



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

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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

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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

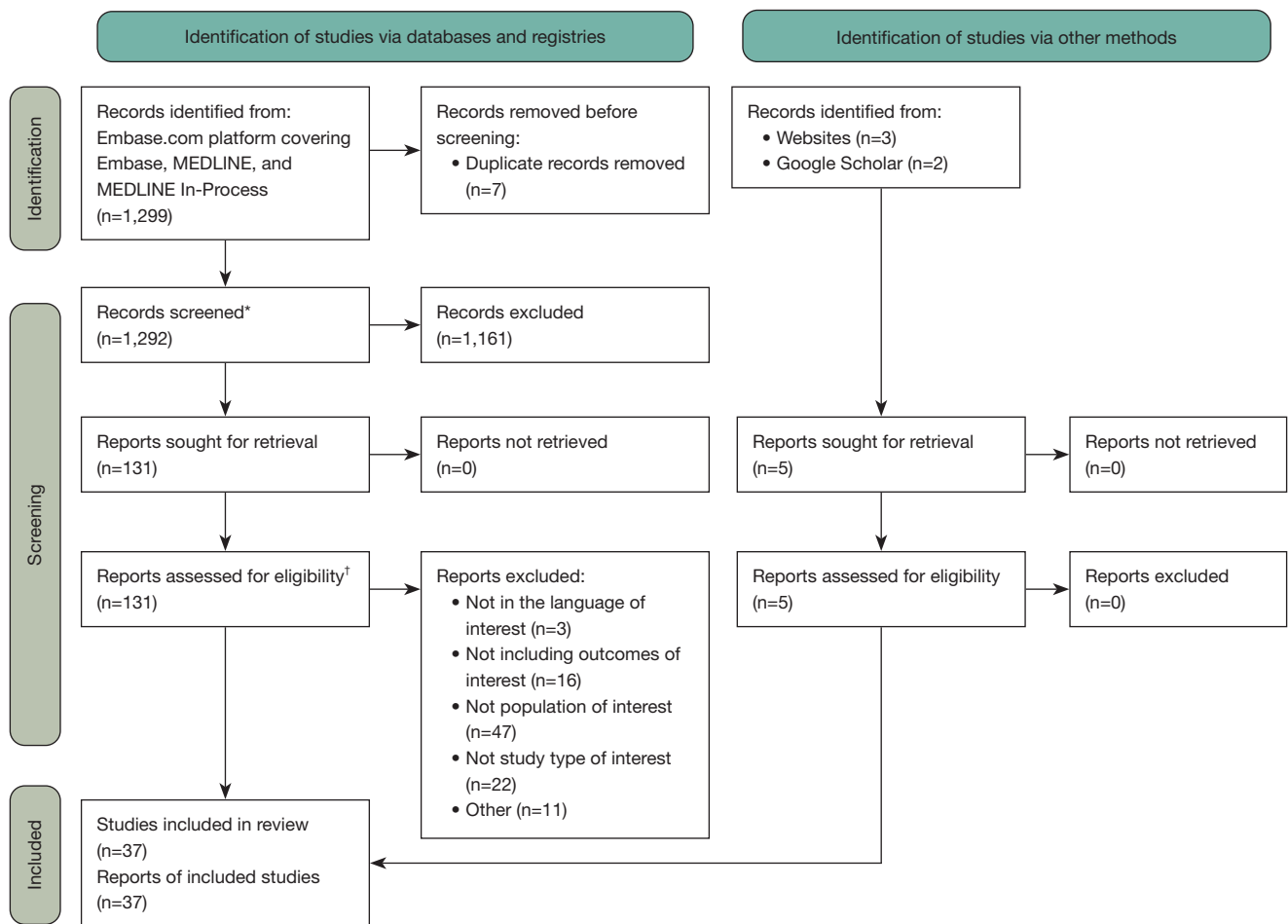


Figure 1 PRISMA flow diagram. *, records were independently screened by two reviewers based on titles and abstracts and according to pre-specified inclusion and exclusion criteria (Appendix 1, Table S3), with conflicts resolved by discussion. †, eligibility was assessed by one reviewer according to pre-specified 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

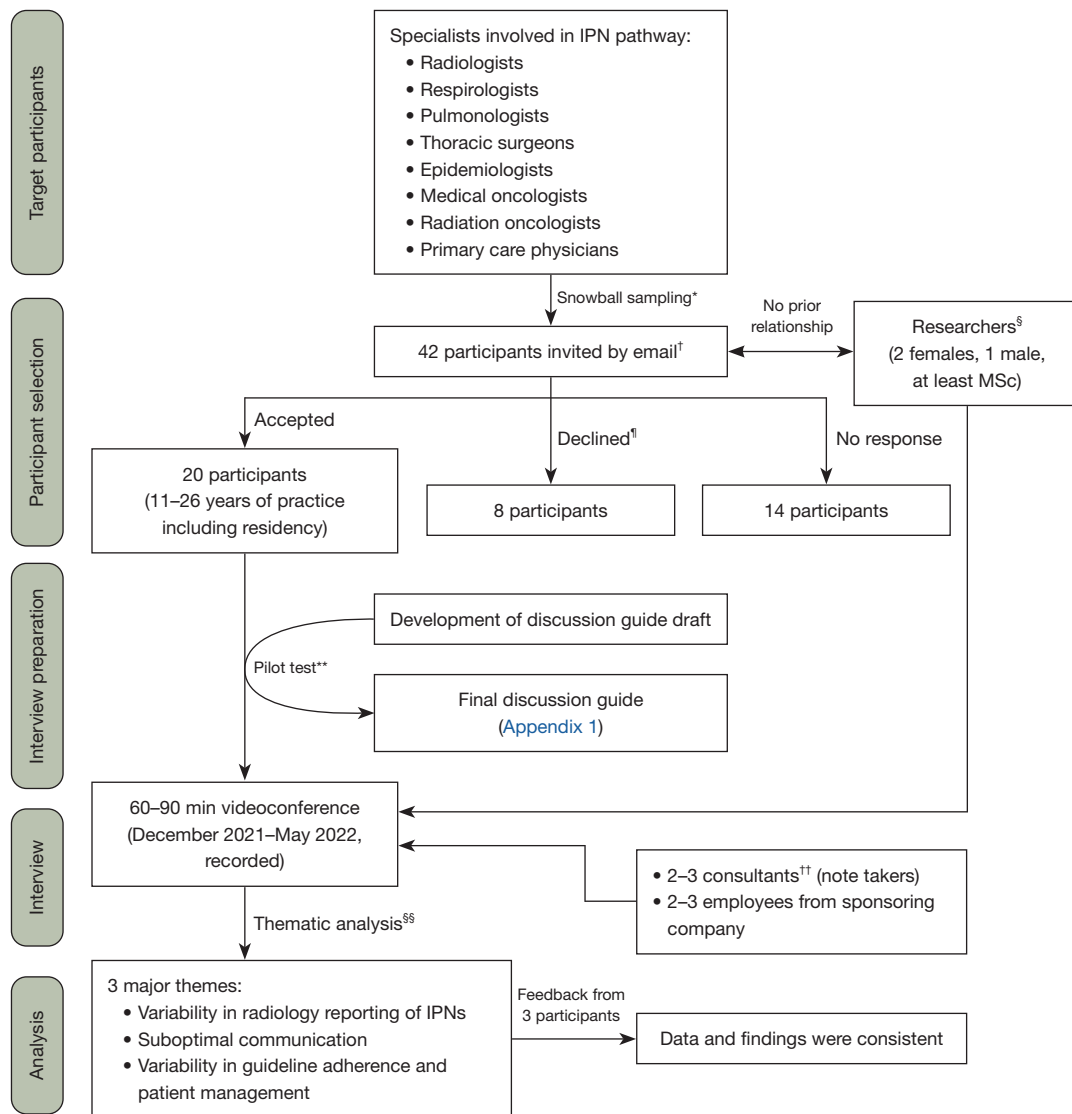


Figure 2 Participant selection and interview process and analysis. *, snowball sampling started with participants belonging to the specialties of interest and who had extensive experience managing lung nodules. †, participants were informed about the researchers' names, occupation, their relationship 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-

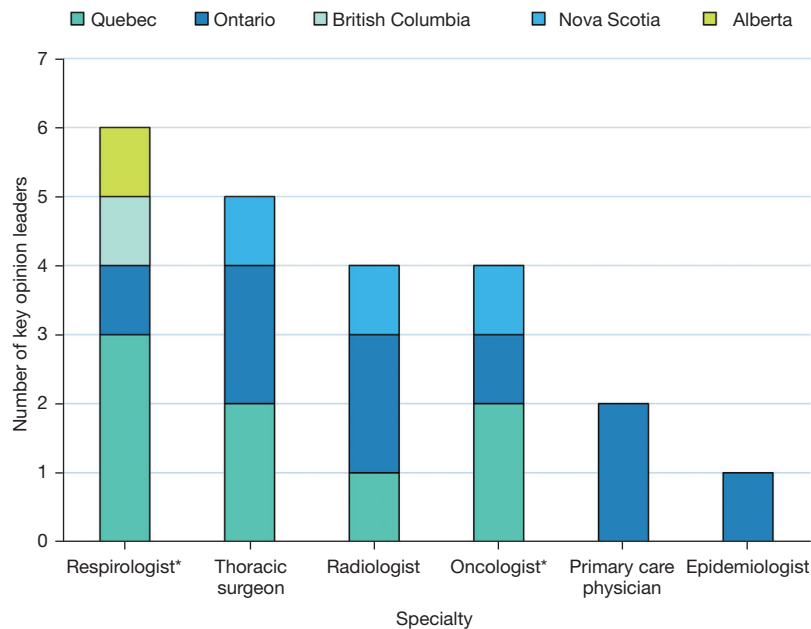


Figure 3 Key opinion leader participants by specialty and province. *, n=2 pulmonary oncologists from Quebec were considered as both respirologists and oncologists.

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.

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Footnote

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Appendix 1 Interview discussion guide

1. Patient pathway

1.1. Questions targeted to radiologists

- 1) When it comes to IPN identification and management, is this a common finding? What is your responsibility, and which tasks are handed off to a different physician? Please outline which activities fall within your remit and those that are managed by other members of the team.
- 2) In your practice do you pro-actively examine scans for IPN? Please explain.
- 3) When interpreting imaging, what factors, if any, would increase the likelihood of you specifically/pro-actively examining the image for pulmonary nodules? Why (i.e., when would you actually look for it)?
- 4) When an IPN is detected, do you always mention it in your report? Why or why not?
 - a. When reporting an IPN, do you mention it in the body or the summary/key impressions of the report? Why?
- 5) When an IPN is detected do you utilize a standardized reporting form/macro to facilitate reporting? Why or why not? Can you choose to utilize it?
 - a. Is this standardized reporting form/macro designed by you or your institution?
- 6) Do you always provide explicit recommendations for patient management/follow-up for IPN to the patient’s management team? Why or why not?

If recommendations are provided, ask questions 6a) to 6c), as well as questions #7 to #10, and #13.

- a. When providing recommendations, do you specifically provide a rationale for the follow-up plan?
- b. When providing recommendations, do you specifically reference any guideline(s) in your report?
- c. Were you ever unable to provide recommendations for patient follow-up/management for IPN in the past? Why? What key information was missing?
- 7) When detecting IPN, on which of the following do you base your recommendations?
 - a. Published clinical guideline(s) (please specify)
 - b. Local/hospital-based protocol(s)
 - i. If yes, how do these protocols vary from published guideline(s)?
- 8) Please indicate your level of agreement with the following statements:
 - a. In my practice, I provide recommendations directly aligned with IPN management guideline(s).

Level of agreement				
1	2	3	4	5
Never	Rarely	Sometimes	Often	Always

- b. In my practice, when I choose not to follow guidelines, it is usually because I believe that more intensive management is needed.

Level of agreement				
1	2	3	4	5
Never	Rarely	Sometimes	Often	Always

- c. In my practice, when I choose not to follow guidelines, it is usually because I believe that less intensive management is needed.

Level of agreement				
1	2	3	4	5
Never	Rarely	Sometimes	Often	Always

- 9) Which of the following factors, if any, increase the likelihood of you deviating from guideline(s)/protocols when providing recommendations?
 - a. Level of patient risk/risk factors
 - b. Lack of agreement with guidelines
 - c. Insufficient detail in guidelines
 - d. Time constraints
 - e. Lack of priority

f. Other (please specify)

10) Do you provide the following details in your recommendations (yes/no):

- Patient risk stratification?
- Type of follow-up scans?
- Type of follow-up interventions?
- Number of follow-up scans?
- Number of follow-up interventions?
- Frequency/timing of follow-up scans?
- Frequency/timing of follow-up interventions?
- Next steps based on findings in the follow-up?
- Other (please specify)

11) What is the most common referral pathway for patients with IPN that you see? Is a unique pathway triggered when patients have IPN? How does it work?

- a. In your organization, have you noticed any communication breakdowns when dealing with IPN management/follow up?
 - i. If so, when and where is it most noticeable?

12) Has the physician ordering the index scan or the physician downstream in the referral pathway ever asked you for clarification of the management plan?

- a. If yes, is this communication challenging to set up?
- b. If yes, how often have they asked for clarification?

13) Do you receive feedback or monitor whether your recommendations have been followed?

14) In your opinion, is the management plan/risk stratification for IPN easy to follow and execute for non-specialists (i.e., people who are not familiar with guidelines, PCPs, or any generalist)?

- a. What, if anything, do you do in your report in order to ensure that the plan is easy to follow (e.g., specifically refer to guidelines, provide specific recommendation on timing of follow-up imaging, etc.)?

1.2. *Questions targeted to managing physicians (respirologists, thoracic surgeons, and primary care physicians)*

- 1) When it comes to IPN management, what is your responsibility, and which tasks fall outside of your purview/are handed off to a different physician?
- 2) At what stage of their journey do patients with IPN enter your practice? In your practice, how/when are IPN patients most commonly identified?
 - a. In your opinion, is the referral pathway of a patient with incidentally detected pulmonary nodules clear/easy to follow within your organization?
 - b. Do you always receive notification of radiology report? How is it shared with you? What are your next steps when you receive the report?
 - c. Which physician most commonly orders the index scan and why/where? How many come from each referring physician?
 - d. If applicable, how often are patients with IPN referred to your practice for management? Who is the primary referrer?
- 3) Can you describe a situation in your practice where a patient was identified via incidental nodule and how they were managed? In your opinion, did this patient fall through the cracks leading to suboptimal outcomes?
- 4) What challenges do you experience when managing patients with IPN?
 - a. Delays in patients being referred to you
 - b. Lack of clear risk stratification
 - c. Lack of clarity on type of follow-up/interventions
 - d. Lack of clarity on appropriate length of follow-up
 - e. Delays in follow-up imaging/investigations
 - f. Lack of clear communication/referral pathways for follow-up
 - g. Lack of priority from patient side

- 5) What is your approach to determining the management plan for patients with IPN? When setting a plan for managing patients, do you primarily use guidelines or radiologist recommendation, or both? Why?
 - a. What other sources of information do you base your management plan on?
- 6) When setting a plan for managing patients, do you feel that recommendations provided by guidelines/the radiologist are sufficient? What other information would be critical?
 - a. What actions do you take, if any, to validate your management plan when you feel like the guideline/radiologist recommendations are insufficient?
- 7) How often do you deviate from:
 - a. Radiologist recommendation
 - b. Guideline(s) recommendation
- 8) What factors increase likelihood of deviating from the guideline(s) and providing:
 - a. More intensive management
 - b. Less intensive management
- 9) What factors increase likelihood of deviating from the radiologist recommendation and providing:
 - a. More intensive management
 - b. Less intensive management
- 10) Do you consult other physicians when determining the management plan/determining whether to deviate from guideline(s)/radiologist recommendations?
 - a. If yes, do you engage in formal multi-disciplinary collaboration?
- 11) When patients arrive at your practice or are referred to your practice, have they already been notified that they have an IPN?
 - a. If they are not aware, do you always inform patients of a presence of IPN? Why or why not?
 - b. What factors increase the likelihood that you will report and explain an IPN to the patient?
- 12) Do you find that patients are frequently concerned when you notify them of the presence of IPN? What factors, if any, affect the likelihood of patients being concerned?
- 13) Do you find that patients frequently ask many questions when you notify them of the presence of IPN?
 - a. Do you feel well equipped to answer their questions on:
 - i. Management plans/follow-up
 - ii. Risk/clinical outcomes
- 14) Does nursing staff support your practice in explaining IPN to patients?
- 15) Do you feel patients are motivated to follow the recommendations? What factors are associated with greater patient motivation?
- 16) When, if at all, do you consider referring patients out for IPN management?
 - a. Where/to whom do you refer patients?
 - b. What factors increase the likelihood that you will out-refer patients?

1.3. *Questions targeted to medical oncologists*

- 1) Firstly, we'd like to know more about the patients that you manage, and specifically how many of those are patients who were originally identified incidentally. Thus, when patients come to your clinic/practice, are you aware of whether they had a nodule detected incidentally vs other route of diagnosis?
 - a. If yes, how many incidental pulmonary nodule patients do you see or are identified incidentally per year in your practice?
 - b. If no, what clinical history is shared with you?
 - i. Do you get a full history of the monitoring and interventions that were performed for the patient with a pulmonary nodule before they come to your clinic? Why or why not?
 - ii. Do you receive the initial scans and associated radiology report?
 - iii. Do you see the explicit recommendations for patient management/follow-up for IPN that were received prior to the patient being referred to your clinic? How, if at all, would this impact your management of the patient?

- 2) At what point, in their monitoring and/or treatment journey, does a patient with a pulmonary nodule get referred to you? Do you know how long a patient with an incidental lung finding may be managed/triaged prior to being referred to your clinic?
- 3) Is the prognosis or patient profile different for patients detected incidentally compared to other patients? In particular, would you say patients with incidentally detected pulmonary nodules referred to you are more often at a late stage (progressed or metastatic)?
 - a. What are the differences? Which are easier to manage?
 - b. What factors are associated with a patient having late stage/stage IV lung cancer at diagnosis?
 - c. Does this differ between patients with incidentally detected versus screen detected nodules/other patients? Is one more efficient than the other?
- 4) Can you describe a situation in your practice where a patient was identified via incidental nodule and how they were managed? In your opinion, did this patient fall through the cracks leading to suboptimal outcomes?_
- 5) Do you ever manage patients who do not have confirmed cancer (pulmonary nodule under investigation)?
- 6) Are you ever involved in multidisciplinary discussions around risk-stratifying or managing patients with pulmonary nodules who do not (yet) have confirmed cancer? How different would this be for IPN patients?
- 7) In your practice, who are the most common physicians referring patients to you with incidentally detected pulmonary nodules/incidentally detected cancer?
 - a. Are the referring physicians different when patients are coming from a screening program? When cancer is detected due to symptoms/at a late stage? How?
- 8) In your opinion, is the referral pathway of a patient with incidentally detected pulmonary nodules clear/easy to follow within your organization?
 - a. How about if the patient is coming from outside your organization?
 - b. How does this compare to patients coming from a screening program or who are symptomatic/have late-stage lung cancer?
- 9) What investigations have IPN patients undergone before being referred to your clinic (imaging, biopsy, other)?
 - a. Are the past investigations/monitoring different when patients are coming from a screening program?
 - b. When the patient is symptomatic/identified at late stage?
 - c. How does this inform the management plan?
- 10) Does the quality/breadth of the patient's clinical history vary whether they are a patient with an incidental nodule versus a nodule detected in a screening program versus any other route of diagnosis?
 - a. What history is key to your management of the patient?
- 11) Which guidelines on the management of IPN are you familiar with?
- 12) How appropriate/useful are IPN guidelines? Under what situation do you think guideline recommendations may not be applicable or it is appropriate to deviate from IPN guidelines?
 - a. Level of patient risk/risk factors
 - b. Lack of agreement with guidelines
 - c. Insufficient detail in guidelines
 - d. Time constraints
 - e. Lack of priority
 - f. Other (please specify)
- 13) Could better IPN guideline adherence help patient care in oncology?

2. Healthcare infrastructure and communication

2.1. General questions targeted to all KOLs

- 1) In your current organization, overall, how would you rate the unmet need associated with the management and follow-up of IPN on a scale of 1 (low) to 5 (high) and why?

Unmet need associated with the management of IPN				
1	2	3	4	5
Low	Low Medium	Medium	Medium high	High

- 2) What are the main challenges/obstacle you face with IPN management?

- a. Communication breakdowns, lack of follow-up
 - b. Complex clinical guidelines
- 3) In your opinion, do the following challenges/obstacles occur today when managing patients with IPN? Would you be able to rank them by level of importance (most important/highest priority to least important/lowest priority).

Challenges/obstacle	Yes/No?	Priority
Lack of awareness/ adherence to clinical guidelines (e.g., inappropriately applied during identification or IPN management pathway)		
Lack of staffing, time etc.		
Lack of appropriate systems that would facilitate IPN follow up and/or monitoring		
Lack IPN education materials that would help guide discussion with patients		
Lack of standardized radiology report (i.e., methods of reporting) that would inform IPN management strategy/pathway and improve uniformity/completeness of IPN reports		
Lack of patient awareness which may lead to delay or lack of compliance to follow up recommendations		
Overshadowing IPN management by both clinicians and patients		
Suboptimal IPN management guidelines		
Other (Note to moderator, please allow the KOL to add additional points, if applicable)		

- 4) What 2-3 key changes could significantly improve IPN follow up/management?
- 5) In your opinion, what would be the ideal system to ensure appropriate IPN follow up/management? Where is this implemented?

2.2. *Communication questions targeted to all KOLs*

- 1) In your organization, have you noticed any communication breakdowns when dealing with IPN management/ follow up?
 - a. If so, when and where is it most noticeable?
 - b. At what point in the pathway does this most commonly happen and why?
 - i. Are the communication breakdowns noticeable or within the organization?
 - ii. Are the communication breakdowns noticeable between organization (e.g., from hospital to hospital, from hospital to clinic)
 - c. What piece of information gets commonly lost?
- 2) In your organization, is there a communication pathway/system in place to ensure appropriate IPN follow up? If yes, please describe the system. If not, can you explain why such systems have not been implemented?
- 3) How appropriate are the communication systems in place to monitor patient follow up within your organization? Please explain
- 4) How appropriate are the communication systems in place to monitor patient follow up between organizations?
- 5) What ideal system/tool would be needed in order to avoid communication breakdown in IPN management? Where is this implemented?
- 6) How familiar are you with multidisciplinary clinics/teams for IPN management?
- 7) In your opinion, how would the implementation of multidisciplinary clinics/teams improve IPN management?
- 8) Do you think that implementing a formal multidisciplinary clinics/teams is necessary in IPN management? (Note to moderator, please ask if this question is relevant for all patients or some)

2.3. *Adherence to guidelines questions targeted to all physicians*

- 1) In your organization and your practice, would you say that there is enough awareness of IPN guidelines? Question targeted/tailored to medical oncologists
 - a. Is awareness of lung cancer screening guidelines sufficient?
- 2) In your organization and your practice, would you say that there is enough adherence to IPN guidelines? What is the impact on patient outcome when deviating from guideline?
- 3) Do you think the guideline are detailed enough (i.e., flexible) to support the management of a broad population?
- 4) In your opinion, what can be done to improve awareness and adherence to guidelines?

2.4. *Questions targeted to medical oncologists*

- 1) In your current organization, overall, how would you rate the unmet need associated with the management of patients with IPN on a scale of 1(low) to 5 (high) and why?

Unmet need associated with the management of IPN					
0	1	2	3	4	5
NA	Low	Low Medium	Medium	Medium high	High

- 2) Do you believe that IPN management requires significant time investment on your part or your colleagues?

Level of agreement					
0	1	2	3	4	5
NA	Never	Rarely	Sometimes	Often	Always

- 3) Do you believe that insufficient emphasis has been placed on management of IPN when discussing initiatives to improve early lung cancer diagnosis?

Level of agreement					
0	1	2	3	4	5
NA	Never	Rarely	Sometimes	Often	Always

- 4) Which of the following reasons are associated with insufficient emphasis being placed on improving IPN management as a key initiative:

- a. Lack of awareness of the issue
- b. Lack of priority on the issue
- c. Lack of clear solution
- d. Lack of consensus between stakeholder on solution
- e. Lack of clarity on key stakeholders/who should take leadership
- f. Lack of funding
- g. Other

- 5) Do you believe that inappropriate management of IPN can lead to delays in lung cancer diagnosis?

Level of agreement				
1	2	3	4	5
Never	Rarely	Sometimes	Often	Always

- a. If so, how often do you see this occur?
- b. Can you describe any example(s) where inappropriate management led to delays?

- 6) Do you believe that the benefits of appropriate IPN management outweigh the potential risks?

Level of agreement				
1	2	3	4	5
Never	Rarely	Sometimes	Often	Always

- 7) Do you feel that appropriate IPN management can lead to cost savings by reducing costs related to lung cancer management/treatment?

Level of agreement				
1	2	3	4	5
Never	Rarely	Sometimes	Often	Always

- 8) Do you think that multidisciplinary communication/collaboration when managing IPN is sufficient? Do you think greater MD collaboration is needed? How can this be implemented?

- 9) Do you find any differences in patient understanding of risk/understanding of lung cancer if they have IPN or come from screening? Do you feel like patient education is a benefit of screening?

- a. What kind of questions do patients ask?

- 10) What are the main challenges/obstacles related to management of IPN patients from a healthcare infrastructure/communication perspective? How does this affect your practice?

- a. What 2-3 key changes could significantly improve IPN follow up/management?

- 11) Can you provide examples of systems that may help improve the referral pathway of IPN patients? Referencing

systems that have been implemented to optimize lung cancer screening patient referrals is welcome.

- 12) Have these systems been used/successful in your organization?
 - a. If so, please explain
 - b. If not, please can you give us the reason for failure
- 13) In your practice, would you say that IPN management is sufficiently in line with the guidelines that are often followed?
- 14) In your opinion, is there a need to improve awareness and adherence to guidelines? What can be done?
 - a. What, if anything, has been done to increase awareness and adherence to lung cancer screening guidelines?

2.5. Questions targeted to epidemiologist

- 1) Based on your experiences in lung cancer screening and identification of screen-detected pulmonary nodules, what are the key factors that can impact IPN identification in Canada? Who are the key stakeholders?
 - a. How important are physician-related factors? (healthcare provider (HCP) education/guideline awareness, HCP motivation, HCP time and resources, etc.)
 - b. How important are patient-related factors? (patient education, patient motivation, patient compliance, etc.)
 - c. How important are healthcare infrastructure/system-related factors? (medical communication, availability of healthcare and health equity, etc.)
- 2) Are you familiar with guidelines related to IPN identification/classification/management?
 - a. Can you comment on which guidelines are most referenced and used across Canada for IPN identification and management?
 - b. If yes, what are the key unmet needs or drawbacks related to the currently available IPN guidelines, in particular from an epidemiological or clinical data perspective?
 - c. What can be done to address these unmet needs?
 - d. What can be done to improve adoption and adherence to guidelines? Can technology be utilized (e.g., AI) to improve identification?
- 3) Overall, how would you rate the unmet need associated with the identification of IPN on a scale of 1 (low) to 5 (high) and why?

Unmet need associated with the management of IPN				
1	2	3	4	5
Low	Low Medium	Medium	Medium high	High

- 4) What are the key factors that can impact IPN management in Canada, once an IPN is identified? Who are the key stakeholders?
 - a. How important are physician-related factors? (HCP education/guideline awareness, HCP motivation, HCP time and resources, etc.)
 - b. How important are patient-related factors? (patient education, patient motivation, patient compliance, etc.)
 - c. How important are healthcare infrastructure/system-related factors? (medical communication, availability of healthcare and health equity, etc.)
- 5) Overall, how would you rate the unmet need associated with the management of IPN on a scale of 1 (low) to 5 (high) and why?

Unmet need associated with the management of IPN				
1	2	3	4	5
Low	Low Medium	Medium	Medium high	High

3. Initiatives launched

3.1. General questions targeted to all KOLs

- 1) In your organization, in recent years, has your organization implemented initiatives in an attempt to improve IPN?
- 2) Can you provide examples of systems that have been implemented in your organization OR that you are

aware of in an attempt to improve IPN management and follow up? (Note to the moderator, a system can be a multidisciplinary clinic, standardized radiology reports etc.)

- 3) Have these systems been successful in your organization.
 - a. If so, please explain what contributed to the success of these initiatives?
 - b. If not, please can you give us the reason for failure.
 - c. Main obstacle faced? (i.e., funding, physician buy-in, resources)

4) Please rank the following initiatives based on the value they would bring to improve IPN in your organization

Initiatives	Value perceived
Enhanced radiology reports (e.g., a strict template)	1-2-3-4-5
Adoption of a closed loop communication tool	1-2-3-4-5
Additional trainings	1-2-3-4-5
Referring the patient to a multidisciplinary nodule clinic	1-2-3-4-5
Adoption of a tracking system	1-2-3-4-5
Other	1-2-3-4-5

- 5) What are the processes for implementing a new initiative?
 - a. What criteria are followed?
 - b. How long does it take?
- 6) Who are the main stakeholders that need to agree in order to implement a new initiative in your organization (buy-in)?
- 7) What would be the main hurdles when trying to implement a new initiative in your organization?
- 8) Please rank the following institutional challenges from 1 (Minor and surmountable challenges) to 5 (major roadblocking) most burdensome

Institutional challenges	Pain points
Financial	1-2-3-4-5
Resources (e.g., lack of staff)	1-2-3-4-5
Physician buy-in (e.g. not critical)	1-2-3-4-5
Complex admin (guidelines at the hospital)	1-2-3-4-5
Heterogeneity of population	1-2-3-4-5

- 9) Based on your ranking, what would be the solutions for the institutional challenges identified previously? What are your recommendations?
- 10) Based on your experience, how would you rate your organization's willingness to change/improve IPN practice/systems? And why?
- 11) Are you aware of any technology/systems used elsewhere that you wish you had access to?

3.2. Questions targeted to medical oncologists

- 1) In your opinion, where do you see medical oncologists falling into place when it comes to implementing initiatives to improve the management of IPN?
- 2) In recent years, has your organization implemented initiatives in an attempt to improve the management of IPN?
 - a. If yes,
 - i. Were these initiatives successful? What contributes to the success of these initiatives?
 - ii. If unsuccessful, why? What were the main reasons they failed?
 - b. If no, why? what were the main obstacle faced? (Probe for funding, physician buy in, resources)
- 3) What are the processes for implementing a new initiative?
 - a. What criteria are followed?
 - b. How long does it take?
- 4) Who are the main stakeholders that need to agree in order to implement a new initiative in your organization

(buy-in)?

- 5) What would be the main hurdles when trying to implement a new initiative in your organization?
- 6) Please rank the following institutional challenges from 1 (Minor and surmountable challenges) to 5 (major roadblocking) most burdensome

Institutional challenges	Pain points
Financial	1-2-3-4-5
Resources (e.g., lack of staff)	1-2-3-4-5
Physician buy in (e.g., not critical)	1-2-3-4-5
Complex admin (guidelines at the hospital)	1-2-3-4-5
Heterogeneity of population	1-2-3-4-5

- 7) Based on your ranking, what would be the solutions for the institutional challenges identified previously? What are your recommendations?
- 8) Based on your experience, how would you rate your organization's willingness to change/improve practice/systems to better manage IPN referred patients? And why?
- 9) Are you aware of any technology/systems used elsewhere that you wish you had access to? Note to moderator: initiatives different from the ones mentioned above

4. Clinical and Economic Implications of IPN Identification and Management

Questions targeted to epidemiologist

- 1) In your opinion, do you think the current evidence on the clinical implications and long-term clinical outcomes of IPN is sufficient? Why?
- 2) Please provide your level of agreement with the following statements:
 - a. Additional evidence on the long-term clinical outcomes of IPN is required

Level of agreement				
1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

- b. Understanding long term clinical outcomes is critical to improve IPN identification/management in Canada

Level of agreement				
1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

- 3) What is the highest priority additional evidence that should be considered on long term clinical outcomes of IPN?
 - a. Patient characteristics and risk factors
 - b. Length of follow-up and type of follow-up
 - c. Rates of loss to follow-up
 - d. Rates of adverse events
 - e. Rates of early lung cancer development (and over what timeframe)
 - f. Rates of metastatic cancer diagnosis (and over what timeframe)
 - g. Rates of death (and over what timeframe)
- 4) What can be done to fill in this gap?
 - a. Are there any specific studies you would like to see? What are the key considerations for study design?
- 5) Who are the relevant stakeholders that would need to be engaged to fill in this gap? How can we ensure stakeholder buy-in?
 - a. How do needs vary across different stakeholder audiences?
- 6) How can this data be best utilized/disseminated to improve IPN management?
 - a. How was similar data utilized/disseminated for lung cancer screening programs? What learnings can be applied to IPN identification/management?
- 7) Do you think learnings of clinical outcomes from studies examining screen-detected nodules is applicable to IPN?
 - a. What are the key differences, from a clinical data/clinical outcomes perspective, when considering IPN vs

screen detected nodules?

- b. What are the key differences, from a clinical study to fill in the relevant gaps perspective, when considering IPN vs screen detected nodules?
- 8) What learnings can be drawn from studies examining data and outcomes of nodules detected in screening?
 - 9) In your opinion, do you think the current evidence on the economic implications and economic outcomes of IPN management is sufficient? Why?
 - 10) Please provide your level of agreement with the following statements:

- a. Additional evidence on the healthcare resource use required for identification of IPN is required.

Level of agreement				
1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

- b. Additional evidence on the healthcare resource use required for management of IPN is required.

Level of agreement				
1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

- c. Understanding economic outcomes/HCRU is critical to improve IPN identification/management in Canada.

Level of agreement				
1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

- d. Understanding cost-effectiveness of IPN management is critical to improve IPN identification/management in Canada.

Level of agreement				
1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

- 11) What is the highest priority additional evidence that should be considered on economic outcomes of IPN?
 - a. Healthcare resource use and costs related to identification/management of IPN
 - b. Physician time related to identification/management of IPN
 - c. HCRU and physician time related to treatment of downstream lung cancer
 - d. Cost savings related to reduction in lung cancer diagnosis (any stage)
 - e. Cost savings related to late-stage lung cancer diagnosis
- 12) What can be done to fill in this gap?
- 13) Are there any specific studies you would like to see? What are the key considerations for study design?
- 14) Who are the relevant stakeholders that would need to be engaged to fill in this gap? How can we ensure stakeholder buy-in?
 - a. How do needs vary across different stakeholder audiences?
- 15) How can this data be best utilized/disseminated to improve IPN management?
- 16) In particular, can risk prediction models optimize patient management and lead to cost savings? Is this a key value message that can improve stakeholder buy-in?
- 17) Do you think cost-effectiveness data is key for the adoption of new initiatives? What can be done to ensure that the initiatives are cost-effective?

5. Initiatives to Improve IPN Management in Canada

Questions targeted to epidemiologist

- 1) Planning phase:
 - a. What key steps were taken to identify the appropriate solutions to the issues surrounding identification and management of pulmonary nodules identified in the context of a screening program?
 - b. Who were the stakeholders involved in identifying the solution (HCPs, policymakers/government, patients etc.)?
 - i. What role did they play? How were they engaged/recruited?

- ii. How important was cross-functional/multidisciplinary collaboration?
 - iii. What steps were taken to ensure stakeholder buy-in/mitigate stakeholder hesitancy?
 - c. What other resources were utilized when determining the solution (e.g., published research, examining what other countries had done, etc.)
 - d. What were the key challenges in identifying the appropriate solution? Which of the following challenges were experienced:
 - i. Lack of data/clear solution
 - ii. Lack of consensus between stakeholders on what is the appropriate solution
 - iii. Lack of motivation/interest from HCPs
 - iv. Lack of motivation/interest from policymakers
 - v. Lack of funding
 - vi. Lack of priority
 - e. What learnings could be applied to IPN-related challenges?
- 2) Implementation phase:
 - a. What key steps were taken to implement/launch the solution?
 - b. Who were the key stakeholders involved, and what were their roles?
 - i. How important was cross-functional/multidisciplinary collaboration?
 - ii. Were any additional stakeholders (not part of planning phase) engaged at this point in time?
 - iii. What steps were taken to ensure stakeholder buy-in/mitigate stakeholder hesitancy?
 - c. What were the key challenges related to implementation? Which of the following challenges were experienced:
 - i. Lack of consensus between stakeholders on how to implement the solution
 - ii. Lack of motivation/interest from HCPs
 - iii. Lack of motivation/interest from policymakers
 - iv. Lack of funding
 - v. Lack of appropriate infrastructure to implement solution
 - vi. Lack of priority
 - d. What do you think could have/should have been done differently?
 - e. What learnings could be applied to implementing solutions related to IPN identification and management?
- 3) Regarding risk prediction models for risk of malignancy in a lung cancer screened population:
 - a. What was the impact and the key benefits of this solution?
 - b. How was this solution proposed?
 - c. Who were the key stakeholders involved?
 - d. What were the key challenges involved in implementing this solution?
 - e. How relevant is this solution to improving management of IPN?
 - f. How feasible is this solution for improving IPN management?
 - g. What learnings can be applied to IPN? What key stakeholders should be involved?
- 4) How can we utilize technology, including natural language processing/artificial intelligence to optimize IPN management?
 - a. In your opinion, how could this technology impact IPN management?
 - b. What is necessary in order to get buy-in from key stakeholders?
 - c. What data is required and what are the key next steps?

6. Wrap up and closing

General questions targeted to all KOLs

- 1) Do you agree with the following statement: IPN patient identification and follow-up is an issue today (i.e., low rates of patient identification and follow up post imaging).

Level of agreement				
1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

- 2) Do you agree with the following statement: IPN identification relies on guideline awareness and clinical judgement and may not always be reported.

Level of agreement				
1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

- 3) Do you agree with the following statement: Recommendations show varying degrees of radiologist conformance (34.7%-60.8%) with guidelines, based on literature findings.

Level of agreement				
1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

- 4) Do you agree that patients and clinicians often do not adhere to recommended follow-up plan due to lack of continuity and coordination in care?

Level of agreement				
1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

- 5) Do you agree that patients and clinicians often do not adhere to recommended follow-up plan due to information overload?

Level of agreement				
1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

- 6) Do you agree that patients and clinicians often do not adhere to recommended follow-up plan due to communication breakdowns?

Level of agreement				
1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

- 7) In your opinion, what is the primary gap across Canada regarding IPN identification and management? Why? Question targeted to medical oncologists and epidemiologist

Table S1 Search terms for the biomedical electronic literature databases including Embase, MEDLINE, and MEDLINE In-Process

Criteria	No.	Query	Results
Population	#1	((('incidental finding' OR 'incidental findings') NEAR/2 ('lung' OR 'pulmonary')) OR 'incidental lung nodule\$:ti,ab OR 'incidental pulmonary nodule\$:ti,ab OR 'incidental nodule\$:ti,ab OR 'ipn\$:ti,ab OR 'lung nodule'/exp OR 'lung nodule':ti,ab OR 'lung parenchyma nodule':ti,ab OR 'pulmonary nodule':ti,ab	33,423
	#2	((('multiple' OR 'solitary') NEXT/2 ('lung nodule\$' OR 'pulmonary nodule\$')) OR (('pulmonary nodule' OR 'pulmonary nodules' OR 'lung nodule' OR 'lung nodules') NEAR/2 ('ct' OR 'computed tomography' OR 'computer assisted tomography' OR 'scan' OR 'ct scan'))	7,484
	#3	#1 OR #2	35,729
Outcomes	#4	'clinical pathway'/exp OR 'clinical pathway':ti,ab OR 'clinical protocol'/exp OR 'clinical protocol':ti,ab OR 'consensus'/exp OR 'consensus':ti,ab OR 'consensus development'/exp OR 'consensus development':ti,ab OR 'consensus workshop':ti,ab OR 'clinical practice':ti,ab	804,867
	#5	(practice OR treatment OR management OR clinical OR 'current practice') NEXT/2 (guideline\$ OR recommendation\$ OR standard\$ OR algorithm\$)	652,502
	#6	(patient OR care OR current) NEXT/2 (pathway OR journey OR algorithm OR management OR practice)	217,515
	#7	('standard' OR 'integrated' OR 'multidisciplinary' OR 'streamlined') NEAR/2 (care OR 'patient care' OR pathway OR journey OR algorithm OR treatment OR management)	279,295
	#8	((process OR method OR quality OR 'patient outcome\$') NEXT/2 (optimization OR improvement OR management OR control)) OR 'healthcare quality':ti,ab	529,918
	#9	#4 OR #5 OR #6 OR #7 OR #8	2,217,880
	#10	'animal'/exp NOT 'human'/exp	6,045,411
	#11	#3 AND #9	3,243
	#12	#11 NOT #10	3,217
	Full-text publications only	#13	#12 AND ([article]/lim OR [article in press]/lim) AND [2010-2023]/py

Table S2 Key conference proceedings and registries

Provincial Cancer and Health Ministry Websites	National Health Technology Assessment Bodies	National and Provincial Cancer/ Professional Societies
<ul style="list-style-type: none"> • British Columbia (BC) Cancer Agency • HealthLink BC • Alberta Health Services • Cancer Care Manitoba • Cancer Care Ontario • New Brunswick Cancer Network • Nova Scotia Health Authority Cancer Care Program • Prince Edward Island (PEI) Health • Atlantic Cancer Research Institute • Windsor Regional Hospital Cancer Program 	<ul style="list-style-type: none"> • Canadian Agency for Drugs and Technologies in Health (CADTH) • Institut national d'excellence en santé et en services sociaux (INESSS) • INESSS Algorithms in Cancerology 	<ul style="list-style-type: none"> • Canadian Cancer Society • Canadian Association of Radiologists • Lung Cancer Canada • Canadian Thoracic Society (CTS) • BC Cancer Foundation • Alberta Cancer Foundation • Cancer Foundation of Saskatchewan • Fondation québécoise du cancer

Table S3 Inclusion and exclusion criteria

Category	Inclusion criteria	Exclusion criteria
Population	IPN identified patients in Canada. Only those detected incidentally will be of interest.	Lung nodules detected through screening or symptomatically will not be of interest
Intervention	Not applicable	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> <p>Recommendations, methods used, and lessons learned</p>	Outcomes not of interest
Study types	<ul style="list-style-type: none"> • Observational studies of any type • Real-world data studies • Case studies/reports • Diagnostic/treatment guidelines • Reviews • Expert opinion pieces • Government or KOL-led whitepapers 	<ul style="list-style-type: none"> • Randomized controlled trials • Non-randomized controlled trials • Single arm trials • Letters/editorials
Language	English	Other languages [†]
Publication year	From 2010–2023	Before 2010

[†], studies with English abstracts where the full-text articles are in non-English language were excluded from the review. IPN, incidental pulmonary nodule; KOL, key opinion leader.