Interventions to improve adherence to clinical guidelines for the management of pulmonary nodules and their follow-up: a systematic review

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Background: Lung cancer is a leading cause of global cancer mortality and is the most common cancer worldwide. Pulmonary nodules (PNs) can indicate early-stage lung cancer, but suboptimal adherence to guidelines for radiological surveillance hinders early detection and treatment. Despite the development of interventions to improve follow-up, their effectiveness remains unclear.

Objectives: This systematic review aimed to identify interventions developed for improving adherence to guidelines for the management of pulmonary nodules and/or patient follow-up, and to assess their effectiveness.

Methods: A systematic review was conducted by searching Ovid MEDLINE, Cochrane, and Embase databases in March 2024. Studies of all designs measuring outcomes such as follow-up completion, guideline adherence, or early lung cancer diagnosis were included. Exclusion criteria included studies related to diagnosis, reporting screening programs, or not published in English. Screening and data extraction were performed independently, and risk of bias was assessed using three different measures depending on study design. The Midlands PSRC Pathways and Culture PPIE group has been involved in shaping our nodule pathway research programme and had the opportunity to respond to the review findings in multiple meetings. We are planning a follow-up grant on this topic and will involve our PPIE group heavily in its design.

Results: The review identified 3,664 titles and abstracts, leading to the inclusion of 31 studies for synthesis. Six intervention types were identified: tracking systems, process improvement approaches, natural language processing (NLP) systems, radiologist reporting templates, clinical decision-making support tools, and patient involvement improvements. All studies reported positive results, with tracking systems and clinical decision support tools showing significant improvements in follow-up, guideline adherence, and early cancer detection. Tracking systems demonstrated the most potential for effectiveness due to their modification of more of the care pathway and use of automation. However, most non-randomised studies had a serious or critical risk of bias.

Conclusions: Significant variation was observed in achieved follow-up rates across interventions. Tracking systems appeared most effective in improving patient follow-up, likely due to their comprehensive modification of the care pathway and automation reducing human error. Limitations of this review include a high risk of bias and heterogeneity among included studies. Future evaluations should incorporate more comprehensive outcome measures and rigorous designs.

Interventions to improve adherence to clinical guidelines for the management of pulmonary nodules and their follow-up: a systematic review

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Introduction

- Lung cancer remains the leading cause of cancer death.
- Screening programs aim to catch lung cancer early, improving the chances of survival through curative treatment.
- Such programmes together with scans performed for clinical reasons often detect incidental pulmonary nodules (IPNs) which should be followed up to assess their risk of malignancy.
- Failure to properly follow up IPNs can lead to preventable lung cancer deaths.
- There is evidence that adherence to guidelines can be improved along with patient follow-up through a range of interventions.
- To date, there have been no syntheses of these interventions and thus understanding of intervention methods and their effectiveness, is lacking.

Our aims were to investigate:
1. What interventions can improve adherence to guidelines for the management of pulmonary nodules and/or the follow-up of patients?
2. What is the effectiveness of these interventions in terms of improvements in adherence to guidelines, improved follow-up, or reduced patient harm (e.g. earlier diagnosis of cancer)?
3. Which point(s) of intervention in the care pathway might be most effective?

Methodology

- Systematic review following the 2020 PRISMA statement.
- Databases including Ovid MEDLINE, Embase, and the Cochrane Central Register of Controlled Trials were searched on 25.03.24. Google Scholar was searched on 27.06.24 (limited to first 200 records).
- All results were screened by two independent screeners at all stages.
- Studies of any design were included, if they reported an outcome relating to IPN follow-up, guideline adherence, or early diagnosis of lung cancer.
- Data were extracted independently in duplicate by two experienced reviewers.
- Cochrane risk of bias tool for randomised controlled trials 2 (RoB 2) was used for randomised controlled trials and ROBINS-I tool was used for nonrandomised studies.
- Data were synthesised narratively according to guidance for effectiveness studies.

Results

Study selection (Figure 1):
- 3664 titles and abstracts were screened, reducing to 115 full texts. In total, 31 studies were included.

Risk of bias:
- 21 nonrandomised studies were assessed with the ROBINS-I tool. Studies were mostly at serious (n=12) or critical (n=8) risk of bias, with n=1 at moderate risk of bias. Three randomised studies were assessed with the ROB-2 tool, all showing 'some concerns'.

Results of individual studies:
- We identified six main intervention types (Table 1) targeting different parts of the care pathway (Figure 2). All studies reported being effective.
- Outcomes reported were the proportion or odds of proper follow up (n=13), guideline adherence (n=5), time to work up results after initial nodule findings (n=3), report completeness (n=2), odds of diagnosing cancer early (n=2), and malignancy rate within 24 months (n=1). NLP studies reported sensitivity and specificity of their algorithms (n=7).
- Clinical decision support tools improved guideline adherent decision making from 9% to 25%.
- Tracking systems reported unadjusted relative benefit for follow-up ranging from 1.29 (1.06, 1.56) to 3.46 (2.47, 4.85) (Figure 3), and adjusted odds ratios for identifying cancer early ranging of 1.24 (95% CI 1.09, 1.41) and 1.94 (95% CI 1.70, 3.34).
- Radiology reporting template interventions improved report completeness by +14% to +40%.
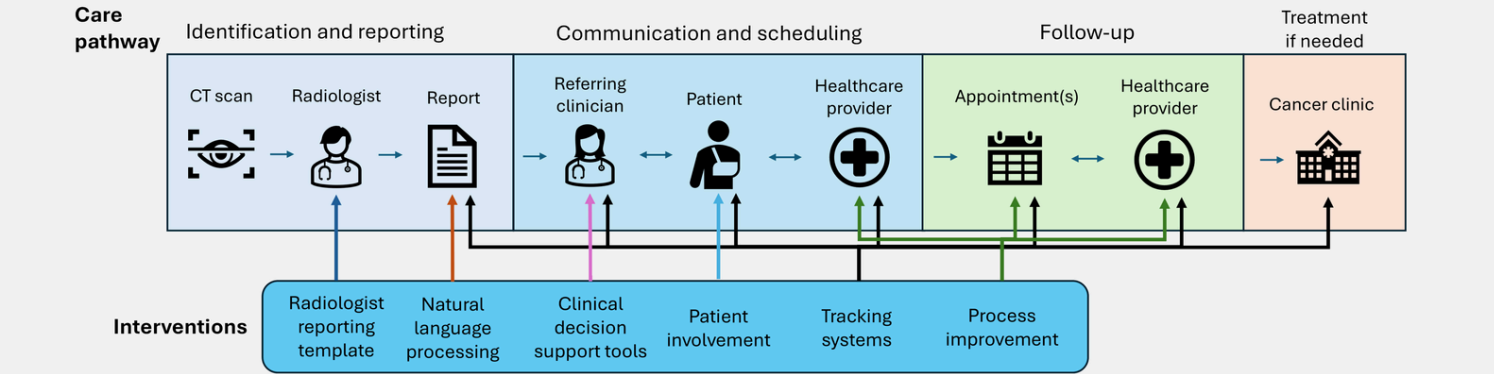

Figure 2. Where interventions seek to change the care pathway.

Table 1. Intervention characteristics.

Intervention type (number of studies)	Intervention description
Tracking systems (n=10)	Systems that are designed to keep track of patients through multiple points of the care pathway. Can combine multiple other intervention types (e.g. a reporting template plus process improvement). Usually using technological and/or human-based enhancements.
Process improvement (n=3)	Enhancements that are non-technological in nature targeting improvements in communication between radiologists, clinicians, and scheduling teams.
Automated natural language processing (NLP) systems (n=7)	Algorithms being developed to automatically read and classify radiology reports against clinical guidelines.
Radiologist reporting templates (n=6)	Templates intended to improve the reporting of all necessary information about pulmonary nodules, to ensure clinicians can properly classify these against clinical guidelines.
Clinical decision-making support tools (n=4)	Systems at the respiratory physician/clinician level to provide information about clinical guidelines for management of nodules at the point of decision-making.
Patient involvement (n=1)	Interventions seeking to involve the patient more in coordination of their own care.

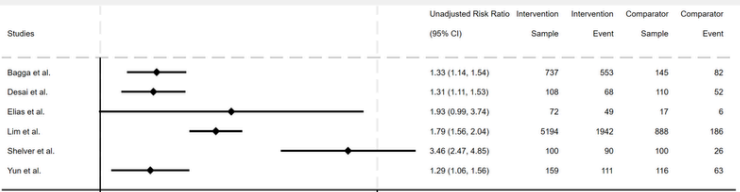| Studies	Unadjusted Risk Ratio (95% CI)	Intervention Sample	Intervention Event	Comparator Sample	Comparator Event
Bagga et al.	1.33 (1.14, 1.54)	737	553	145	82
Desai et al.	1.31 (1.11, 1.53)	108	68	110	52
Elias et al.	1.93 (0.99, 3.74)	72	49	17	6
Lim et al.	1.79 (1.56, 2.04)	5194	1942	888	186
Shelver et al.	3.46 (2.47, 4.85)	100	90	100	26
Yun et al.	1.29 (1.06, 1.56)	159	111	116	63

Figure 3. Unadjusted relative benefit of follow-up completion in tracking system interventions.

Discussion and next steps

- Tracking systems appeared to improve follow-up of patients most effectively, possibly as such systems target and improve multiple parts of the care pathway.
- No study reported achieving a 100% follow-up completion rate, demonstrating that there is still significant room for improvement across included interventions.
- Due to the high risk of bias and small sample sizes, results of this review must be interpreted with caution.
- Certain studies have shown that rigorous RCT designs are possible and should be considered in future evaluations.
- Future evaluations should incorporate more outcome measures across the care pathway, e.g. to measure communication between patient, clinician, and providers.
- More implementations and robust evaluations of these systems are needed in non-USA settings such as the UK, where similar issues have been noted.

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