Review Article on Implementation of CT-based Screening of Lung Cancer

Lung cancer screening and smoking cessation efforts

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Abstract: Randomized-controlled trials have confirmed substantial reductions in lung cancer mortality with low-dose computed tomography (LDCT) screening. Evidence on how to integrate smoking cessation support in lung cancer screening is however scarce. This represents a significant gap in the literature, as a combined strategy of lung cancer screening and smoking cessation greatly reduces the mortality risk due to lung cancer and other related comorbidities. In this review, a literature search in MEDLINE, Embase, Web of Science, the Cochrane Central Register of Controlled Trials and Google Scholar was performed to identify randomized-controlled and observational studies investigating the effect of lung cancer screening trials and integrated cessation interventions on smoking cessation. Of the 236 identified records, we included 32 original publications. Smoking cessation rates in lung cancer screening trials are promising. Especially findings suspicious for lung cancer and referral to a physician might function as a teachable moment to motivate smoking abstinence in current smokers or recent quitters. More intensive, personalized and multi-modality smoking cessation interventions delivered by a clinician appear to be the most successful in influencing smoking behavior. While it is evident that smoking cessation should be incorporated in lung cancer screening, further research is required to ascertain the optimal treatment type, modality, timing, and content of communication including the incorporation of CT results to motivate health behavior change.

Keywords: Smoking cessation; lung cancer screening; literature review

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Introduction

Lung cancer is the leading cause of cancer-related mortality among both men and women, accounting for 28% of all cancer deaths in Europe and 18.4% worldwide. In 2018, there were 470,000 new cases of lung cancer and 338,000 lung cancer deaths in the European Union (EU) (1). About 70% of patients with lung cancer are diagnosed with advanced disease, which results in only 15% surviving 5 years (2). Since approximately 85% of lung cancers can be attributed to smoking (3), smoking cessation is considered the most effective preventive method in stopping its deterioration for current smokers. At this moment, about 1 out of 2 smokers will die as a result form tobacco-related disease, whereby lung cancer is the most threatening tobacco-related health problem. Although the relation between tobacco smoking and the development of lung cancer has been known since 1964, the smoking prevalence is still high throughout the world. In Europe, most countries are not expected to succeed in decreasing the smoking prevalence with at least 30% in 2025. Thereby, smoking is more prevalent in those with a lower socioeconomic status, resulting in health inequalities with respect to lung cancer.

After smoking cessation, the most effective way to reduce lung cancer mortality is by screening with low-dose Computed Tomography (CT). Based on the two large-scale positive randomised-controlled CT lung cancer screening trials, the National Lung Screening trial (NLST)

and the Dutch-Belgian Lung Cancer Screening Trial (NELSON), there is now conclusive evidence on efficacy, with substantial lung cancer mortality reductions (men: 8–26% and women: 26–61%) in screened participants at high risk for developing lung cancer (4,5). Model analyses have estimated long term effects, including harms, and cost-effectiveness. In 2013, the United States Preventive Services Task Force recommended, after an independent review and modelling study in which an efficient strategy with a reasonable harm-benefit ratio could be established (6,7), to annually screen persons aged 55–80 with ≥30 pack-years of smoking history, who currently smoke or quit smoking <15 years ago. Recently, the USPSTF came up with draft evidence review in which new thresholds are proposed: aged 50–80 years and a smoking history of ≥20 pack-years (8). With the increase in implementation of lung cancer screening, the question how to integrate smoking cessation services in these programs becomes more urgent than ever before. Although it is evident that smoking cessation should be offered to lung cancer screening participants, which is reflected by current guidelines and recommendations (9-14), there is still limited evidence on how to integrate (effective) smoking cessation services for both high- as well as low-risk smokers in a CT lung cancer screening context (15,16). This review aims to provide the latest evidence on the impact of lung cancer screening on smoking behaviour and integrating smoking cessation interventions in a lung cancer screening program.

Methods

For this overview, a search strategy (see Appendix) was used that selects papers based on search terms in keywords, title and abstract that relate to (I) lung cancer screening or the early detection of lung cancer, (II) smoking or tobacco use and (III) behavioural effect (cessation, behavioural, quit smoking, smoking abstinence, tobacco dependence). We performed the search with assistance of a medical research librarian in MEDLINE (PubMed), Embase, Web of Science, the Cochrane Central Register of Controlled Trials and Google Scholar. The initial search yielded 568 articles. After removing duplicates, we obtained 236 unique records.

Only original articles that were available online (full text) and published in English until July 2020 were selected. We looked at the references of selected papers to check whether relevant articles were missed. The included articles should be relevant to smoking cessation in the context of lung cancer screening, which implies an asymptomatic adult (50–80 years) population which is at high risk for developing lung cancer. Two reviewers independently reviewed the articles based on title, abstract and full text respectively. Any discrepancies were resolved by discussion. Based on evaluations of abstract, we selected 94 articles and after reviewing the full text, we included 32 publications in the study. These articles were grouped into some relevant main topics: effect of smoking cessation, impact of lung cancer screening on smoking behaviour, impact of the screening result on smoking behaviour and impact of a smoking cessation intervention in the context of lung cancer screening. A total of 2 articles were added based on the reference lists of selected publications.

Results

Effect of smoking cessation in smokers eligible for lung cancer screening

Four studies examined the combined effect of lung cancer screening and smoking cessation on mortality rates. Overall, these studies suggest that a combined strategy is more effective in reducing mortality than either CT lung cancer screening or smoking cessation by itself (17-20). In a secondary analysis of the NLST (17), 7-year smoking abstinence in the control arm (i.e., who underwent chest X-ray) was related to a 20% reduction in lung cancer-specific mortality. The authors note that this reduction is equivalent to the mortality benefit of three annual CT screening rounds. Combined abstinence and CT screening was associated with an almost twofold increase in benefit, resulting in a 38% reduction in lung cancer death, HR: 0.62 (95% CI: 0.51–0.76).

An Italian study based on the MILD-trial examined the effect of smoking cessation on overall mortality rates in LDCT screening participants (18). Here, a 39% reduction in overall mortality was found for former smokers in comparison to current smokers. The results also showed that not only early cessation (i.e., before baseline screening) is associated to reduced mortality; HR: 0.57 (95% CI: 0.38–0.85). Importantly, also late cessation during the trial period has a large mortality benefit when compared to continued smoking; HR: 0.65 (95% CI: 0.44–0.96).

A simulation study using input data from Northeast Pennsylvania (US) (19), modelled the impact of CT lung cancer screening, smoking cessation and their combination until the year 2050. According to the results, lung cancer screening has a greater impact on lung cancer mortality in

the early years. However, its effect diminishes throughout the years as fewer eligible individuals become available and is eventually exceeded by the beneficial effect of smoking cessation. In 2050 for instance, screening was estimated to achieve a mortality reduction of 1.9%, while the mortality reduction of the smoking cessation-only scenario and of the combined strategy were estimated to be 7.1% and 8.2% respectively.

Another recent simulation study, using an established lung cancer simulation model of the Cancer Intervention and Surveillance Modelling Network (CISNET) consortium, evaluated the mortality benefits of screening-only compared to a combined strategy for individuals of the 1950 or 1960 birth cohort from the U.S. (20). The simulation suggests as well that lung cancer screening combined with a one-time smoking cessation intervention achieves a greater reduction in lung cancer mortality than a screening-only scenario. For instance, given a 30% screening uptake and 10% probability of smoking cessation after intervention, the combined strategy would reduce lung cancer mortality by 14% as well as increase life-years gained (LYG) by 81% for the 1950 birth cohort compared with the screening-only scenario.

Impact of lung cancer screening on smoking behaviour

The database search yielded 19 publications that evaluated the impact of enrolment in a lung cancer screening program on smoking behaviour (Table S1). Data used for these publications derived from the following European or US-American randomized-controlled studies: the Danish Lung Cancer Screening Trial (DLCST) (21,22), the Early Detection of Cancer in the Lung Scotland (ECLS) (23), the Italian Lung Cancer Screening Trial (ITALUNG) (24), the Lung Screening Study (LSS) (25) the German Lung Cancer Intervention (LUSI) (26), the Dutch-Belgian Lung Cancer Screening Trial (NELSON) (27,28), the National Lung Screening Trial (NLST) (25,29,30) and the UK Lung Cancer Screening Trial (UKLS) (31). Further data were extracted from the cohort studies Early Lung Cancer Action Program (ELCAP) (32,33), the Mayo study (34,35), ProActive Lung Cancer Detection (PALCAD) (36), the Pittsburgh Lung Cancer Screening Study (PluSS) (37) and two clinical screening programs (Lung Health Check and Lahey Hospital study) (38,39).

Across studies, smoking cessation rates of baseline smokers who quit during the study period range from 7% to 23%. Two studies found that a majority (55% and 87%) of participants who quit smoking recognized that the screening trial played a major role in their decision to quit (33,38). Relapse rates of baseline smokers who restarted smoking during the study period ranged from 1.6% to 12%.

Among the included studies, five randomized-controlled trials compared smoking outcomes between screening and control arm (22,24,26,27,31). In the DLCST, no differences between screen and control arm were found in 1-month point prevalence of cessation (11.9% *vs*. 11.8%) 1 year after randomization using Intention-To-Treat (ITT) analysis (22). The differences between control and screen arm remained insignificant in all four annual follow-ups (21). Similarly, in the LUSI trial, the difference in the reduction of smoking prevalence between the intervention (3.4%) and the control arm (4.5%) was not statistically significant two years after randomization (26).

In contrast, in NELSON, prolonged abstinence was lower for the screen arm (14.5%) than for the control arm (19.1%) 2 years after randomization, although after ITT analysis, the difference was no longer observed (27). In the UKLS trial, cessation rates were found to be higher for the screen arm than for the control arm 2 years after the screening (24% *vs*. 21%) using ITT-analysis (31). In the most recently published trial, the ITALUNG trial, the cessation rates were also higher for the screen arm than the control arms four years after baseline screening (20.8% *vs*. 16.7%: P=0.029) (24). When using ITT-analyses, one still found a trend in more favourable outcomes in screen arm participants (16.04% *vs*. 14.64%; P=0.059).

Impact of screening result on smoking behaviour

Thirteen observational studies investigated the impact of particular screening results on smoking behaviour. In six studies a single baseline CT test result did not influence smoking abstinence or smoking attitudes (23,25,33,34,38,39): individuals with a negative baseline result did not significantly differ in their smoking behaviours from participants with a positive baseline result or referral to a physician. Similarly, when examining the impact of multiple CT screening results, van der Aalst *et al.* and Anderson *et al.* did not find differences in prolonged abstinence for individuals with consistently negative results compared to those with at least one or more suspicious findings at 2-year and respectively 6-year follow-up (28,32). In most studies, however, even though differences were not significant, parameters of smoking outcomes were more favourable for participants with finding suspicious for lung

cancer (25,28,32-34).

UKLS and ITALUNG data showed that participants with a positive baseline scan were more likely to quit smoking compared to participants in the control arm, while no significant differences between the control group and those with a negative baseline scan were observed (24,31). Moreover, seven studies found higher cessation rates after a positive CT scan result or referral to physician compared to a negative result (22,29-32,35,37). Of these studies, all reported higher point prevalence abstinence rates after a positive scan compared to a negative scan. Clark *et al.* are so far the only ones to report higher prolonged (>6 months) abstinence rates after a positive scan (29). Townsend *et al.* found a positive association between the amount of positive results and smoking abstinence at 3-year follow-up (35). A similar result was found by van der Aalst *et al.* (28), although it did not reach significance. Clark *et al.* could not replicate these findings (29): individuals with two or more positive results were not more likely to quit smoking as compared to those with only one positive result.

Studies on the association between the screening result and smoking relapse are scarce. Two publications reported that recent quitters were less likely to relapse with at least one positive result compared to those with a negative screen (29,39). However, the definition of recent quitting differed in the two studies: in Clark *et al.* recent quitters stopped smoking six or less months before randomization, while in Borondy-Kitts *et al.* recent quitters stopped smoking 2 or fewer years before baseline screen. Ashraf *et al.* reported that the relapse rate was lower for baseline ex-smokers with positive CT findings (4.7%) than for their counterparts with negative findings (10.6%) (22), but did not make a distinction between recent quitters or long-term former smokers. None of the other three included studies found a relationship between screening result and relapse in long-term former smokers (29,32,39).

Smoking cessation interventions in lung cancer screening

The database search yielded 11 publications that evaluated smoking cessation interventions incorporated in lung cancer screening trials (Table S2). Data used for these studies derived from five randomized-controlled studies [ITALUNG (24), LUSI (26), the Multicentric Italian Lung Detection trial (MILD) (40), NELSON (41) and NLST (42)] and five cohort studies [Alberta Lung Cancer Screening (43), the Continuous Observation of Smoking Subjects-II (COSMOS-II) (44,45), Lombardi Comprehensive Cancer Center (46), Mayo study (47) and Queensland Lung Cancer Screening (48)].

Two pilot RCT's and a small randomized-controlled study (N=344) compared personalized clinician-delivered counselling to usual care (i.e., standard information material) (43,46,48). At 12 months of follow-up, no differences in self-reported smoking behaviour were found when intervention involved either telephone-delivered counselling (43) or a single face-to-face session complemented with MP3 material (48). Taylor *et al.* found higher biochemically-verified smoking cessation rates in the group that received telephone-based counselling (17.4%) compared to the control group (4.3%) at 3 months (46). In this pilot study, uptake (i.e., attendance to six sessions) was 60.9%. Tremblay *et al.* reported that only 42% of participants had more than one telephone contact, although seven sessions were originally planned. In an observational study based on the LUSI-trial, the decline in smoking prevalence was much higher for participants who attended the personalized smoking cessation counselling (9.6–10.4%) than for non-attenders (0.8–1.6%) (26). The counselling was offered to all trial participants, but only 31% attended the counselling.

Furthermore, in an observational study based on NLST data with 1,668 cases and 1,668 matched controls, exposure to clinician-delivered 5A (Ask, Advise, Assess, Assist, and Arrange) was retrospectively reviewed and linked to self-reported cessation outcomes of baseline smokers (42). The more intensive interventions of assist (i.e., talking about how to quit smoking or recommending pharmacological cessation aid or counselling) and arrange (i.e., proposing a follow-up session) were associated with a 40% and 46% increase in odds of post-screen smoking cessation. In contrast, the rates of exposure to less intensive interventions (ask, advise, and assess) did not differ between cases (study quitters) and controls (continued smokers).

Three Italian observational studies based on the ITALUNG, MILD and COSMOS-II trial examined the effect of clinician-delivered behavioral counselling combined with pharmacological treatment on smoking cessation (24,40,45). In the ITALUNG study, participants who voluntarily entered a structured smoking cessation intervention consisting of behavioral counselling and pharmacotherapy (varenicline, bupropion, NRT or a combination of these agents, n=119) were compared to baseline smokers enrolled at the same screening site who did not enter the smoking cessation program (n=306) (24). The results showed that participation in the smoking

cessation program was associated with a threefold increase in the odds of smoking cessation. Furthermore, those ITALUNG participants who completed all counseling visits (n=76) had higher cessation rates than smokers from routine practice who did not undergo CT-screening but participated in the same smoking cessation intervention (n=66) across a 12-months follow-up period. For example, at 12-months of follow-up, the cessation rates were 28.9% and 13.6% respectively. According to a retrospective analysis of 71 clinical records of participants, receiving behavioral counselling combined with NRT, varenicline or bupropion, 57% of the participants achieved prolonged abstinence for at least 6 month (45). In a prospective cohort study, in which 187 participants received behavioral counselling combined with varenicline, 33.7% achieved sustained abstinence at 6-months follow up, which decreased to 19.8% at 12-months follow-up (40). Additionally, the authors found a 40% increase in odds of smoking cessation for those participants who received the smoking cessation intervention compared to trial participants who did not attend the smoking cessation intervention. In the three studies, around 40% of participants (36.2%, 42.9% and 38.9% respectively) interrupted the treatment (24,40,45).

A recent RCT based on the COSMOS-II trial was the first publication to investigate the effectiveness of an e-cigarette intervention combined with telephone-based smoking cessation counselling in a lung cancer screening trial (44). No differences in abstinence were observed between the nicotine e-cigarettes group (n=70), the placebo group (when e-cigarettes did not contain nicotine; n=70) or the control group that only received behavioural telephone-based counselling (n=70). However, participants in the nicotine e-cigarettes group smoked significantly fewer daily cigarettes (M=11.0) than participants in nicotine-free e-cigarette group (M=14.0) or control group (M=13.5) at 6 months.

RCT's that investigated internet-based interventions did not find a significant benefit over standard written brochure material (41,47). In the NELSON-based trial (642 control and 641 intervention), computer-tailored smoking cessation information was compared to a standard smoking cessation brochure (41). No differences in prolonged smoking abstinence were found at 2-year follow-up. However, only 23% of the intervention arm completed the questionnaire that was needed to offer the tailored cessation program. In another RCT from the Mayo clinic, no significant differences in smoking abstinence or readiness to quit were found at 1-year follow-up between a group that received a standard written self-help brochure (n=86) and a group that received a list of internet resources for smoking cessation (n=85) (47). The group receiving the standard material was more likely to study all the information than the group receiving the internet-based intervention (56% *vs*. 23% read all the material).

Discussion

The purpose of this review was to provide the latest evidence on the integration of smoking cessation interventions in lung cancer screening programs. We have looked into the impact on smoking behaviour of both lung cancer screening trials in general and specific smoking cessation interventions incorporated in these trials.

Overall, enrolment in a lung cancer screening program seems to contribute to motivating high-risk individuals to quit smoking. Smoking cessation rates ranged between 7% and 23% in lung cancer screening trials, which is supportive. Additionally, studies reported that the majority of baseline smokers who quit during the study period acknowledged the major role that screening played in their smoking cessation succees (33,38).

The existing randomized-controlled trials offer contradictory evidence on whether actual participation in screening is necessary to achieve smoking cessation. While higher cessation rates in the screen than in the control arm were found in the UKLS and ITALUNG trial (24,31), the NELSON-trial found a reversed effect and the DLSCT and LUSI trials found no effect (21,26,27). However, comparing trial data remains difficult due to differences in handling of participants lost to follow-up, outcome measures and follow-up periods as well as the proportion of females. Moreover, participants in the NELSON, DLCST, UKLS, ITALUNG or LUSI received different type of interventions, such as standard smoking cessation information leaflets, computer-tailored information, minimal (<5 min) smoking cessation counselling or more intensive personalized counselling, respectively (21,24,26,27,31). Such differences in the kind and intensity of smoking cessation support might have also influenced the discrepancies between screen and control arm. Finally, it is also unknown to what extent the expectation that participants should quit smoking was conveyed in the different trials, which is usually done in smoking cessation intervention trials.

Higher cessation rates in control groups of screening trials than in the general population could imply that consideration of participation in a screening program

might already be a teachable moment by itself. Invitation to lung cancer screening potentially increases the salience of a possible lung cancer diagnosis and the negative consequences of smoking for high-risk individuals, and might thereby motivate rethinking of one's smoking habits. On the other hand, the higher quit rates in the screening trial population including the control group might also be explained by self-selection effects. The two large scale-trials with sufficient power showed some self-selection effect, a common phenomenon in clinical trials. NLST and NELSON participants were higher educated, younger, less likely to smoke at baseline, healthier and more physically active compared to the general population according to census data (4,49). Prior research has also shown that smokers from more socially deprived groups are less likely to both participate in a lung cancer screening program and to be abstinent from smoking (50,51). Further research is needed to disentangle the effects of CT screening and self-selection on smoking cessation to further understand the opportunities for promoting smoking cessation after lung cancer screening.

Evidence on the impact of screening results on smoking behaviour is still inconclusive. More than half of the included studies reported higher point prevalence of smoking after a finding suspicious for lung cancer as compared to a negative result (22,29-32,35,37). Furthermore, the results suggest that a positive CT screening result decreases the risk for relapse for those former smokers who have quit smoking recently (29,39). Long-term former smokers might be less susceptible to the impact of the screening result (29,32,39). Receiving a positive finding and referral to a physician might thus be a teachable moment motivating smoking abstinence in current smokers or recent quitters, at least in the short-term. Conclusions on long-term smoking abstinence cannot be drawn yet, as studies have relatively short follow-up periods, with only three of thirteen studies having a follow-period longer than 3 years (29,30,32). So far, only the publication based on the NLST found evidence for increased prolonged abstinence after a positive result compared to a negative result (29), while the ELCAP and NELSON publications have not found such an effect (28,32). However, these studies used different screening regimens than the NLST, which hinders direct comparison of the results. For instance, the NELSON study compared the impact of negative versus indeterminate results (28). Those with an indeterminate screening test result were invited only for repeat scan, which is a different experience than a referral to the pulmonologist for further work-up and diagnosis. The NELSON screening results are thus not suspicious for lung cancer until the result of the repeat scan is available. Consequently, the results are not directly comparable to the positive findings of NLST and ELCAP, although an increased number of indeterminate screening test results tend to increase smoking abstinence among participants. In the ELCAP trial, diagnostic work-up algorithms after a positive finding were more narrowly defined, while NLST trial radiologists did not mandate a specific work-up approach in their guidelines (52). Different work-up regimens might have introduced discrepancies in the experiences of NLST and ELCAP participants with positive findings. More data of more comparable studies is thus still required to determine the effects of screening results on long-term smoking behaviour.

Concerns have previously been raised that participants with negative CT screening results could falsely appraise their favourable results as a 'license to smoke'. Up until now, there is however no evidence to suggest that participants with negative 'all-clear' findings are less likely to quit smoking than individuals who have not underwent screening (24,31). Smoking prevalence of those with continuously negative findings seem to decline over time (29,30,32), reflecting the smoking behavior of those with at least one positive finding. Although current lung cancer screening trials reported supportive cessation rates, the potential negative effect on the motivation to quit smoking due to serious misperceptions in relation to risk and effectiveness of lung cancer screening should be avoided through careful communication about screening (53).

Smoking cessation support should be incorporated in lung cancer screening trials, as trial data and simulation studies have demonstrated that a combination of screening and smoking cessation reduces lung cancer-specific and overall mortality more than each component on its own (17-20). So far, only a few studies investigated the effects of specific smoking cessation interventions integrated in screening trials. Preliminary RCT's that compared clinician-delivered behavioural counselling to usual care have not shown an effect on self-reported smoking behaviours (43,46,48). However, caution is warranted when interpreting these results, as these studies lack sufficient power. Furthermore, one study has reported significantly higher abstinence in the group that received multiple sessions of telephone counselling, when measuring smoking abstinence biochemically (46). This result highlights the importance of employing biochemical verification of

smoking status when the researchers' objective of smoking cessation is apparent to participants and may evoke response biases.

Studies that combined clinician-delivered behavioural counselling with pharmacotherapies demonstrated the feasibility of such combined programs and showed cessation rates up to 57% in the first six months (24,40,44,45). The promising results of multi-modality interventions in lung cancer screening programs should be corroborated by sufficiently powered RCT's. Moreover, the beneficial effects seem to decline after a year and participants increasingly relapse with passage of time (40), indicating that follow-up sessions might be required to maintain treatment effects.

Low-intensity, internet-based interventions such as computer-tailored cessation advice or a list of internet resources did not show a significant benefit over standard written information material (41,47). The two RCT'S investigating these internet-based interventions experienced problems with participant engagement: a substantial proportion of participants did not fill in required information, read the material or recall ever having received cessation support at all. In line with findings of a meta-analysis among populations eligible for lung cancer screening and a systematic review on the effectiveness of smoking cessation interventions embedded within lung cancer screening (54,55), our results suggest that more intensive interventions such as clinician-delivered interventions, combined with pharmacologic cessation aids delivered across multiple sessions, appear to be more successful in influencing smoking behaviour.

A low participation rate as well as premature interruption of treatment are commonalities shared by many smoking cessation interventions. For instance, Bade *et al.*, Marshall *et al.* and van der Aalst *et al.* reported that less than half of eligible participants enrolled in the smoking cessation program (26,41,48). Other studies showed that approximately 40% or more discontinued clinician-delivered behavioural counselling and pharmacological-enhanced interventions (24,40,43,45,46). The poor attendance and retention rates may lead to underestimation of potential beneficial effects of the smoking cessation interventions. More participant-centered research is required to understand how to effectively communicate personal relevance of smoking cessation and increase (continuous) motivation for participation in smoking cessation interventions.

Another important key issue for future research is to curtail the variability in study characteristics and outcome variables, which hitherto makes pooled analysis difficult. Standardization of smoking outcomes such as reporting on 7-day point prevalence and prolonged abstinence of at least 6 months measured at 6, 12 and 24 months would facilitate comparison and pooling of studies.

Smoking cessation impacts a wide spectrum of other serious tobacco-related health problems such as cardiovascular diseases and COPD and their associated mortality risk. CT lung cancer screening has been shown to be an excellent method to detect these smoking-related comorbidities, which are very common in the eligible population (56). However, little research has been done on how to address these other concurrent diseases. Personalised information, derived from the CT scan related to personalised risk for developing lung cancer, coronary heart disease and emphysema, could be used as an incentive for people to adopt risk-reducing behaviour and change smoking behaviour. Due to the current pre-implementation stage of lung cancer screening in an increasing number of countries, additonal research on how to integrate information about the risk of lung cancer and the co-morbidites to motivate smoking cessation is strongly needed.

Conclusions

The context of CT lung cancer screening serves as a unique opportunity to motivate smoking cessation and thereby reduce mortality due to lung cancer and other related comorbidities. A positive CT finding and referral to a physician might especially serve as teachable moment increasing readiness to quit and smoking abstinence. The message, that smoking abstinence is valuable at all times, should be communicated to all eligible and non-eligible smokers. Smoking cessation support should constitute an integral part of lung cancer screening programs, with more intensive, personalized and multi-modality interventions showing the most promising results. More data is required concerning the most cost-effective type and modality of intervention, timing, frequency or content of the communication including the incorporation of the CT results. Ongoing trials such as the SCALE collaboration, the YESS trial, and 4-In-The-Lung-Run will hopefully provide first answers in the coming year(s) (57-59).

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Footnote

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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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