cancer screening, highlighted that IPNs may be missed entirely by the reviewing radiologist, or the radiologist may choose not to report all nodules. The radiologists also agreed with this point. Radiologists noted that inconsistent efforts to obtain and inconsistent availability of prior imaging also contributes to the variability in reporting. This process poses challenges in certain jurisdictions, where logistical constraints or limited access to previous imaging studies hinder the ability to accurately assess temporal evolution of IPNs. This has been documented in the literature (50). KOLs noted that in some provinces, all publicly funded imaging is available on a single imaging network, but in other provinces, nearby hospitals use separate imaging networks making comparison with prior imaging cumbersome.

Theme two: suboptimal communication between radiologist and ordering physician, between healthcare providers, and with patients

Radiologists expressed frustration that physicians requesting CTs often do not communicate adequate clinical information to suggest IPN management. For example, the Fleischner Society guidelines for management and follow-

up of IPNs require knowledge of the patient's risk of lung cancer (e.g., smoking history) and do not apply to patients with known malignancies (4,51). Radiologists noted that this information is rarely included on requisitions, limiting the ability to provide specific surveillance recommendations.

Experts agreed that standardized communication between physicians can ensure appropriate and collaborative follow-up. Several radiologists, respirologists, and thoracic surgeons noticed a disconnect in communication between the patient, the ordering physician, and the radiologist. One radiologist estimated that 30–40% of patients with small IPNs and 5% of patients with more concerning lesions are lost to follow-up. A Canadian chart review supports this estimate, finding that 27% of patients with IPNs are lost to follow-up (49). PCPs noted the risk of patients being lost to follow-up due to the large volume of tests requiring action. Radiologists noted the absence of processes to confirm whether their recommendations are followed.

Radiologists, respirologists, and thoracic surgeons suggested that automated communication could avoid communication breakdown between physicians. In some healthcare settings, patients with high-risk nodules may be automatically referred by radiology to a rapid assessment or lung nodule clinic to initiate work-up. One health jurisdiction provides a follow-up CT appointment

Table 3 Quotations from interviewed KOLs to support the identified themes

Themes	KOL participants quotations
Theme one: variability in radiology reporting of IPNs	<p>KOL 2: <i>"In my experience, radiologists did not want to collect a lot of data, they were too busy to collect a lot of data and want everything trimmed down and record/describe them in minimal details to avoid a big workload. And so the issue is that sometimes they may see things that their gut reaction might tell them is not a problem and do not report it properly. So, if that process was smoothed out and made more mandatory and made to be known to be good practice to insist nodules are followed up."</i></p> <p>KOL 3: <i>"By setting up the framework and establish [sic] the management protocol, the CT screening protocol, the reporting standard and we would change the overall management of lung cancer that way."</i></p> <p>KOL 11: <i>"There's no standardized reporting for incidental nodules."</i></p> <p>KOL 14: <i>"There is a need to improve the overall consistency and reducing the variability around the standards of radiology reporting. I think there is there's [sic] variability and [sic] reporting standards and there's variability in radiologists."</i></p> <p>KOL 14: <i>"I think that there are some regions that are more organized than others and in a need to [sic] and as we even see within our region some variability between the community and the academic center in between radiologists. Standardize the radiology reporting between the community and the academic center in terms of the thresholds that a radiologist uses to report something as being suspicious for malignancy."</i></p>
Theme two: suboptimal communication	<p>KOL 11: <i>"I think in Halifax or in Nova Scotia, they have you know, the radiologist just like in breast screening has the ability to actually order or schedule you know [sic] a follow up, whereas in other jurisdictions in certainly in [sic] Ontario, I don't have that ability."</i></p> <p>Regarding communication systems:</p> <p>KOL 7: <i>"The radiologist report, and their recognition is very important 'cause [sic] often they'll tell the doctor, you know, recommend CT scan in six months and that might save the system and the patient a lot of hassle of sending the patient for pulmonary or thoracic or PET scan or all these things because the radiologist just says it's a low risk and this is what you should do."</i></p> <p>KOL 9: <i>"Things to make that more robust or automated would be great."</i></p> <p>Regarding guidelines:</p> <p>KOL 19: <i>"Based on what it seems to me like [sic] they're deciding based on what it looks like as opposed to necessarily having a lot of history of the patient."</i></p>
Theme three: variability in guideline adherence and patient management	<p>KOL 4: <i>"But there's also patient factors. Uhm, [sic] there's a much higher incidence of lung cancer diagnosis among people who live in rural areas compared to urban, a much higher propensity if you come from a lower income bracket, your health literacy."</i></p> <p>KOL 5: <i>"It should then go back to the person that ordered this scan and the family doctor, but again, some of those lines are dotted, not straightened. It can all fall apart there. Most of the time, the referring physician would be responsible to read the report and refer to an appropriate place. In certain jurisdictions, Ontario and increasingly across the country there is."</i></p> <p>KOL 12: <i>"Lack of staffing time to manage. Lack of staffing and time. I think in radiology departments, it's probably difficult to get."</i></p> <p>KOL 14: <i>"The importance is to get patients with IPNs to a specialist pathway where you would hope that the adherence to guidelines would be better if not perfect."</i></p>

KOL, key opinion leader; IPN, incidental pulmonary nodule; CT, computed tomography; PET, positron emission tomography.

embedded within the initial radiology report (49). Similarly, two radiologists praised Rapid Investigation Clinics that have improved IPN management. Such clinics use tracking systems to minimize delays in care and include

multidisciplinary investigation and rapid access to diagnostic procedures as well as treatment (52). However, the experts noted that most jurisdictions do not have similar established clinics or pathways.

The experts highlighted the heterogeneity of systems across Canadian provinces and the lack of provincially integrated, privacy-compliant electronic medical records as key barriers for the implementation of standardized and automated communication and tracking systems. Radiologists were the only specialty that suggested the adoption of a tracking system. All specialties agreed that a closed-loop communication tool would be beneficial. One PCP, however, was concerned that automated notifications would be too frequent.

Finally, some experts expressed concerns about patients not adhering to recommended follow-up imaging due to suboptimal communication between physicians and patients or suboptimal imaging appointment communication; however, this theme was not fully explored during the interviews. Additionally, a few KOLs raised the issue of shared decision making with patients regarding their care plan and the importance of patient education and empowerment in ensuring timely IPN follow-up, though this theme was not prominent in the KOL interviews and not further explored.

Theme three: variability in guideline adherence and patient management

While several specialists agreed on the importance of considering individual clinical factors and patient preferences when managing IPNs, many experts also expressed concerns regarding both over and under investigation of IPNs resulting from lack of awareness, adherence, or conformity with guideline-recommended care. This lack of guideline adherence was thought to relate in part to unclear or suboptimal guidelines. All thoracic radiologists interviewed stated that they employ Fleischner Society guidelines to inform their recommendations for managing IPNs. However, they noted that the guidelines may be vague or not applicable for some nodules. Experienced radiologists noted that they exercise their own judgment and deviate from the guidelines based on their expertise in interpreting clinical history and IPN characteristics. General radiologists or clinicians who are not specialized in lung disease were less familiar with Fleischner Society guidelines. Meanwhile, several specialists noted that referral pathways in Canada are non-standardized and vary by jurisdiction, further leading to inconsistencies in patient care.

The experts expressed concern that patients from low socioeconomic status and rural areas are at higher risk

of suboptimal management and being lost to follow-up. Socioeconomic status is linked to health literacy and some patients are more likely to experience barriers to adhering to recommended follow-up. This is particularly relevant for lung cancer diagnosis given that people who live in rural and remote communities experience inequities in cancer risk, access to care, and outcomes (53).

A summary of key initiatives and recommendations from the interviewed KOLs is presented in *Table 4*. Additional items that arose which did not relate to the major themes included: patient education and outreach, multidisciplinary collaboration, involvement of nurse navigators, and lack of staffing, time, and resources.

Clinical implications

Through a narrative literature review and interviews with KOLs, we found evidence of suboptimal management of patients with IPNs in Canada, which aligns with international perspectives on IPN management (5). The main opportunities for improvement include inconsistency in radiology reporting of IPNs, inadequate communication (between healthcare providers and between healthcare providers and patients), and variability in patient management pathways. To our knowledge, this is the first study describing the Canadian landscape of IPN management from a multidisciplinary perspective with insights on regional heterogeneity.

The addition of a qualitative component to our review allowed a richness of data that would not have been available through chart reviews or other clinical research. While the KOL interviews were structured to obtain personal clinical experience and opinion, rather than quantitative data, many of the KOL opinions are supported by the literature. For example, the frustration noted by the radiologist KOLs regarding clinical information that is insufficient to allow specific IPN management recommendations mirrors multiple publications documenting poor requisitions as a contributor to medical error (50,54-56). Expanded use of electronic medical records may help solve some of the issues regarding missing information on radiology requisitions by automatically populating the missing fields (57). This could be further explored as an area for improvement.

Several opportunities for improvement identified in this study have also been identified in other countries, where efforts and initiatives to improve IPN management have demonstrated promising results. For example, US studies show that using structured radiology reports can reduce

Table 4 Summary of key initiatives and recommendations from interviewed key opinion leaders

Key initiatives and recommendations	Summary of the key recommendations by speciality			
	Radiologists	Respirologists	Thoracic surgeons	Primary care physicians
Standardized radiology reports	Standardized radiology reports should be a priority in initiatives launched	Standardized radiology reports are needed with a level of agreement and consistency in establishing the management protocol and follow-up	Radiology reports should be standardized	Radiology reports should be standardized, and radiologists should provide more guidance for PCPs in the report
Adoption of a closed-loop communication tool	Closed-loop communication with automated communication systems	Automatic referral process is needed to track patient's diagnostic assessments and provide efficient communication between providers	A two-way closed communication loop would be beneficial	Mixed opinions: a closed-loop communication tool would create too many notifications for PCP, but automated systems could improve communication
Adoption of a tracking system	A better tracking system is needed to avoid losing patients in follow-up	N/A	N/A	N/A
Referring the patient to a multidisciplinary nodule clinic	Not enough multidisciplinary clinics due to lack of resources: should only be used for concerning nodules. Many small nodules do not require a multidisciplinary clinic	Multidisciplinary collaboration is valuable for cases that are more difficult to assess and important for physicians who are not used to evaluating a lung nodule	Not a key initiative according to thoracic surgeons	N/A
Additional training	Better education is needed on nodule risk stratification and for better awareness/adherence of guidelines	Additional training is needed to ensure standardization of radiology reporting and for practitioners lacking knowledge on IPN management	Additional training is needed especially with radiologists	PCPs need additional training on radiology reports and on how to follow-up each type of nodule

PCP, primary care physician; N/A, not applicable; IPN, incidental pulmonary nodule.

missing information and significantly improve follow-up care (33,34,58,59). Interviewed experts agreed that standardized radiology reports would be beneficial and highlighted success where implemented. In Canada, the use of standardized radiology reporting is usually at the discretion of the individual radiologist (50). Implementation of standardized radiology reporting at a larger scale across the country may be supported by non-radiologist physicians.

The KOLs supported strategies to facilitate follow-up and monitoring of patients with IPNs, such as implementation of closed-loop communication and tracking systems. A US single-center retrospective study using the Radiology Result Alert and Development of Automated Resolution tracking system showed that the interactive

system facilitates follow-up by engaging the ordering physician in the follow-up process and relieving some administrative burden (59). One radiology department in Canada has implemented an automatic CT booking program for nodules that require follow-up CT but do not currently need a referral to a specialist (49).

This study highlights the significant variability that exists in Canadian healthcare pathways as healthcare delivery remains a provincial and territorial mandate. Therefore, implementation of standardized processes and referral pathways at multiple levels could reduce variability and optimize IPN management. For example, a standardized interdisciplinary triage and diagnostic pathway implemented at a health region in Ontario for patients undergoing evaluation for suspected lung cancer, including those with

IPNs, improved the efficiency of a rapid assessment clinic and timeliness of care and diagnosis (60).

Moreover, the results highlight the challenges of adhering to existing lung nodule guidelines in Canada, due to a lack of awareness, adherence, or conformity with guideline-recommended care. Thoracic radiologists are guided by Fleischner Society recommendations, but note their inapplicability to certain patient populations, and potential differences in interpretation of the recommendations that lead to deviations based on individual expertise. The lack of familiarity with these guidelines among some general radiologists and non-specialized clinicians, coupled with non-standardized referral pathways that vary by jurisdiction, contribute to inconsistencies in patient care. Understanding and addressing these barriers to guideline implementation are essential for optimal IPN management and should be explored in future research.

In considering improvement strategies, initiatives to improve IPN management should be well-integrated into the current administrative/information technology ecosystem and must be easy to use. Challenges include heterogeneity of systems across Canada, barriers to sharing of electronic patient information, and the low prioritization of a perceived less-urgent health issue. However, given the morbidity and mortality associated with lung cancer (61,62), the evidence in favor of early detection of primary lung malignancies (8-11), and the rise in detection of IPNs through increased imaging (15), an opportunity exists to improve the health of Canadians through the implementation, standardization, and dissemination of optimal IPN management processes across the country. Lastly, while the importance of patient education and shared decision making were not featured prominently in our review of the literature or interviews with KOLs, these aspects warrant further investigation when considering improvement opportunities (63).

Limitations

This study has several limitations. Despite following a predefined structured protocol to decrease risk of bias, our literature review did not include double-blinded eligibility assessment of all full text reports that were included after screening of titles and abstracts, such that findings may be subject to some bias. While we did not assess the risk of bias of the included studies, this was not the intent in performing a narrative review. Findings from the qualitative interviews were presented descriptively and full data coding was not

performed. While most included studies in the literature review were conducted in the US, the KOLs expressed that many of the IPN management concerns in other countries apply to Canada as well. The paucity of literature specific to the Canadian landscape highlights the need for this study. We also note that most experts interviewed were from Ontario and Quebec, such that generalizability of findings within the country is limited. Additionally, we only interviewed two PCPs, both from Ontario, and we did not interview patient representatives. Finally, we did not report findings from the interviews beyond those related to the major themes identified, and these warrant further investigation.

Conclusions

Significant variability exists across Canada in IPN management. Despite available guidelines, there remain barriers to optimal management at all phases of the IPN pathway. We identify the need to facilitate more widespread use of standardized radiology reporting to guide the management of IPNs, to improve communication processes between healthcare providers and patients, and to ensure consistency in IPN management pathways. Future research should aim to develop recommendations for implementation of initiatives that address these identified needs to optimize the management of patients with IPNs across Canada.

Acknowledgments

Paola Marino and Danielle Guy, employees from Amaris Consulting, provided medical writing support. Petar Atanasov, employee from Amaris Consulting, provided valuable review and feedback.

Funding: This work was supported by AstraZeneca (to G.C.D., J.H., J.S., L.Z., and D.M.).

Footnote

Reporting Checklist: The authors have completed the Narrative Review and COREQ reporting checklists. Available at <https://jtd.amegroups.com/article/view/10.21037/jtd-23-1453/rc>

Peer Review File: Available at <https://jtd.amegroups.com/article/view/10.21037/jtd-23-1453/prf>

Conflicts of Interest: All authors have completed the ICMJE

uniform disclosure form (available at <https://jtd.amegroups.com/article/view/10.21037/jtd-23-1453/coif>). G.C.D., J.H., and D.M. received unrestricted support for meetings, planning and data collection, manuscript writing and editing, participating in a working group, and consulting fees from AstraZeneca. J.S. and L.Z. were employees of Amaris Consulting at the time of conduction of this study, which is a paid consultancy to AstraZeneca to support the conduction of this study. The authors have no other conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Cite this article as: Digby GC, Habert J, Sahota J, Zhu L, Manos D. Incidental pulmonary nodule management in Canada: exploring current state through a narrative literature review and expert interviews. *J Thorac Dis* 2024;16(2):1537-1551. doi: 10.21037/jtd-23-1453