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Interactive Voice Response (IVR) for Tobacco Cessation: A Systematic Review

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Title: Interactive Voice Response (IVR) for Tobacco Cessation: A Systematic Review

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Abstract

Objective: To summarize the uses, outcomes, and implementation of interactive voice response (IVR) as a tobacco cessation intervention.

Data sources: A systematic review was conducted. Searches were performed on May 3, 2023. The strategies used key words such as “tobacco cessation”, “smoking reduction” and “interactive voice recording”. Ovid MEDLINE®ALL, Embase, APA PsycInfo, CINAHL, Cochrane Library, and Web of Science were searched. Grey literature searches were also conducted.

Study selection: Titles and abstracts were assessed by two independent reviewers. Studies were included if: IVR was an intervention for tobacco cessation for adults; any outcomes were reported; and study design was comparative. Any abstract included by either reviewer proceeded to full text review. Full texts were reviewed by two independent reviewers.

Data extraction: Data was independently extracted by two reviewers using a standardized form. The ROB-2 and the ROBINS-I tools were used to assess study quality.

Data synthesis: Of 308 identified abstracts, 20 moderate- to low-quality studies were included. IVR was used standalone or adjunctly as a treatment, follow-up or risk-assessment tool across populations including general smokers, hospitalized patients, quitline users, perinatal women, cancer patients and veteran smokers. Effective studies found that IVR was delivered more frequently with shorter follow-up times. Significant gaps in the literature include a lack of population diversity, limited implementation settings and delivery schedules, and limited patient and provider perspectives.

Conclusions: While the evidence is weak, IVR appears to be a promising intervention for tobacco cessation. However, pilot programs and research addressing literature gaps are necessary.

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Strengths and limitations

- This systematic review followed a prior written protocol and searched multiple databases and grey literature sources to identify relevant studies.
- Details on study selection and data extraction were explicitly reported and conducted by at least two independent reviewers.
- Study quality was assessed using the Cochrane risk of bias tools for controlled and observational studies.
- Due to limited time and resources, only relevant studies published in English or French language were included.
- Where possible, outcomes were stratified by population, sex and/or gender, however significant heterogeneity across studies precluded a meta-analysis.

Introduction

As of 2020, 22.3% of the global population reported using tobacco products - around 1.3 billion individuals (1). The annual economic costs of tobacco use are significant, equaling an estimated US$ 1.4 trillion and 1.8% of the world's annual gross domestic product (1). Over eight million deaths per year are attributed to direct and indirect tobacco use (1). While current global tobacco control efforts contribute to decreasing the prevalence of tobacco use and associated morbidity and mortality rates, it is crucial to continue finding ways to support patients who want to make a quit attempt or change their smoking behaviour.

Interactive voice response (IVR) is a phone-based platform that can be used to deliver health behaviour interventions (2). IVR can be used to deliver educational messages, reinforce behaviours, motivate and guide patients, record patient symptoms or outcomes, encourage medication adherence, and connect patients with further resources or professionals (3). With IVR, a human speaker is replaced with a high-quality, pre-recorded interactive script and responds to patients based on answers provided (2). Patients can either call the IVR or receive calls. The possible advantages of IVR include its ability to make multiple

calls during and outside regular business hours, it can connect with patients quickly, and it can identify those who are at higher risk and more likely to benefit from continued support (3, 4).

IVR has been used in interventions for alcohol consumption, asthma, heart failure, obesity, sleep apnea, hypertension, high cholesterol, dietary behaviour, to increase physical activity and to improve medication adherence (2). IVR has also been used as a tool to support tobacco cessation in patients, particularly post-hospital discharge (5). Post-discharge, patients receive tailored automated IVR calls at different time points (5). The calls typically assess patients' current smoking status, intention to quit or confidence in staying quit, current cessation medication use, and desire for additional support, and provides motivational messages, encourages patients to stay quit or continue attempting, promote the use of cessation medication, and offer to transfer patients to a counselor (5). IVR is also frequently used in conjunction with other interventions, such as nicotine replacement therapy (NRT), or after counselling with a physician in-hospital or in a primary care setting (5). However, the effectiveness of IVR as a tobacco cessation intervention for specific population groups, and the best uses and optimal delivery schedule of IVR interventions, are unknown.

This systematic review aims to synthesize and understand the current knowledge regarding IVR for tobacco cessation and to identify any gaps in the literature. Questions that guided this review included the ideal IVR delivery schedule, components of IVR, utilization of the intervention, outcomes reported in the literature, patient and provider perspectives, and costs of using IVR for tobacco cessation.

Methods

Search strategy

This systematic review followed a written, unregistered protocol and was conducted by following the Cochrane best practice guidelines and the PRISMA reporting standards (6, 7). An experienced medical information specialist developed and tested the search strategies through an iterative process in consultation with the review team. The MEDLINE strategy was peer reviewed by another senior information specialist using the PRESS Checklist (8). The strategies utilized a combination of controlled vocabulary (e.g., "Smoking Reduction", "Tobacco Use Cessation", "Reminder Systems") and keywords (e.g., "quit smoking", "interactive voice response"). Vocabulary and syntax were adjusted across

databases. Using the multifile option and deduplication tool available on the Ovid platform, we searched Ovid MEDLINE®ALL, Embase, APA PsycInfo, CINAHL (Ebsco), the Cochrane Library (Wiley), and Web of Science (Core Databases). Records were downloaded and deduplicated using EndNote version 9.3.3 (Clarivate Analytics). All searches were performed on May 3, 2023. Grey literature searches were conducted through the Canadian Agency for Drug and Technologies in Health Grey Matters database, targeted Google searches, and preprint databases including medRixV and Research Square.

Study selection

A calibration exercise was conducted by four reviewers on a sample of the retrieved abstracts. After 100% agreement was reached among reviewers, the remaining abstracts were screened in duplicate by two independent reviewers. Abstracts selected for inclusion by either reviewer proceeded to full-text review. This initial screen was intentionally broad to ensure that all relevant literature was captured. Abstracts proceeded to full-text review if: IVR was used as an intervention tool for tobacco cessation; IVR targeted adults; any outcomes were reported, including treatment completion, quit rates, smoking abstinence, and patient perspectives; and was a comparative study, comparing IVR to any comparator. Studies that reported other kinds of interventions but used IVR for data collection purposes were excluded.

Full texts were included if they met the above inclusion criteria. Conference abstracts, case series, reviews, letters, and editorials were excluded. Along with grey literature databases, the reference lists of relevant systematic reviews were also searched. Full-text review was conducted in duplicate by two independent reviewers. Discrepancies between reviewers were resolved through discussion and consensus.

Data extraction

Publication year, country, study design, target population, participant characteristics, intervention setting, purpose or use of IVR, IVR schedule and follow-up, and outcomes were extracted by a single reviewer using standardized data extraction forms. A second reviewer verified the extracted data. Discrepancies between reviewers during data extraction were resolved through consensus.

Quality assessment

The quality of controlled trials was assessed using the revised Cochrane Risk-Of-Bias Tool for Randomized Trials (ROB-2) (9), while the observational studies were assessed with the Risk of Bias in Non-Randomized Studies of Interventions (ROBINS-I) tool (10). Controlled trials were assessed using five criteria broadly covering the areas of randomization, deviation from intended intervention, missing outcome data, measurement of outcome, and selection of reported results (9). Observational studies were assessed based on the following parameters: bias due to confounding, selection bias, bias in classification, bias due to deviations from intended interventions, bias due to missing data, bias in measurement, and reporting bias (10). Quality assessment was completed by one reviewer and verified by a second reviewer.

Data analysis and synthesis

Significant heterogeneity of studies was expected. Therefore, a narrative approach to synthesis was adopted a-priori. A stratified analytic approach by population was adopted. Interventions used, outcomes, effectiveness, trends, and any gaps in the literature were assessed by population.

Patient and public involvement

Patients and the public were not involved this review. Stakeholders (and co-authors) from Alberta Health Services were involved in the conceptualization of this review and provided feedback on the final manuscript draft.

Results

Overall results

The search strategy yielded 308 unique citations, 271 of which were excluded after abstract review, Figure 1. Six studies were identified through hand and grey literature searches. Following abstract review, 43 studies proceeded to full-text review. At the full text-review phase, 23 studies were excluded for the following reasons: not IVR (n=4), IVR used as a data collection method (n=6), commentary or abstract (n=9), no outcomes (n=2), or duplicates (n=2), Figure 1.

The final dataset included 20 studies; 13 controlled trials and seven observational studies, Figure 2, panel A. Sixteen studies were conducted in the US (11-26), two were conducted in Canada (27, 28), and the remaining two were conducted in Norway (29, 30), Figure 2, panel B. Studies were published between 1995 – 2022, Figure 2, panel C. In eight studies, study sample sizes ranged between 100 to 500 participants while five studies each included between 500-1,000 participants, and >1,000 participants respectively. Only two studies included less than 100 participants, Figure 2, panel D. Appendix A includes additional details on the characteristics and outcomes of the 20 studies.

Quality of included studies

The risk of bias assessment of the 13 controlled trials ranged from some concerns (n=7) to high risk of bias (n=6), Figure 3, panel A. The most common critical weakness across the controlled trials was the deviation from intended intervention and the selection of reported results. However, most studies were assessed at a low risk of bias in the measurement of outcomes and the randomization process.

Overall, one observational study was assessed at a moderate risk of bias, two studies were at a high risk of bias, and the remaining four studies were assessed at critical risk of bias. The most common critical weakness across studies were confounding, deviation from interventions, measurement of outcomes, and the selection of reported results. Most of the observational studies were assessed at a low risk of bias in the classification of interventions and selection of participants to the study, Figure 3, panel B.

How was IVR used as an intervention?

Two uses of IVR were identified. Across the 20 studies, IVR was used as either a standalone (n=6) or an adjunct intervention (n=13) for tobacco cessation. The use of IVR was unclear in one study (17). When used as a standalone intervention, IVR was the primary intervention reported in the study (13, 14, 18, 20, 25, 31). When used as an adjunct intervention, IVR was used in combination with other interventions including counselling, referrals, quitlines, and web- or SMS-based cessation activities (11, 12, 15, 16, 19, 21-24, 26, 27, 29, 30).

When in the care trajectory was IVR used?

Studies examined IVR use along different points in the care treatment trajectory. Included studies used IVR as a treatment tool, a follow-up tool and a risk-assessment tool, Figure 4.

As a treatment tool, IVR asked questions regarding smoking habits, overall goals, and fears surrounding tobacco cessation. IVR provided tailored behaviour change therapeutic responses based on answers given by the patients, through personalized motivational messages and advice, coping mechanisms, and interactive activities. When IVR was used as a treatment tool, IVR delivery schedule varied widely for interventions with call schedules ranging from calls every day (20) to every 2-, 12-, 28-, 68-, and 88-days post-discharge (24) to every two weeks for 39 weeks (27). In two studies, IVR was available on an as-needed basis where patients were called regularly in response to their unique requirements (29, 30) and in two studies IVR was available 24/7 for participants to utilize when they wanted (18, 25).

As a follow-up tool, IVR was used post-discharge to monitor patients' progress, provided personalized motivational messages, provided access to requests for NRTs/pharmacotherapy, and directed calls to a quitline or counsellor. Five studies delivered IVR at 3-,14-, and 30-days post-discharge (12, 15, 16, 22, 28) and one delivered IVR at eight predetermined unspecified time periods over 12 weeks post-discharge (11). In all the studies that used IVR as a follow-up tool, IVR was also used as a risk-assessment tool (11, 28).

As a risk assessment tool, IVR assessed the risk of relapse based on responses to curated questions, flagging at-risk patients and connecting them to a counsellor, quitlines or nurse specialists to mitigate relapse and provide immediate support. Risk assessment was conducted differently across the different studies. In one study, specific questions were asked to assess risk of relapse and "at risk" patients were transferred to a quit coach for brief intervention (21). Frequency of IVR calls and follow-up times ranged widely.

For whom was IVR more likely to be effective?

IVR was used as a tobacco cessation intervention across multiple specific populations. Six studies targeted general adult smokers (20, 24, 25, 27, 29, 30), seven studies targeted hospitalized patients (11, 15, 16, 19, 22, 23, 28), three studies targeted quitline users (13, 14, 21), two studies targeted adult perinatal or pregnant women (12, 18), one study targeted cancer patients (17), and one study targeted veteran smokers (26), Figure 5.

General adult smokers

Four studies were controlled trials and the remaining two were observational studies (20, 24, 25, 27, 29, 30). Four controlled trials used IVR as an adjunct treatment tool. One reported biochemically confirmed abstinence rates and three reported self-reported point abstinence rates (24, 27, 29, 30). No statistically significant difference in past-7-days biochemically confirmed abstinence was found at 6-month follow-up (24). However, three controlled trials reported significantly higher self-reported point abstinence rates at 1-, 3-, 6, and 12-month follow-ups (24, 29, 30).

One observational study used IVR as a standalone treatment tool and reported abstinence rates. Of participants that reported abstinence at the 1-month follow-up, 47.1% were still abstinent at the 3-month follow-up and 37.3% were still abstinent at the 6-month follow-up (25). One observational study examined IVR as a treatment and risk assessment tool and focused on quit rates (20). Overall, 30% of individuals that opted into the IVR program were smoke-free at the last contact.

Hospitalized patients

Seven studies included patients admitted to hospital; four controlled trials and three observational studies (11, 15, 16, 19, 22, 23, 28). In the two controlled trials that used IVR as an adjunct treatment tool, one study found that 25.8% of intervention patients were biochemically confirmed abstinent in the past 7 days (p=0.009) and self-reported abstinence rates in the past-7-days at the 1-month and 6-month follow-ups were significantly higher in intervention patients (23). However, the other study found no statistically significant difference in self-reported abstinence rates between intervention and usual care participants (19). One controlled trial found that intervention patients were significantly more likely to be abstinent at 6-month follow-up (8.9%) compared to usual care control patients (3.5%, p=0.01) (11). Finally, one controlled trial that examined IVR as a standalone follow-up and risk assessment tool reported abstinence rates and found no difference in abstinence rates between intervention and control groups (28).

Two observational studies examined different outcomes of the same IVR follow-up program. One study reported that IVR was associated with significantly lower total healthcare costs at one-year post-discharge, with mean charges for the IVR group being over $8,000 less than the usual care control group (15). The other study found no statistically significant reduction in odds of readmission between the IVR

group and the usual care control group and no significant difference in readmission rates at 30-, 90-, or 180-days post-discharge (16). IVR reach was also reported to be low as IVR only reached about 43% of eligible participants, and 36.4% of those reached reported abstinence since their last IVR call. The remaining observational study examined the reach of a hospital-based counselling and IVR tobacco cessation program (22). IVR reach was low as only 43% of eligible participants were reached. While no difference was found between IVR alone and bedside counselling with IVR, counselling with IVR was associated with an increase in response to IVR utilization (22).

Quitline users

Three controlled trials targeted tobacco cessation quitline users (13, 14, 21). Two controlled trials used IVR as a standalone treatment tool. IVR intervention participants were significantly more likely to re-enroll into the quitline (28.2% intervention vs. 3.3% usual care; p<0.001), though the proportion of those that re-enrolled was small (14). Of those followed-up, 79.9% of those followed-up reported making a quit attempt lasting 24 hours or more in the last 90 days, with 24.0% reporting abstaining from tobacco in the last 7 days (13). One controlled trial used IVR as an adjunct risk assessment tool reported quit rates in quitline users at two different IVR delivery schedules: twice weekly for 2 weeks then weekly for 6 weeks (10 calls total) or daily for 2 weeks and weekly for 6 weeks (20 calls total) (21). The intervention found no difference in abstinence rates between the two IVR delivery schedules and the frequency of IVR calls did not impact tobacco cessation. Those that did not screen as at-risk for relapse during the scheduled IVR relapse risk assessments were 77% more likely to be abstinent at the 6-month follow-up (21).

Adult perinatal women

Two studies targeted adult perinatal women (12, 18). In the controlled trial, IVR was used as a standalone treatment tool and while 16.7% of IVR intervention participants were biochemically confirmed end-of-pregnancy quitters, there was no significant difference compared to usual care patients (18). The observational study used IVR as an adjunct follow-up and risk-assessment tool. There was no difference in reported abstinence between participants that only received IVR and those that received bedside counselling with IVR (12).

Cancer patients

One observational study examined IVR as a treatment tool at cancer centers (17). This study compared the effectiveness of multiple different tobacco cessation interventions, including IVR, implemented across 38 participating cancer centers. IVR was implemented at 4 out of the 38 cancer centers. Of all the cessation interventions, IVR had the greatest mean, median, minimum, and maximum ranges for reach, with responses from an average of 56% of those reached by IVR. No IVR-specific or patient-specific abstinence rates were reported; however, 22% of patients reported not smoking in the past 7 days and 19% not smoking in the past 30 days across all cancer centers and implemented interventions (17).

Veteran smokers

One controlled trial examined IVR as an adjunct treatment tool targeting veteran smokers (26). IVR was implemented in conjunction with a tobacco cessation manual, an expert system feedback report, and NRT use. At follow-up, 6-month prolonged abstinence rates at month 10 (6.6%), month 20 (9.3%) and month 30 (15%) showed a steady increase in abstinence, however, this increase was not statistically significant (26).

What were the patient-reported experiences with IVR?

Three controlled trials included elements of patient-reported experience with IVR for tobacco cessation (21, 29, 30). Most participants (96%) reported satisfaction with the overall quitline program and 98% stated that they would likely recommend the program to others (21). Furthermore, most participants reported that it was easy to answer questions using the IVR system (95%) regardless of IVR delivery schedule (21). Satisfaction with the IVR intervention was also highly positive, regardless of whether participants were given the option to utilize NRTs (29, 30).

What was the reach of IVR?

Eight studies reported reach of the IVR intervention (12, 14, 17, 18, 20, 22, 25, 26). The rate of participants interacting with IVR ranged from 20.8% to 42.8% (12, 14, 17, 18, 20, 22, 25, 26). In one study, IVR did have the highest average reach, compared to other smoking cessation interventions, with responses from 55.8% of those called by IVR; however, these results were at the institution-level, not the individual-level (17).

Sex and gender in this literature

Only one study stratified outcomes by sex or gender; it is unclear which (20). This observational study, of low quality, assessed IVR used as a standalone treatment and risk assessment tool for general adult smokers. It was found that females were significantly more likely to opt-in to the IVR intervention compared to males (OR = 0.78; 95% CI = 0.65-0.95). Of those that opted-in and received IVR calls, females were more likely to report being smoke free at last contact compared to males (OR = 0.87; 95% CI = 0.66-1.15), though this difference was not significant (20).

Discussion

Overall, this review included 20 heterogenous studies. While the evidence base is weak, results indicate that IVR is a promising intervention that can be implemented in multiple healthcare settings, across distinct populations. IVR was implemented as either a standalone or adjunct technology. When implemented as an adjunct technology, IVR was often paired with in- and out-patient counselling, nicotine replacement therapy, or self-help materials, though the type of adjunct intervention did not impact effectiveness of IVR. IVR was also implemented at several points along the patient trajectory and was effective at increasing self-reported abstinence and increasing the use of other tobacco cessation interventions across diverse populations, including general smokers, hospitalized patients, quitline users, adult perinatal or pregnant women, cancer patients, and veteran smokers. The frequency of IVR calls and follow-up times varied widely and studies comparing different IVR delivery schedules reported no differences between brief/short-term and sustained IVR delivery. However, increased IVR frequency and shorter time between follow-ups were generally associated with increased effectiveness of IVR. IVR also reduced healthcare costs. However, IVR did not significantly affect other outcomes, including hospitalization and biochemically confirmed abstinence. Additionally, the reach of IVR was consistently low. Despite variability of findings, no application or use of IVR was shown to be harmful to participants and studies that reported patient perspectives were positive.

Our investigation of the applications, uses and outcomes associated with IVR as a tobacco cessation intervention highlights considerable implications of this health technology on patients, providers, and the healthcare system. For patients, IVR can be an accessible tobacco cessation tool, whether delivered independently or as a supplementary treatment. It can provide a private, judgement-free environment for patients to speak freely about their smoking habits, tobacco use, goals, fears, and motivations, and

can offer an opportunity for patients to engage in self-monitoring of their own care and progress as they persist towards becoming smoke-free. However, due to the automated nature of IVR, there is a loss of the emotional support patients may receive with in-person counselling and the risk of response bias. For providers, IVR can reduce workloads and may be valuable tool to provide optimal care for many patients. IVR can help providers gain regular insight on the progress of their patients, can help guide or revise treatment plans and provide additional support. IVR implementation considerations for providers may include technical training, privacy concerns, and costs. IVR may provide considerable benefits for healthcare systems by helping to address smoking and tobacco use which continues to pose a high public health burden through smoking-related diseases. IVR can also assist with data collection, appropriate resource allocation and may serve as a cost-saving healthcare tool.

To our knowledge, this review is the first to compile available evidence on the utilization, application, and effectiveness of IVR technology for tobacco cessation, limiting the possibility for comparison with previous reviews. A previous review by Shoesmith et al. examining different tobacco cessation interventions, including IVR, found that while both longer (> 6 months) and shorter (<6 months) follow-up durations produced an effect in favour of the smoking cessation interventions, abstinence rates showed a decreasing trend once follow-up length exceeded 6 months, supporting our findings that tobacco cessation intervention effectiveness may be associated with shorter follow-up times (32). However, Shoesmith et al. did not provide IVR-specific findings, opting to examine different behaviour change techniques for smoking cessation and relapse prevention (32). Conclusions made in this study may not appropriately correlate with the findings of this review due to the variability in purpose, mode of delivery, frequency and quality of behaviour change smoking cessation interventions and the impact of these factors have on intervention outcomes.

While this study provides a broad overview of the current literature surrounding IVR for tobacco cessation, several limitations exist. The majority of included studies were of low to moderate quality. Though most studies were controlled trials, variability in interventions, methods and outcome measures precluded a meta-analysis. This limited the extent to which the comparative effectiveness of IVR applications and uses across the different populations could be inferred. Further, due to the low number and quality of studies available for multiple populations, generalizations cannot be made, and results should be interpreted cautiously.

There are significant gaps in the literature that should be noted. First, while this review identified some studies targeted at several populations, no studies were found for some populations that may benefit from IVR including racialized groups and Indigenous Peoples. Furthermore, only one study stratified outcomes by sex or gender. Second, no studies compared IVR initiated in different contexts or settings, such as inpatient versus outpatient settings. Third, only two studies compared different IVR delivery schedules and found no difference (21, 27). Different schedules and times to follow-ups may have different effectiveness. Finally, no qualitative studies examining patient or provider perspectives on IVR were identified.

Conclusion

Tobacco cessation interventions should be approached with effective mitigating and preventative strategies. Overall, IVR was effective at increasing abstinence rates and encouraging positive health outcomes for tobacco cessation. While this review summarized the current knowledge base of IVR for tobacco cessation, several significant gaps in the literature still exist. Organizations can pilot tobacco cessation intervention programs using IVR and contribute, using real-life contexts, to the growing knowledge base of this technology.

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Supplemental material Appendix A. Table of Study Characteristics

Ethics approval

All data were from published studies so ethics approval was not required.

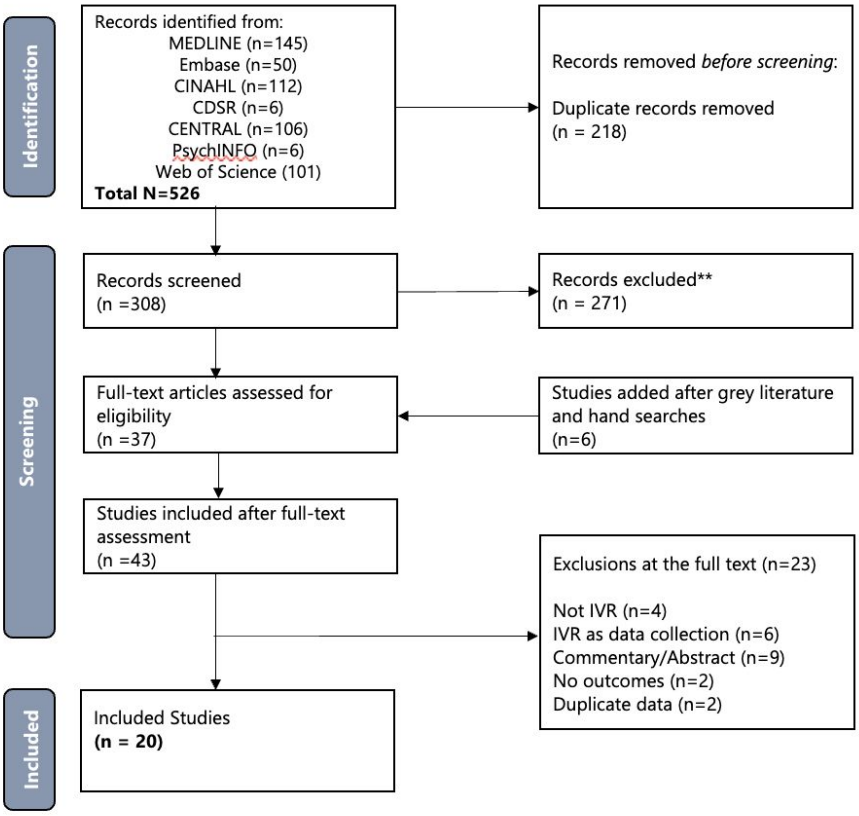
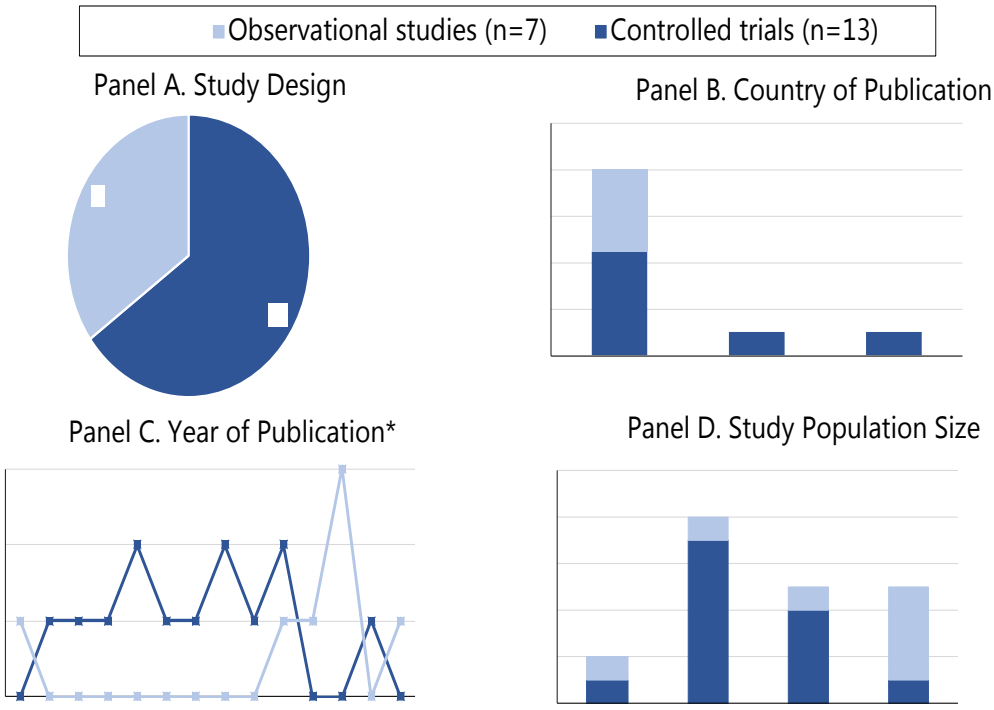


Figure 1. PRISMA for systematic review



*Only the 14 years with at least one publication are shown

Figure 2. Summary characteristics of included studies

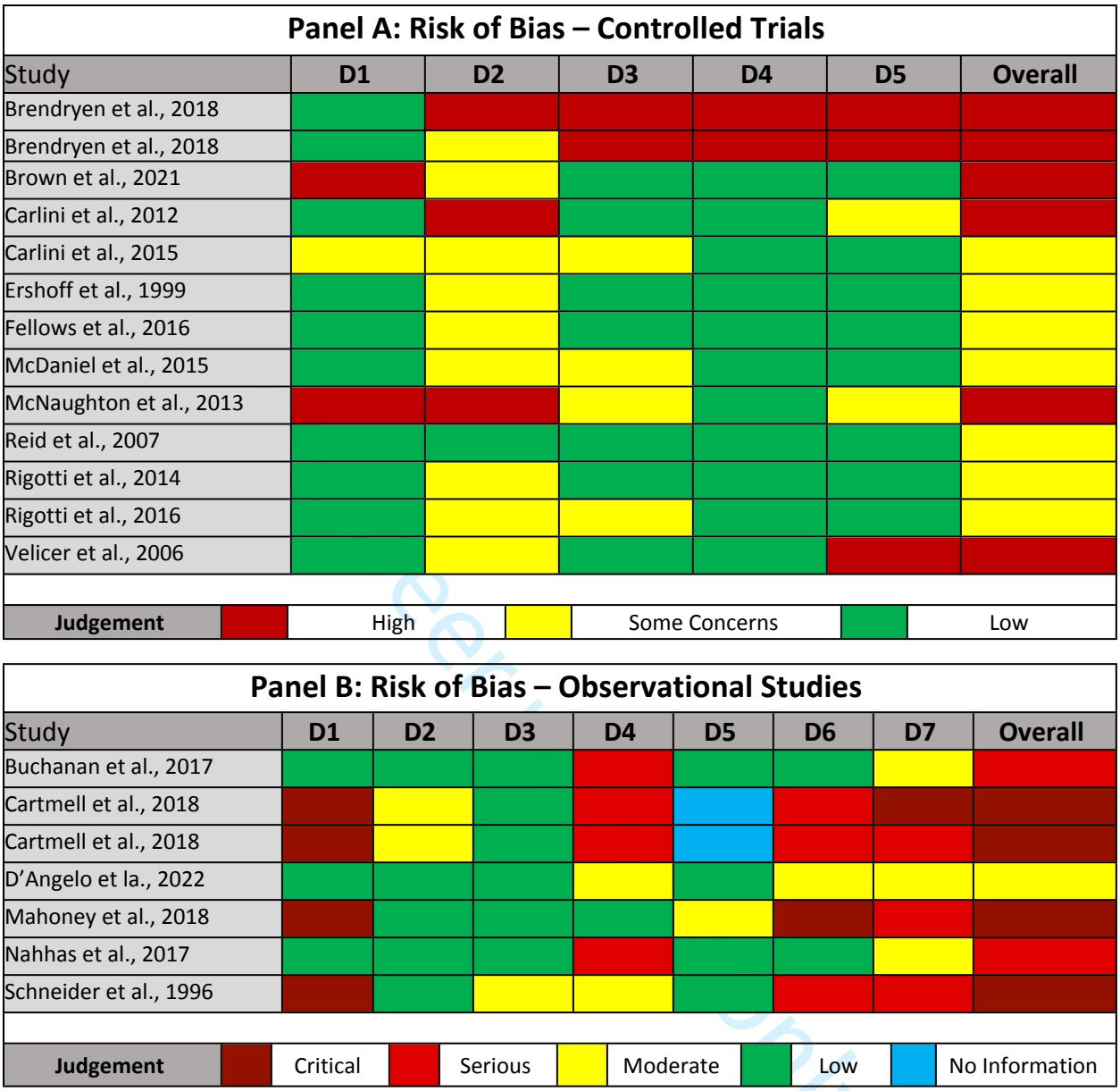


Figure 3. Quality assessment for included studies

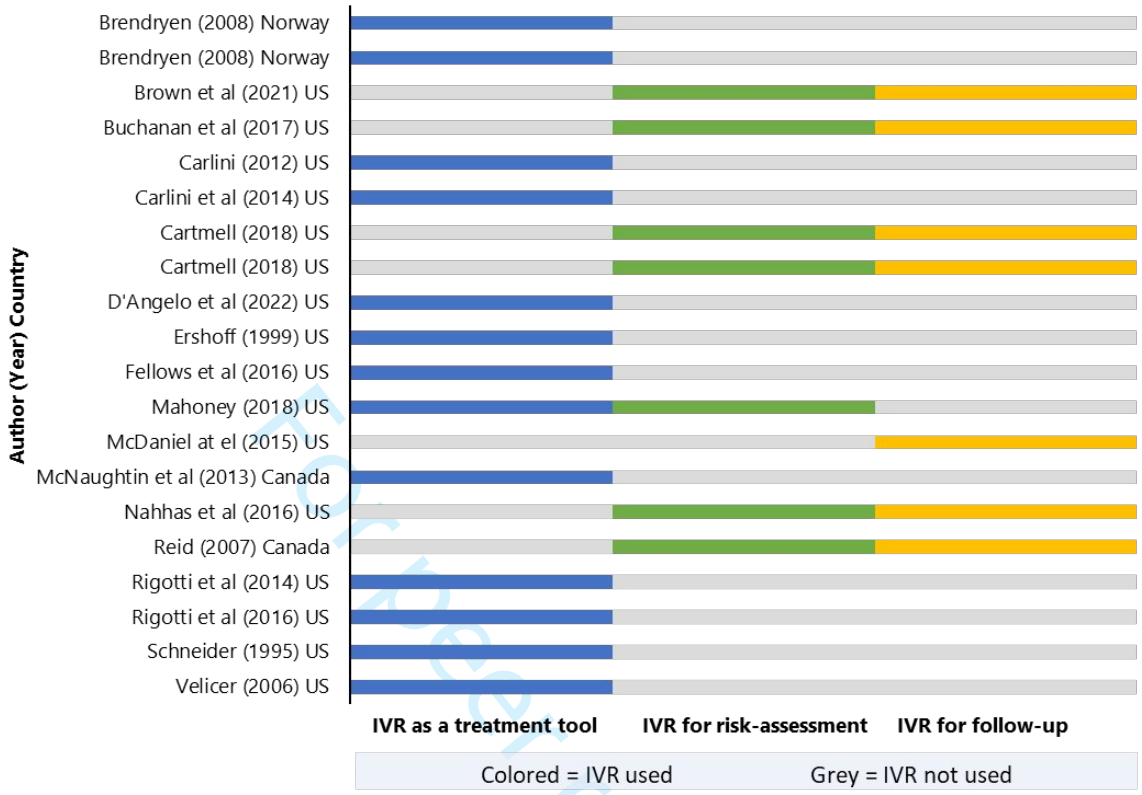


Figure 4. Timing of IVR use in the care trajectory

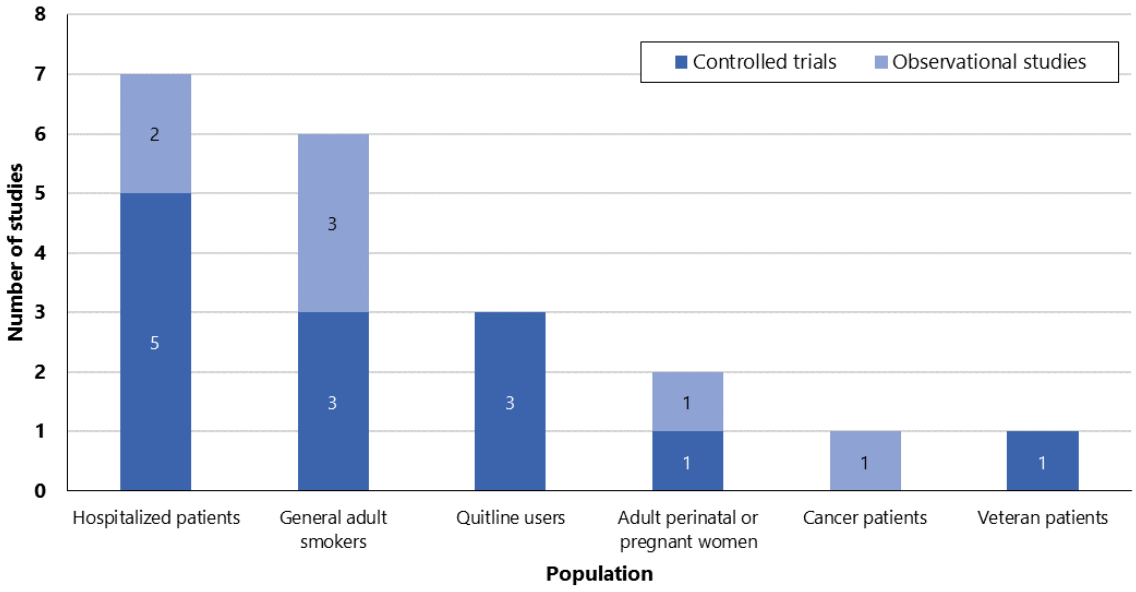


Figure 5. Populations assessed in systematic review

Appendix A: Table of Study Characteristics

	Study information	Intervention	Patient characteristics	Primary Outcomes	Other outcomes
Brendryen et al. (2008) Norway Trial #: Not reported Funder: Norwegian Research Council Industry sponsored: No	Study design: Controlled Study setting: Digital/Quitline Inclusion criteria: Wanting to attempt quitting, 18 or older, smoking 5+ cigarettes a day, attempt quit without nicotine replacement therapy	Purpose of IVR: Intervention Description of intervention: Happy Ending program is an internet-based multimedia intervention that used CBT techniques to help people quit smoking without the use of nicotine replacement therapies. IVR is an aspect of the intervention, along with website-based activities and SMS messages. Standalone or adjunct: Adjunct IVR/Follow-up Schedule: Regular IVR	Population: Adult Smokers Comparator: Usual care N: 144 Control: 146 Age: 39.5 % female: 50%	Reach: 62% of participants answered log-in calls. 87 intervention participants completed treatment. Abstinence at follow-up: Repeated point abstinence was 20% for intervention group and 7% for control group (p=0.002)	At 1 month, 51% of participants found HE to be “helpful,” and 32% reported HE to be “very helpful”.

		calls depending on participants' needs; follow up at 1, 3, 6 and 12 months			
Brendryen et al. (2008) Norway Trial #: Not reported Funder: Norwegian Research Council, Pfizer Industry sponsored: Yes	Study design: Controlled Study setting: Digital/Quitline Inclusion criteria: Wanting to attempt to quit smoking, aged 18+, smoking 10+ cigarettes a day and have access to the internet, email and cellphone	Purpose of IVR: Intervention Description of intervention: Happy Ending program is an internet-based multimedia intervention that used CBT techniques to help people quit smoking. IVR is an aspect of the intervention, along with website-based activities and SMS messages. Participants were given and allowed to use NRT products if they wanted. Standalone or adjunct: Adjunct IVR/Follow-up Schedule: Regular IVR	Population: Adult Smokers Comparator: Usual Care N: 197 Control: 199 Age: 35.9 % female: 50.8%	Reach: 71% of participants answered log-in calls. 152 participants completed treatment. Abstinence at follow-up: Repeated point abstinence was significantly higher in treatment group (22.3%) vs. control (13.1%) (p = 0.02. At the 12 month follow up, 74 treatment participants reported abstinence vs. 48 control participants (p = 0.005)	At 1 month, 48.2% found HE to be 'helpful' and 44.7% reported HE to be 'very helpful'. Most participants in both groups opted for NRT therapy (93% intervention vs. 87% control - p = 0.07). At 1 month, the mean number of days of NRT use was significantly higher in treatment group (M = 5.1 vs. 3.9; p = 0.02).

		calls depending on participants' needs; follow up at 1, 3, 6 and 12 months			
Brown et al. (2021) US Trial #: NCT02204956 Funder: National Institute of Mental Health Industry sponsored: No	Study design: Controlled Study setting: Acute care private Psychiatric hospital Inclusion criteria: Inpatient psychiatric patients aged 18 or older who smoked at least 5 cigarettes per day Exclusion: a current diagnosis of non-nicotine substance use disorder, dementia, intellectual disability, autistic spectrum or other cognitive impairment, an inability to provide consent, medical	Purpose of IVR: Follow-up monitoring Description of intervention: Patients received in-patient tobacco cessation counselling. Following discharge, IVR asked about participants' smoking, intentions to quit, desire for an additional 4 weeks of transdermal nicotine patches (ie, 8weeks total), and interest in connecting with free telephone quitline counseling. Standalone or adjunct: Adjunct IVR/Follow-up Schedule: 8 times over	Population: Hospitalized Patients Comparator: Usual Care N: 174 Control: 179 Age: 36.1 % female: 46.7%	Abstinence at follow-up: 8.9% intervention reported abstinence vs. 4.5% of control, p=0.04, verified at 6 months by saliva cotinine analysis	Use of any smoking cessation treatment: 74.6% of intervention vs. 40.5% of control at 6 months, p<0.001 Use of counselling: 37.3% of intervention vs. 11.0% of control at 6 months, p<0.001 Use of pharmacotherapy: 71.0% vs. 37.0% at 6 months, p<0.001

	contraindication to the use of NRT or a current pregnancy.	12 weeks post-discharge			
Buchanan et al. (2017) US Funder: MUSC, NIDA Industry sponsored: No	Study design: Observational Study setting: Academic medical center Inclusion criteria: Adult women admitted to the peripartum, delivery, and postpartum units Exclusion criteria: Women over 41 and admitted for something non-pregnancy-related	Purpose of IVR: Follow-up monitoring and transfer Description of intervention: Patients counselled in-hospital by a tobacco treatment specialist; Post-discharge, IVR collected info on smoking status, frequency, quit attempts, motivation to quit, use of nicotine replacement therapy (NRT) and whether the patient wanted to be transferred to the quitline Standalone or adjunct: Adjunct IVR/Follow-up Schedule: 3-, 14-, and 30-days post-discharge	Population: Adult perinatal women Comparator: Bedside Cessation Counselling + IVR N: 421 Age: 29 % female: 100%	Reach: 35.5% of patients reached by IVR Abstinence at follow-up: 12.8% those who received both counselling and IVR reported abstinence vs. n.r. of those who received IVR only	15.4% of IVR + counselling participants used NRT vs. 4% of IVR only 10.8% of IVR + counselling participants were transferred to the quitline vs. 14.0% of IVR only

10.1136/bmjopen-2023-081972 on 9 July 2024. Downloaded from

Carlini et al. (2012) USA Trial #: NCT0126059 Funder: National Cancer Institute Industry sponsored: No	Study design: Controlled Study setting: Quitline Inclusion criteria: Previously enrolled in quitline, Medicaid or uninsured, 18 or older, sought help for cigarette/tobacco use	Purpose of IVR: Intervention Description of intervention: Recruited participants who were previously enrolled in a quitline intervention; IVR call assessed smoking behaviours, current smoking status; if participants were interested in reattempting quit, they were enrolled into connected with quitline specialist and reenrolled into IVR intervention. Standalone or adjunct: Standalone IVR/Follow-up Schedule: One IVR call to assess and/or recruit into intervention. Up to 20 call attempts made.	Population: Quitline users Comparator: Usual Care N: 245 Control: 276 Age: 42.2 % female: 66.5%	Reach: 23.6% of previous quitline users reached Re-enrollment rate was 28.2% for intervention vs. 3.3% for control (< 0.001) IVR participants were 11.2 times more likely to re-enroll than comp. (OR - $p < 0.001$)	

Carlini et al. (2014) US Trial #: Funder: Quitline Registries for Continuously Engaging Participants in Cessation from the Centers for Disease Control and Prevention Industry sponsored: No	Study design: Controlled Study setting: Quitline Inclusion criteria: 18 or older, having received services in English, providing verbal consent, being a cigarette smoker, not being incarcerated, and not having received quitline services for at least 5 months before the study launch	Purpose of IVR: Intervention Description of intervention: IVR system delivered a set of questions to identify motivational and informational barriers to recycling into a new quit attempt and provided tailored messages to specifically address these barriers Standalone or adjunct: Standalone IVR/Follow-up Schedule: Two cycles of 6 IVR attempts each; follow-up at 90 days	Population: Quitline Users Comparator: Usual Care N: 3,510 Control: 22,824 Age: 65.2% over 40 % female: 53.8%	Abstinence at follow-up: 24.0% reported abstaining from tobacco in the last 7 days Quit rate: 79.9% those followed with reported making a quit attempted lasted 24 hours or more in the last 90 days	
Cartmell et al. (2018) USA Funder: Agency of Healthcare Research and Quality, Pfizer	Study design: Observational Study setting: Hospital Inclusion criteria: 18+ smokers	Purpose of IVR: Follow-up monitoring and transfer Description of intervention: IVR call at discharge determined	Population: Hospitalized patients Comparator: Usual Care N: 764	Cost/Cost-effectiveness: Total mean healthcare cost post-discharge: $51,937 IVR vs. $59,132 control, p=0.03.	

Industry sponsored: Yes	admitted to the hospital Exclusion criteria: Those admitted for psychiatric care, same day surgery, <24-hour observation or not discharged	smoking status and referred to the tobacco treatment specialist that assessed patients' behaviour and developed a treatment plan with the patient. IVR also conducts follow-up calls to evaluate smoking status and transfer to counsellor if needed. Standalone or adjunct: Adjunct IVR/Follow-up Schedule: At discharge, 3, 14, 30 days post-discharge	Control: 1439 Age: 49.4 % female: 47.5%	Comparing overall health care charges for the TDTS low exposed (IVR) versus unexposed patient groups, the mean charges for the IVR group were $8006 lower than for the control group (P=0.08). Intervention implementation costs were $34.21 per participant in 12-month period (incl. start-up cost) with total intervention cost being $158,140.	
Cartmell et al. (2018) USA Funder: Agency of Healthcare Research and Quality, Pfizer	Study design: Observational Study setting: Hospital	Purpose of IVR: Follow-up monitoring and transfer Description of intervention: IVR call at discharge determined	Population: Hospitalized patients Comparator: Usual Care	Readmission rates 30-day - 9.8% IVR vs. 11.9% control (p=0.05), 90 day - 17.3% IVR vs. 18.6% control (p = 0.258), 180 day -	

Industry sponsored: Yes	Inclusion criteria: 18+ smokers admitted to the hospital Exclusion criteria: Those admitted for psychiatric care, same day surgery, <24-hour observation or not discharged	smoking status and referred to the tobacco treatment specialist that assessed patients' behaviour and developed a treatment plan with the patient. IVR also conducts follow-up calls to evaluate smoking status and transfer to counsellor if needed. Standalone or adjunct: Adjunct IVR/Follow-up Schedule: At discharge, 3, 14, 30 days post-discharge; Follow-up at 30-, 90- and 180-day post-discharge.	N: 764 Control: 1439 Age: 49.4 % female: 47.5%	22.4% IVR vs. 24.3% control (p=0.239).	
D'Angelo et al. (2022) US Funder: National Cancer Institute	Study design: Observational Study setting: Cancer Centers	Purpose of IVR: Intervention Description of intervention: IVR used to automatically identify and contact	Population: Cancer Patients Comparators: Other smoking cessation intervention	Reach: IVR had the highest average reach with an average of 55.8% of patients reached.	21.7% of patients had not smoked in the past 7 days and 18.6% had not smoked in the past 30 days, however, this result applies to

Industry sponsored: No	Inclusion criteria: Adults 18 years and older	patients who smoked to provide treatment. Implemented in 4/38 cancer centers. Standalone or adjunct: Unclear IVR/Follow-up Schedule: Not reported	including telephone counselling, in-person counselling, cessation medication and access to a quitline. N: 38 Cancer centers Age: N/A % female: N/A		all cancer centers, across all implemented interventions and is not specific to IVR.
Ershoff et al. (1999) USA Trial #: Not reported Funder: Not reported Industry sponsored: No	Study design: Controlled Study setting: Hospital Exclusion criteria: Women under the age of 18, and those who began prenatal care past the 26th week of pregnancy, smoked less than 7 cigarettes week pre-	Purpose of IVR: Intervention Description of intervention: For the IVR subgroup, participants were given informational booklet along with access to computerized IVR support system that they had access to 24/7 toll-free. IVR would ask	Population: Adults Perinatal women Comparators: Cessation booklet, Motivational Interviewing N: 120 Control: 111 Age: 29.6	Reach: 285 participants successfully reached for follow up at the 34th week of pregnancy (IVR only group not specified) Quit rate: 16.7% of IVR intervention group were biochemically	Only 20.8% of IVR patients placed one or more calls to the system and it had no impact on their quit status

	pregnancy, had experienced a miscarriage/ abortion, and had not smoked prior to the baseline interview	about smoking behaviour and readiness to change as well as stage-appropriate, customized motivational messages, interactive activities and reinforcement. Standalone or adjunct: Adjunct IVR/Follow-up Schedule: Available 24/7 for participants to utilize as needed; Follow-up at 32 weeks pregnancy	% female: 100%	confirmed end-of-pregnancy quitters, - not statistically significant	
Fellows et al. (2016) US Trial #: NCT01236079 Funder: National Heart, Lung, and Blood Institute Industry sponsored: No	Study design: Controlled Study setting: Hospitals Inclusion criteria: Adult patients admitted to one of the hospitals who reported having	Purpose of IVR: Intervention Description of intervention: Patients were counselled in-hospital and created a tailored discharge treatment recommendation; medications; IVR	Population: Hospitalized patients Comparator: Usual Care N: 597 Control: 301 Age: 53	Reach: 50.6% of patients completed call 1, 31.3% completed call 4; mean total calls completed = 2 (SD 1.7) Abstinence at follow-up: 30-day abstinence = 18%	Use of any quit program: 8.4% in intervention, 5.0% in control, p=0.096 Use of telephone quitline: 6.9% intervention vs. 2.5% control, p=0.014

	smoked a cigarette in the previous 30 days, spoke English, had a working phone, and were interested in remaining abstinent post-discharge Exclusion criteria: Patients living more than 50 miles away, admitted to a critical care, labor/delivery, or psychiatric unit, were pregnant or breastfeeding, were physically too ill or cognitively unable to provide informed consent	contacted patients for smoking status, cessation program enrollment status, and cessation medication use, and received tips for quitting Standalone or adjunct: Adjunct IVR/Follow-up Schedule: 4, 14, 28, and 49 days; Follow-up at 6 months	% female: 56.6%	for intervention, 17% for control, p=0.569	Use of any medication: 47.9% intervention vs. 38.0% control, p=0.013
Mahoney et al. (2018) USA Funder: Western New York Cancer Coalition Center, Roswell Park	Study design: Observational Study setting: Telephone Inclusion criteria: 18 years or older,	Purpose of IVR: Intervention, transfer Description of intervention: Looks at AVR system (same as IVR). Following chart review of smokers in	Population: Adult Smokers Comparator: Usual Care N: 1049 (opt-in)	Reach: 32% of patients reached following chart review, 55% of these opted in to AVR program.	Females (OR = 0.78, CI 0.65-0.95) and those over 40 were less likely to opt out, while rural smokers (OR = 3.84, CI 3.01-3.90) were more likely to opt out.

Comprehensive Cancer Center, National Cancer Institute Industry sponsored: No	visited an urban/rural primary care office community health center, academic site or private practice in a medically underserved communities of interest	area, baseline AVR call was made to all eligible patients. Opt-in participants received AVR calls every day. AVR customized motivational messages, activities and questions during call to specific stage of change. If participant relapsed, they were transferred to primary care office or state quitline for counselling. Standalone or adjunct: Standalone IVR/Follow-up Schedule: IVR calls every day for study period (undefined)	Control: 850 (opt-out) Age: 59.1% over 50 % female: 51.9%	Abstinence at follow-up: 30% of intervention group that completed the AVR program reported abstinence	Smokers from rural medical offices were more likely to report being smoke free (OR, 1.41, CI 1.01-1.97) - smoke free status did not differ by sex, racial group or age.
McDaniel et al. (2015) US Trial #: NCT0088899	Study design: Controlled Study setting: QFL program	Purpose of IVR: Risk Assessment Description of intervention: All participants received	Population: Quitline users Comparators: Standard	Abstinence at follow-up: At 6 months: No smoking in last 7 days = 66.0% of control, 69.6% of	98% were satisfied, 98% would recommend the programme to others; overall, 87% said IVR was helpful

Funder: National Institutes for Health Industry sponsored: No	Inclusion criteria: Tobacco users enrolled in the Quit For Life (QFL) programme who were quit for 24 hours or more, English-speaking, 18 or older, having access to a touch-tone phone Exclusion criteria: Smokeless tobacco users, actively participating in another tobacco cessation programme, had previously enrolled in QFL during the past 6 months, had limited phone access	five counselling calls from a Quit Coach; IVR calls delivered risk assessments, and high-risk participants were transferred to a Quit Coach Standalone or adjunct: Adjunct IVR/Follow-up Schedule: TEQ-10 = twice weekly for 2 weeks, then weekly for 6 weeks; TEQ-20 = daily for 2 weeks, then weekly for 6 weeks; follow-up at 6 and 12 months	quitline uses, TEQ-10, TEQ-20 N: 602 in TEQ-10, 591 in TEQ-20 Control: 592 Age: 43.4 % female: 54.2%	TEQ-10 (p=0.3051 vs. control), 67.3% of TEQ-20 (p=0.7121 vs. control); Did not smoke in the last 30 days: 60.6% of control, 65.2% of TEQ-10 (p=0.1946), 61.7% of TEQ-20 (p=0.8947); At 12 months: No smoking in last 7 days = 65.3% of control, 67.0% of TEQ-10 (p=1691), 62.2% of TEQ-20 (p=0.4655); in last 30 days: 61.6% of control, 63.1% of TEQ-10 (p=0.6821), 56.6% of TEQ-20 (p=0.1871)	
McNaughton et al. (2013) Canada	Study design: Controlled	Purpose of IVR: Intervention	Population: Adult Smokers	Abstinence at follow-up: Of patients who had quit smoking at 12	

Trial #: NCT00832806 Funder: Pfizer Canada Industry sponsored: Yes	Study setting: Outpatient Clinic Inclusion criteria: Smoking ≥35 cigarettes per week or ≥5 cigarettes per day for at least 2 years with no period of abstinence longer than 3 months Exclusion criteria: Use of any smoking cessation drugs or nicotine replacement in the last 3 months, use of medications to treat depression or any psychiatric illness, history of depression or an unstable medical condition	Description of intervention: All participants received a 12-week supply of varenicline; IVR asked about cigarette use, side effects, confidence in maintaining abstinence, and motivational messages; at 12 weeks, all participants who were still abstinent were randomized to receive either further IVR or no IVR Standalone or adjunct: Adjunct IVR/Follow-up Schedule: Days 1, 3, 8 and 11 post-quit then every 2 weeks for following 39 weeks; follow-up at 52 weeks and 2 years	Comparator: Participants who only received IVR for 12 weeks. N: 101 initially and then 44 IVR only Control: 41 Age: 52.6 overall % female: 33%	weeks, 59% were smoke-free at 52 weeks, 52% of intervention and 66.7% of control (p=0.33) At two years, 1[illegible] of overall population, 30% those abstinent 12 weeks, and [illegible] of those abstinent at 52 weeks (n=40) were confirmed to be non-smoker; of these, 21% had received extended IVR (so 21.7% of intervention vs 42.9% of control, p=0.13, were smoke-free at two years)	

Nahhas et al. (2016) US Funder: Medical University of South Carolina Health Industry sponsored: No	Study design: Observational Study setting: Medical University Inclusion criteria: Adult cigarette smokers Exclusion criteria: Patients who died during hospitalization, receiving hospice care, not discharged back home, and psychiatric inpatients	Purpose of IVR: Follow-up monitoring and transfer Description of intervention: Patients counselled in-hospital by tobacco treatment specialist and developed an individualized tobacco-treatment plan; IVR collected info on smoking status and provide additional support through the offer of a direct immediate referral "warm transfer" to a quitline Standalone or adjunct: Adjunct IVR/Follow-up Schedule: 3-, 14-, and 30-days post-discharge	Population: Hospitalized Patients Comparator: Bedside Counselling + IVR N: Not reported Age: Not reported % female: Not reported	Reach: 42.8% were reached at least once within 30 days Abstinence at follow-up: 36.4% those who were reached reported not smoking at time of their last phone contact; based on intention to treat, 13.5% of patients were classified as not smoking based on their most recent follow-up call	19.6% who were reached asked to be transferred to the quitline Bedside counselling was associated with a 13% increase in response to IVR (55% vs. 49%), a 90% increase in reported abstinence (51% vs. 27%), and double the rate of those using medications (21% vs. 8%)

Reid et al. (2007) Canada Trial #: Not reported Funder: Canadian Tobacco Control Research Initiative Industry sponsored: No	Study design: Controlled Study setting: Hospital Inclusion criteria: Current smokers (5 or more cigarettes per day), 18+, hospitalized for acute coronary syndrome	Purpose of IVR: Follow-up monitoring and risk assessment Description of intervention: IVR system called participants post-discharge and asked about smoking status, confidence in staying smoke free until next call, and use of self-help materials and pharmacotherapies. Patients were flagged and connected with nurse specialists if they reported relapse but interest in quit reattempt or if they were not confident in their ability to stay smoke free. Further telephone counselling was given. Standalone or adjunct: Standalone	Population: Hospitalized patients Comparator: Usual Care N: 50 Control: 50 Age: 54 % female: 39%	Reach: At 3-day follow-up, 70 participants answered IVR calls. Abstinence at follow-up: At the 52-week follow-up, 46% of the IVR group and 34.7% of the control group were abstinent (p = 0.07).	

		IVR/Follow-up Schedule: 3-, 14- and 30-days post-discharge; 12- and 52-weeks post-discharge (by telephone, not IVR)			
Rigotti et al. (2014) US Trial #: NCT01177176 Funder: National Institutes of Health/National Heart, Lung, and Blood Institute Industry sponsored: No	Study design: Controlled Study setting: Hospital Inclusion criteria: 18 or older, smoked ≥1 cigarette/day during the month before admission, received smoking cessation counseling in the hospital, stated that they planned to try to quit smoking after discharge Exclusion criteria: Expected hospital stay of <24 hours, substance use in the	Purpose of IVR: Intervention Description of intervention: Participants give a 30-day supply of tobacco cessation medication, refillable for up to 90 days of treatment; 5 IVR calls provided advice and support messages that prompted smokers to stay quit, encouraged proper use and adherence to cessation medication, offered medication refills, and triaged smokers to a return telephone call from a live counselor	Population: Hospitalized patients Comparator: Usual Care N: 198 Control: 199 Age: 53.9 % female: 48.5%	Abstinence at follow-up: Biochemically confirmed abstinence for at 7 days = 25.8% of intervention, 11.1% of control, p=0.009 Self-reported abstinence in past 7 days: At 1 month = 52.0% of intervention, 39.2% of control, p=0.01; at 6 months = 40.9% of intervention, 28.1% of control, p=0.008 Abstinent since hospital discharge	Any smoking cessation use: at 1 month = 82.8% of intervention, 62.8% of control, p<0.001; at 6 months = 89.9% of intervention, 80.4% of control, p=0.01

	past 12 months other than tobacco, alcohol, or marijuana, admitted for an alcohol or drug overdose, could not consent or participate in counselling, admitted to obstetric or psychiatric units, life expectancy <12 months, medical instability	Standalone or adjunct: Adjunct IVR/Follow-up Schedule: 2, 14, 30, 60, and 90 days; follow-up at 6 months		at 1 month = 46.0% of intervention, 33.2% of control, p<0.01; at 6 months = 27.3% of intervention, 17.7% of control, p=0.03 Reducing costs: Hospital cost per quit: = $4,910 in year 1, $2,670 in subsequent years Incremental per-patient costs: $540 in year 1, $294 in subsequent years (year 1 costs were primarily for building the phone system and training staff)	
Rigotti et al. (2016) US Trial #: NCT0171432	Study design: Controlled Study setting: Hospitals	Purpose of IVR: Intervention Description of intervention: Intervention patients	Population: Adult smokers Comparator: Usual Care	Reach: Intervention participants answered (62%) of IVR calls; median = 3 of 5 planned calls per person	59% requested transfer to a Quit Coach Any use of smoking-cessation treatment

Funder: NIH/NHLBI Industry sponsored: No	Inclusion criteria: Adults 18 or older who smoke one or more cigarettes daily, had >5 minutes of smoking cessation counselling in the hospital, stated they planned to try to quit smoking post-discharge Exclusion criteria: Had no telephone, could not give informed consent or participate in counselling, were admitted to obstetric or psychiatric units, were admitted for IV drug overdose, had medical instability, had <1 year of estimated life expectancy.	receive a 30-day supply of free FDA-approved tobacco cessation medication, refillable for up to 90 days of treatment; IVR calls prompted smokers to quit or stay quit, offered support messages, encouraged adherence to cessation medication, and offered smokers the option of a direct two-step transfer to a telephone quitline Standalone or adjunct: Adjunct IVR/Follow-up Schedule: 2, 12-, 28-, 58-, and 88-days post-discharge; follow-up at 6 months	N: 680 Control: 677 Age: 49.6 % female: 48.8%	Abstinence at follow-up: Abstinent for past 7 days, at 1 month = 43.4% intervention, 3[illegible] control, p<0.00[illegible] at 6 months: 36.[illegible] intervention, 2[illegible] control, p<0.10 abstinent since a hospital discharge at 1 month: 31.0% intervention, 26.4% control, p<0.10; at 6 months: 17.8% intervention, 14.9% control, not significant Quit rate: Biochemically confirmed tobacco abstinence immediately post-discharge = 16.6% of intervention,	at 6 months: 85.3% of intervention, 66.2% of control, p<0.001

				15.5% of control, not significant	
Schneider et al. (1995) USA Funder: National Institute of Health Industry sponsored: No	Study design: Observational Study setting: Telephone Inclusion criteria: 18 or older, smoke daily	Purpose of IVR: Intervention Description of intervention: Early IVR system monitored participants progress, provided motivation, helpful techniques and coping mechanisms and interactive activities (smoking diary). Standalone or adjunct: Standalone IVR/Follow-up Schedule: Participants called as needed following the initiation call; follow-up at 1, 3 and 6 months after initiation call (letter and post-card for data collection)	Population: Adult Smokers Comparator: Self-Comparison N: 571 Age: Not reported % female: Not reported	Reach: 610 called program at least once, 571 were included in the final analysis. Of these 473 participants made 2 or more calls, 262 participant made 5 or more calls. Abstinence at follow-up: Of those that reported abstinence at 1 month follow-up, 47.1% were still abstinent at 3-month follow-up and 37.3% were abstinent at 3- and 6-month follow-ups.	Those who used IVR more often were more likely to remain abstinent at 6 month follow up (m = 17.67 calls vs. 7.65 calls; p < .001). Similar results found at 1- and 3-month follow-ups.

Velicer et al. (2006) USA Trial #: Not reported Funder: Not reported Industry sponsored: No	Study design: Controlled Study setting: Telephone Inclusion criteria: Regularly smoke 10+ cigs a day	Purpose of IVR: Intervention Description of intervention: IVR was used in conjunction with a manual, expert system feedback report and NRT. With the addition of IVR, calls were made on a schedule depending on NRT acceptance. IVR system asked questions and provided support according to participant responses. Standalone or adjunct: Adjunct IVR/Follow-up Schedule: 2 contact schedules depending on NRT acceptance: if not accepted, IVR calls made monthly for 6 months; if accepted, IVR calls made weekly	Population: Veteran Smokers Comparators: Cessation booklet, Cessation booklet + NRT, Cessation booklet + NRT + expert system feedback report N: 500 Control: 523 Age: 49.9 % female: 24.2%	Reach: 30% of participants used IVR multiple times, 30% used it once and 40% did not use it at all. Abstinence at follow-up: The 7-month prolonged abstinence rate at month 10 = 6.6% intervention group, at month 20 = 3% of intervention group and at month 30 = 15% of intervention group.	

		for 1st month, biweekly for second month and monthly for months 3-6. Follow-up at month 10, 20 and 30.			

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	Ln. 2
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	Pg. 2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Pg. 3 - 4
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Pg. 4
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Pg. 5
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Pg. 4
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Pg. 4
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	Pg. 4 - 5
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	Pg. 5
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Pg. 4 - 5
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	Table. A
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Pg. 5, 7
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	Pg. 6
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Pg. 6
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	Pg. 6
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Pg. 6
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	Pg. 6
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	N/A
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	N/A
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	Pg. 5
Certainty	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	Pg. 5

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
assessment			
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Fig. 1
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Fig. 1
Study characteristics	17	Cite each included study and present its characteristics.	Table. A
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Fig. 3
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Table. A
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	N/A
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	N/A
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	N/A
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	Pg. 7
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Pg. 7
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Pg. 13
	23b	Discuss any limitations of the evidence included in the review.	Pg. 14
	23c	Discuss any limitations of the review processes used.	Pg. 14
	23d	Discuss implications of the results for practice, policy, and future research.	Pg. 14
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	Pg. 4
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	N/A
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	N/A
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	Pg. 15
Competing interests	26	Declare any competing interests of review authors.	Pg. 15
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	Pg. 15

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

PRISMA 2020 Checklist

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Interactive Voice Response (IVR) for Tobacco Cessation: A Systematic Review

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Title: Interactive Voice Response (IVR) for Tobacco Cessation: A Systematic Review

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Key words: Nicotine, cessation, health services, smoking cessation, interactive voice response, behaviour intervention, priority/special populations, surveillance and monitoring, systematic review

Abstract

Objective: To summarize the uses, outcomes, and implementation of interactive voice response (IVR) as a tobacco cessation intervention.

Data sources: A systematic review was conducted. Searches were performed on May 3, 2023. The strategies used key words such as "tobacco cessation", "smoking reduction" and "interactive voice recording". Ovid MEDLINE®ALL, Embase, APA PsycInfo, CINAHL, Cochrane Library, and Web of Science were searched. Grey literature searches were also conducted.

Study selection: Titles and abstracts were assessed by two independent reviewers. Studies were included if: IVR was an intervention for tobacco cessation for adults; any outcomes were reported; and study design was comparative. Any abstract included by either reviewer proceeded to full text review. Full texts were reviewed by two independent reviewers.

Data extraction: Data was independently extracted by two reviewers using a standardized form. The ROB-2 and the ROBINS-I tools were used to assess study quality.

Data synthesis: Of 308 identified abstracts, 20 moderate- to low-quality studies were included. IVR was used standalone or adjunctly as a treatment, follow-up or risk-assessment tool across populations including general smokers, hospitalized patients, quitline users, perinatal women, cancer patients and veteran smokers. Effective studies found that IVR was delivered more frequently with shorter follow-up times. Significant gaps in the literature include a lack of population diversity, limited implementation settings and delivery schedules, and limited patient and provider perspectives.

Conclusions: While the evidence is weak, IVR appears to be a promising intervention for tobacco cessation. However, pilot programs and research addressing literature gaps are necessary.

Word Count: 248/250

Strengths and limitations of this study

- This was a thorough and comprehensive search of the literature created by an experienced medical information specialist and peer reviewed by another specialist. Six peer-reviewed databases were searched, along with grey literature searches and hand searches of the included studies.
- There was significant heterogeneity in the interventions utilized, reported methods, and outcome measures reported, meaning meta-analysis was not possible.
- Limited populations and settings were assessed by the included studies, meaning generalizability is limited and significant gaps still remain.

Introduction

As of 2020, 22.3% of the global population reported using tobacco products - around 1.3 billion individuals (1). The annual economic costs of tobacco use are significant, equaling an estimated US$ 1.4 trillion and 1.8% of the world's annual gross domestic product (1). Over eight million deaths per year are attributed to direct and indirect tobacco use (1). While current global tobacco control efforts contribute to decreasing the prevalence of tobacco use and associated morbidity and mortality rates, it is crucial to continue finding ways to support patients who want to make a quit attempt or change their smoking behaviour.

Interactive voice response (IVR) is a phone-based platform that can be used to deliver health behaviour interventions (2). IVR can be used to deliver educational messages, reinforce behaviours, motivate and guide patients, record patient symptoms or outcomes, encourage medication adherence, and connect patients with further resources or professionals (3). With IVR, a human speaker is replaced with a high-quality, pre-recorded interactive script and responds to patients based on answers provided (2). Patients can either call the IVR or receive calls. The possible advantages of IVR include its ability to make multiple calls during and outside regular business hours, it can connect with patients quickly, and it can identify those who are at higher risk and more likely to benefit from continued support (3, 4).

IVR has been used in interventions for alcohol consumption, asthma, heart failure, obesity, sleep apnea, hypertension, high cholesterol, dietary behaviour, to increase physical activity and to improve medication adherence (2). Effectiveness has been mixed, with IVR having small but significant effects on medication adherence and physical activity, but limited effectiveness for alcohol consumption or dietary behaviour (2). IVR has also been used as a tool to support tobacco cessation in patients, particularly post-hospital discharge (5). Post-discharge, patients receive tailored automated IVR calls at different time points (5). The calls typically assess patients' current smoking status, intention to quit or confidence in staying quit, current cessation medication use, and desire for additional support, and provides motivational messages, encourages patients to stay quit or continue attempting, promote the use of cessation medication, and offer to transfer patients to a counselor (5). IVR is also often used in conjunction with other

interventions, such as alongside nicotine replacement therapy (NRT), or after counselling with a physician in-hospital or in a primary care setting (5). However, the effectiveness of IVR as a tobacco cessation intervention for specific population groups, and the best uses and optimal delivery schedule of IVR interventions, are unknown.

This systematic review aims to synthesize and understand the current knowledge regarding IVR for tobacco cessation and to identify any gaps in the literature. Questions that guided this review included the ideal IVR delivery schedule, components of IVR, utilization of the intervention, outcomes reported in the literature, patient and provider perspectives, and costs of using IVR for tobacco cessation.

Methods

Search strategy

This systematic review followed a written, unregistered protocol and was conducted by following the Cochrane best practice guidelines and the PRISMA reporting standards (6, 7). An experienced medical information specialist developed and tested the search strategies through an iterative process in consultation with the review team. The MEDLINE strategy was peer reviewed by another senior information specialist using the PRESS Checklist (8). The strategies utilized a combination of controlled vocabulary (e.g., “Smoking Reduction”, “Tobacco Use Cessation”, “Reminder Systems”) and keywords (e.g., “quit smoking”, “curtail tobacco”, “interactive voice response”). Vocabulary and syntax were adjusted across the databases. Using the multifile option and deduplication tool available on the Ovid platform, we searched Ovid MEDLINE®ALL, Embase, APA PsycInfo, CINAHL (Ebsco), the Cochrane Library (Wiley), and Web of Science (Core Databases). No language restrictions were placed on the search. Records were downloaded and deduplicated using EndNote version 9.3.3 (Clarivate Analytics). All databases were searched from inception to May 3, 2023. The final search strategy is available in the supplementary material, Appendix A.

Grey literature searches were conducted through the Canadian Agency for Drug and Technologies in Health Grey Matters database, a database of government reports and non-

commercially published reports, and preprint databases including medRixV and Research Square. Targeted Google searches were also conducted to identify any relevant reports that may have been missed by these databases.

Study selection

A calibration exercise was conducted by four reviewers on a sample of the retrieved abstracts. After 100% agreement was reached among reviewers, the remaining abstracts were screened in duplicate by two independent reviewers. Abstracts selected for inclusion by either reviewer proceeded to full-text review. This initial screen was intentionally broad to ensure that all relevant literature was captured. Abstracts proceeded to full-text review if: IVR was used as an intervention tool for tobacco cessation; IVR targeted adults; any outcomes were reported, including treatment completion, quit rates, smoking abstinence, and patient perspectives; and was a comparative study, comparing IVR to any comparator. Any comparative study design was eligible for inclusion. Studies that reported other kinds of interventions but used IVR for data collection purposes were excluded.

Full texts were included if they met the above inclusion criteria and were in English. Conference abstracts, case series, reviews, letters, and editorials were excluded. Along with grey literature databases, the reference lists of relevant systematic reviews were also searched. Full-text review was conducted in duplicate by two independent reviewers. Any discrepancies between reviewers were resolved through discussion and consensus.

Data extraction

For all included studies, year of publication, country, study design, target population, participant characteristics, intervention setting, purpose or use of IVR, details about IVR schedule and follow-up, and outcomes were extracted by a single reviewer using standardized data extraction forms. A second reviewer verified the extracted data. Discrepancies between reviewers during data extraction were resolved through consensus.

Quality assessment

The quality of controlled trials was assessed using the revised Cochrane Risk-Of-Bias Tool for Randomized Trials (ROB-2) (9), while the observational studies were assessed with the Risk of Bias in Non-Randomized Studies of Interventions (ROBINS-I) tool (10). Each controlled trial was assessed using five criteria broadly covering the areas of randomization, deviation from intended intervention, missing outcome data, measurement of outcome, and selection of reported results (9). The observational studies were assessed based on the following parameters: bias due to confounding, selection bias, bias in classification, bias due to deviations from intended interventions, bias due to missing data, bias in measurement, and reporting bias (10).

Quality assessment was completed by one reviewer and verified by a second reviewer.

Data analysis and synthesis

Significant heterogeneity of studies was expected. Therefore, a narrative approach to synthesis was adopted a-priori. A stratified analytic approach by population was adopted. The types of interventions used, the outcomes reported, the effectiveness, overall trends, and any gaps in the literature were assessed by population.

Ethics approval

All data were from published studies so ethics approval was not required.

Patient and public involvement

There was no patient or public involvement in this review.

Results

Overall results

The search strategy yielded 308 unique citations, 271 of which were excluded after abstract review, Figure 1. Six studies were identified through hand and grey literature searches. Following abstract review, 43 studies proceeded to full-text review. At the full text-review phase, 23 studies were excluded for the following reasons: not IVR (n=4), IVR used as a data collection method (n=6), commentary or abstract (n=9), no outcomes (n=2), or duplicates (n=2), Figure 1.

The final dataset included 20 studies, including 13 controlled trials and seven observational studies, Figure 2, panel A. Sixteen of the included studies were conducted in the US (11-26), two were conducted in Canada (27, 28), and the remaining two were conducted in Norway (29, 30), Figure 2, panel B. The included studies were published between 1995 – 2022, Figure 2, panel C. In most of the studies (n=8), study sample sizes ranged between 100 to 500 participants while five studies each included between 500-1,000 participants, and >1,000 participants respectively. Only two studies included less than 100 participants, Figure 2, panel D. Appendix B includes additional details on the characteristics and outcomes of the 20 studies.

Quality of included studies

Full risk of bias assessments can be found in the supplementary material, Appendix C. The risk of bias assessment of the 13 controlled trials ranged from some concerns (n=7) to high risk of bias (n=6), Figure 3, panel A. The most common critical weakness across the controlled trials was the deviation from intended intervention and the selection of reported results. However, most studies were assessed at a low risk of bias in the measurement of outcomes and the randomization process.

Overall, one observational study was assessed at a moderate risk of bias, two studies were at a high risk of bias, and the remaining four studies were assessed at critical risk of bias. The most common critical weakness across studies were confounding, deviation from interventions, measurement of outcomes, and the selection of reported results. Most of the observational studies were assessed at a low risk of bias in the classification of interventions and selection of participants to the study, Figure 3, panel B.

How was IVR used as an intervention?

Two uses of IVR were identified. Across the 20 studies, IVR was used as either a standalone (n=6) or an adjunct intervention (n=13) for tobacco cessation. The use of IVR was unclear in one study (17). When used as a standalone intervention, IVR was the primary intervention reported in the study (13, 14, 18, 20, 25, 31). When used as an adjunct intervention, IVR was used in combination with other interventions including counselling, referrals, quitlines, and web- or

SMS-based cessation activities (11, 12, 15, 16, 19, 21-24, 26, 27, 29, 30). In one study, participants were able to contact the IVR services (18); in all other interventions, the IVR system contacted participants.

When in the care trajectory was IVR used?

Studies examined IVR use along different points in the care treatment trajectory. Included studies used IVR as a treatment tool, a follow-up tool and a risk-assessment tool, Figure 4.

As a treatment tool, IVR asked questions regarding smoking habits, overall goals, and fears surrounding tobacco cessation. IVR provided tailored behaviour change therapeutic responses based on answers given by the patients, through personalized motivational messages and advice, coping mechanisms, and interactive activities. When IVR was used as a treatment tool, IVR delivery schedule varied widely for interventions with call schedules ranging from calls every day (20) to every 2-, 12-, 28-, 68-, and 88-days post-discharge (24) to every two weeks for 39 weeks (27). In two studies, IVR was available on an as-needed basis where patients were called regularly in response to their unique requirements (29, 30) and in two studies IVR was available 24/7 for participants to utilize when they wanted (18, 25).

As a follow-up tool, IVR was used post-discharge to monitor patients' progress and track tobacco behaviour, as well as provide personalized motivational messages and give patients direct access to resources such as requesting additional NRTs/pharmacotherapy and directing calls to a quitline or counsellor. Five studies delivered IVR at 3-,14-, and 30-days post-discharge (12, 15, 16, 22, 28) and one delivered IVR at eight predetermined, yet unspecified, time periods over the course of 12 weeks post-discharge (11). In all the studies that used IVR as a follow-up tool, IVR was also used as a risk-assessment tool (11, 28).

As a risk assessment tool, IVR assessed the risk of relapse based on responses to curated questions, flagging at-risk patients and connecting them to a counsellor, quitlines or nurse specialists to mitigate relapse and provide immediate support. Risk assessment was conducted differently across the different studies. As an example, one study specifically asked questions as part of a risk assessment for relapse and flagged "at risk" patients and directly transferred the call

to a quit coach for brief intervention (21). Frequency of IVR calls and follow-up times ranged widely.

For whom was IVR more likely to be effective?

IVR was used as a tobacco cessation intervention across multiple specific populations. Six studies targeted general adult smokers (20, 24, 25, 27, 29, 30), seven studies targeted hospitalized patients (11, 15, 16, 19, 22, 23, 28), three studies targeted quitline users (13, 14, 21), two studies targeted adult perinatal or pregnant women (12, 18), one study targeted cancer patients (17), and one study targeted veteran smokers (26), Figure 5.

General adult smokers

In the six studies that looked at general adult smokers, four were controlled trials and two were observational studies (20, 24, 25, 27, 29, 30). Four controlled trials used IVR as an adjunct treatment tool. One reported biochemically confirmed abstinence rates and three reported self-reported point abstinence rates (24, 27, 29, 30). No statistically significant difference in past-7-days biochemically confirmed abstinence was found at the 6-month follow-up (24). However, three controlled trials reported significantly higher self-reported point abstinence rates at 1-, 3-, 6, and 12-month follow-ups (24, 29, 30).

One observational study used IVR as a standalone treatment tool and reported abstinence rates. Of participants that reported abstinence at the 1-month follow-up, 47.1% were still abstinent at the 3-month follow-up and 37.3% were still abstinent at the 6-month follow-up (25). One observational study examined IVR as a treatment and risk assessment tool and focused on quit rates (20). Overall, 30% of individuals that opted into the IVR program were smoke-free at the last contact.

Hospitalized patients

Of the seven studies that included patients admitted to hospital, four were controlled trials and three were observational studies (11, 15, 16, 19, 22, 23, 28). In the two controlled trials that used IVR as an adjunct treatment tool, one study found that 25.8% of intervention patients were biochemically confirmed abstinent in the past 7 days (p=0.009) and self-reported abstinence rates

in the past-7-days at the 1-month and 6-month follow-ups were significantly higher in intervention patients (23). However, the other study found no statistically significant difference in self-reported abstinence rates between intervention and usual care participants (19). One controlled trial found that intervention patients were significantly more likely to be abstinent at 6-month follow-up (8.9%) compared to usual care control patients (3.5%, p=0.01) (11). Finally, one controlled trial that examined IVR as a standalone follow-up and risk assessment tool reported abstinence rates and found no difference in abstinence rates between intervention and control groups (28).

Two observational studies examined different outcomes of the same IVR follow-up program. One study reported that IVR was associated with significantly lower total healthcare costs at one-year post-discharge, with mean charges for the IVR group being over $8,000 less than the usual care control group (15). The other study found no statistically significant reduction in odds of readmission between the IVR group and the usual care control group and no significant difference in readmission rates at 30-, 90-, or 180-days post-discharge (16). IVR reach was also reported to be low as IVR only reached about 43% of eligible participants, and 36.4% of those reached reported abstinence since their last IVR call. The remaining observational study examined the reach of a hospital-based counselling and IVR tobacco cessation program (22). IVR reach was low as only 43% of eligible participants were reached. While no difference was found between IVR alone and bedside counselling with IVR, counselling with IVR was associated with an increase in response to IVR utilization (22).

Quitline users

Three controlled trials targeted tobacco cessation Quitline users (13, 14, 21). Two controlled trials used IVR as a standalone treatment tool. IVR intervention participants were significantly more likely to re-enroll into the quitline (28.2% intervention vs. 3.3% usual care; p<0.001), though the proportion of those that re-enrolled was small (14). Of those followed-up with, 79.9% of those followed-up reported making a quit attempt lasting 24 hours or more in the last 90 days, with 24.0% reporting abstaining from tobacco in the last 7 days (13). One controlled trial used IVR as an adjunct risk assessment tool reported quit rates in quitline users at two different IVR delivery schedules: twice weekly for 2 weeks then weekly for 6 weeks (10 calls total) or daily for

2 weeks and weekly for 6 weeks (20 calls total) (21). The intervention found no difference in abstinence rates between the two IVR delivery schedules and the frequency of IVR calls did not impact tobacco cessation. Those that did not screen as at-risk for relapse during the scheduled IVR relapse risk assessments were 77% more likely to be abstinent at the 6-month follow-up (21).

Adult perinatal women

Two studies targeted adult perinatal women (12, 18). In the controlled trial, IVR was used as a standalone treatment tool and while 16.7% of IVR intervention participants were biochemically confirmed end-of-pregnancy quitters, there was no significant difference compared to usual care patients (18). The observational study used IVR as an adjunct follow-up and risk-assessment tool. There was no difference in reported abstinence between participants that only received IVR and those that received bedside counselling with IVR (12).

Cancer patients

One observational study examined IVR as a treatment tool at cancer centers (17). This study compared the effectiveness of multiple different tobacco cessation interventions, including IVR, implemented across 38 participating cancer centers. IVR was implemented at 4 out of the 38 cancer centers. Of all the cessation interventions, IVR had the greatest mean, median, minimum, and maximum ranges for reach, with responses from an average of 56% of those reached by IVR. No IVR-specific or patient-specific abstinence rates were reported; however, 22% of patients reported not smoking in the past 7 days and 19% not smoking in the past 30 days across all cancer centers and implemented interventions (17).

Veteran smokers

One controlled trial examined IVR as an adjunct treatment tool targeting veteran smokers (26). IVR was implemented in conjunction with a tobacco cessation manual, an expert system feedback report, and NRT use. At follow-up, 6-month prolonged abstinence rates at month 10 (6.6%), month 20 (9.3%) and month 30 (15%) showed a steady increase in abstinence, however, this increase was not statistically significant (26).

What were the patient-reported experiences with IVR?

Only three studies, all controlled trials, included elements of patient-reported experience with IVR for tobacco cessation (21, 29, 30). Most participants (96%) reported satisfaction with the overall quitline program and almost all participants (98%) stated that they would likely recommend the program to others (21). Furthermore, most participants reported that it was easy to answer questions using the IVR system (95%) regardless of IVR delivery schedule (21). Satisfaction with the IVR intervention was also highly positive, regardless of whether participants were given the option to utilize NRTs (29, 30).

What was the reach of IVR?

Eight studies reported reach of the IVR intervention (12, 14, 17, 18, 20, 22, 25, 26). The rate of participants interacting with IVR ranged from 20.8% to 42.8% (12, 14, 17, 18, 20, 22, 25, 26). In one study, IVR did have the highest average reach, compared to other smoking cessation interventions, with responses from 55.8% of those called by IVR; however, these results were at the institution-level, not the individual-level (17).

Sex and gender in this literature

Only one study stratified outcomes by sex or gender; it is unclear which (20). This observational study, of low quality, assessed IVR used as a standalone treatment and risk assessment tool for general adult smokers. It was found that females were significantly more likely to opt-in to the IVR intervention compared to males (OR = 0.78; 95% CI = 0.65-0.95). Of those that opted-in and received IVR calls, females were more likely to report being smoke free at last contact compared to males (OR = 0.87; 95% CI = 0.66-1.15), though this difference was not significant (20).

Discussion

Overall, 20 studies were included. There was a heterogenous body of literature identified in the present review. IVR was implemented as either a standalone or adjunct technology. When implemented as an adjunct technology, IVR was often paired with in- and out-patient counselling, nicotine replacement therapy, or self-help materials, though the type of adjunct

intervention did not impact effectiveness of IVR. IVR was also implemented at several points along the patient trajectory and was effective at increasing self-reported abstinence and increasing the use of other tobacco cessation interventions across multiple different populations, including general smokers, hospitalized patients, quitline users, adult perinatal or pregnant women, cancer patients, and veteran smokers. While the frequency of IVR calls and follow-up times varied widely in the literature and studies specifically comparing different IVR delivery schedules reported no differences between brief/short-term and sustained IVR delivery, increased IVR frequency and shorter time between follow-ups were generally associated with increased effectiveness of IVR. The studies that reported on costs reported that IVR reduced healthcare costs. However, IVR did not significantly affect other outcomes, including hospitalization and biochemically confirmed abstinence. Additionally, the reach of IVR was consistently low. Despite variability of findings, no application or use of IVR was shown to be harmful to participants and studies that reported patient perspectives were highly positive.

The results of our search are mixed on the effectiveness of IVR, and the use of IVR in other contexts is similarly mixed. Some studies report significantly improved patient outcomes with the use of IVR, particularly those for disease management and medication adherence (32-34); others, however, report minimal effectiveness of IVR, particularly for alcohol dependence (35-37). The studies on alcohol dependence found that while clinical outcomes were not different, IVR was useful for self-monitoring and provided regular feedback on alcohol use to patients (36, 37). Additionally, most studies noted that IVR is relatively inexpensive and can have a high reach, particularly for otherwise hard-to-reach patients, meaning it may be useful in keeping patients engaged in treatment even if clinical effectiveness is low (34-37). These findings, along with the results of our search, may suggest that IVR for tobacco cessation may be most effective when used as a way of engaging patients in treatment rather than as a treatment itself.

Our review, along with the wider literature on IVR, suggests that while IVR may have limited clinical effectiveness, there are other factors that should be considered for IVR use in tobacco cessation. For patients, IVR can be an accessible tobacco cessation tool. Barriers to entry are relatively low, it can provide a private, judgement-free environment for patients to speak freely about their smoking habits, tobacco use, goals, fears, and motivations, and it can offer an

opportunity for patients to engage in self-monitoring of their own care and progress. However, due to the automated nature of IVR, there may be a loss of the emotional support patients can receive with in-person counselling (38). For providers, IVR can immensely reduce their workload and optimize their time and scalability, while still allowing them to thoroughly care for many patients simultaneously. IVR can help providers gain regular insight on the progress of their patients and can help guide or revise treatment plans and provide additional support when needed most. However, there is required technical training, privacy concerns, and implementation costs that providers should consider when thinking about using IVR for tobacco cessation. Implications on the healthcare system include important public health and population health considerations. IVR directly addresses smoking and tobacco use which continues to highly burden the healthcare system through smoking-related diseases. IVR can also assist with appropriate resource allocation and may serve as a cost-saving healthcare tool. Ultimately, though the clinical effectiveness of IVR may be low for some patients, it may still be a useful tool for patients, providers, and the healthcare system for increasing smoking cessation and reducing healthcare use and costs.

While this study provides a broad overview of the current literature surrounding IVR for tobacco cessation, several limitations exist. First, the majority of included studies were of low to moderate quality. Though most studies were controlled trials, variability in interventions, methods and outcome measures prevented the possibility for a metanalysis. This limited the extent to which the comparative effectiveness of IVR applications and uses across the different populations could be inferred. Further, due to the low number and quality of studies available for multiple populations, generalizations cannot be made, and results should be interpreted with caution.

There are also significant gaps present in the literature that should be noted. Though the literature review identified several unique populations, there were several populations that were not identified that may uniquely benefit from IVR, such as racialized groups and Indigenous Peoples, and only one study stratified by sex or gender. Therefore, little is known about how the effectiveness of IVR is affected by race, marginalization, or sex or gender. Similarly, there were no studies that compared IVR initiated in different contexts or settings, such as inpatient versus

outpatient, and very few compared rural and urban settings. The effectiveness of IVR could be impacted by the context or setting in which it is initiated as this may affect how open patients are to quitting, and different considerations or barriers associated with different settings may be required. Further, only two studies compared different IVR delivery schedules and found no difference (21, 27). Different schedules and times to follow-ups may have different effectiveness, and effectiveness may be dependent on patient needs. Finally, the literature search did not identify any qualitative studies examining patient perspectives on IVR, the usefulness of IVR, and patient's responsiveness to IVR for tobacco cessation and no studies examined providers' opinions on IVR.

Conclusion

It is imperative that tobacco cessation interventions be approached with effective mitigating and preventative strategies. While the evidence base is weak, results of this review indicate that IVR appears to be a promising intervention that can be implemented in multiple healthcare settings, across multiple distinct populations. Overall, IVR was effective at increasing abstinence rates and encouraging positive health outcomes for tobacco cessation. However, several significant gaps in the literature still exist. Organizations can pilot tobacco cessation intervention programs using IVR and contribute, using real-life contexts, to the growing knowledge base of this technology.

Contributors: MK: Analysis and interpretation of data, data quality assessment, draft and editing of manuscript. AM: Analysis and interpretation of data, data quality assessment, draft and editing of manuscript. NE: Conceptualization and design of work, analysis and interpretation of data, draft and editing of manuscript. BA: Analysis and interpretation of data, data quality assessment. RD and KA: Conceptualization and design of work. FC: Conceptualization and design of work, study registration, critical review and editing of manuscript. All authors critically assessed, edited, and approved the final manuscript. The corresponding author attests that all listed authors meet the authorship criteria and no others meeting the criteria have been omitted. FC is the guarantor.

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Supplemental material Appendix A. Final Search Strategies; Appendix B. Table of Study Characteristics; Appendix C. Full Risk of Bias Assessment

Data sharing: Not applicable.

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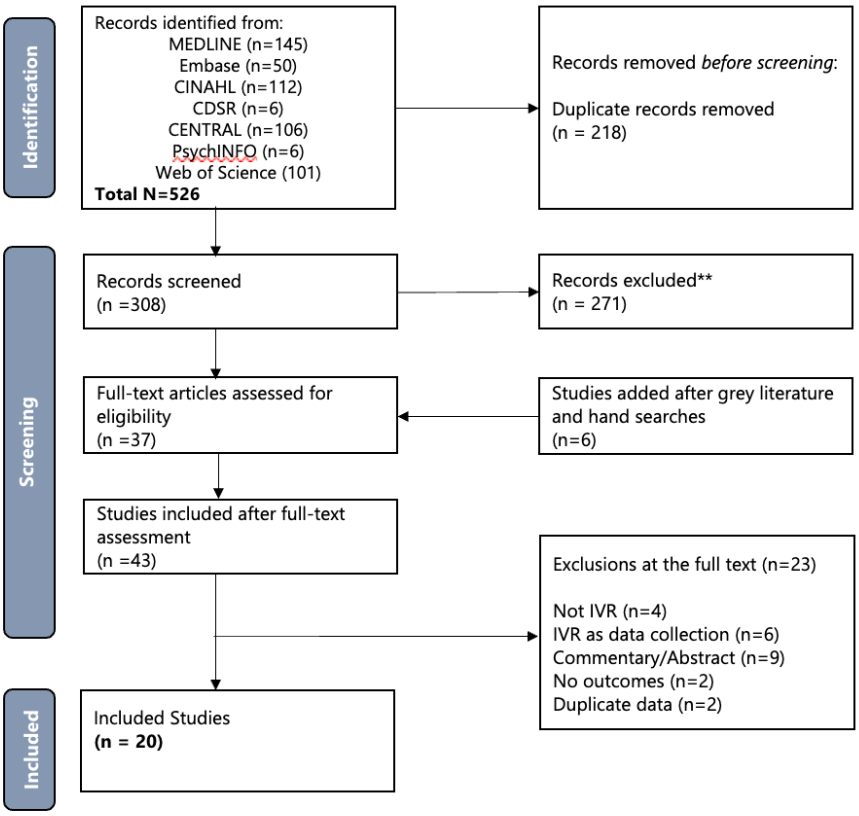
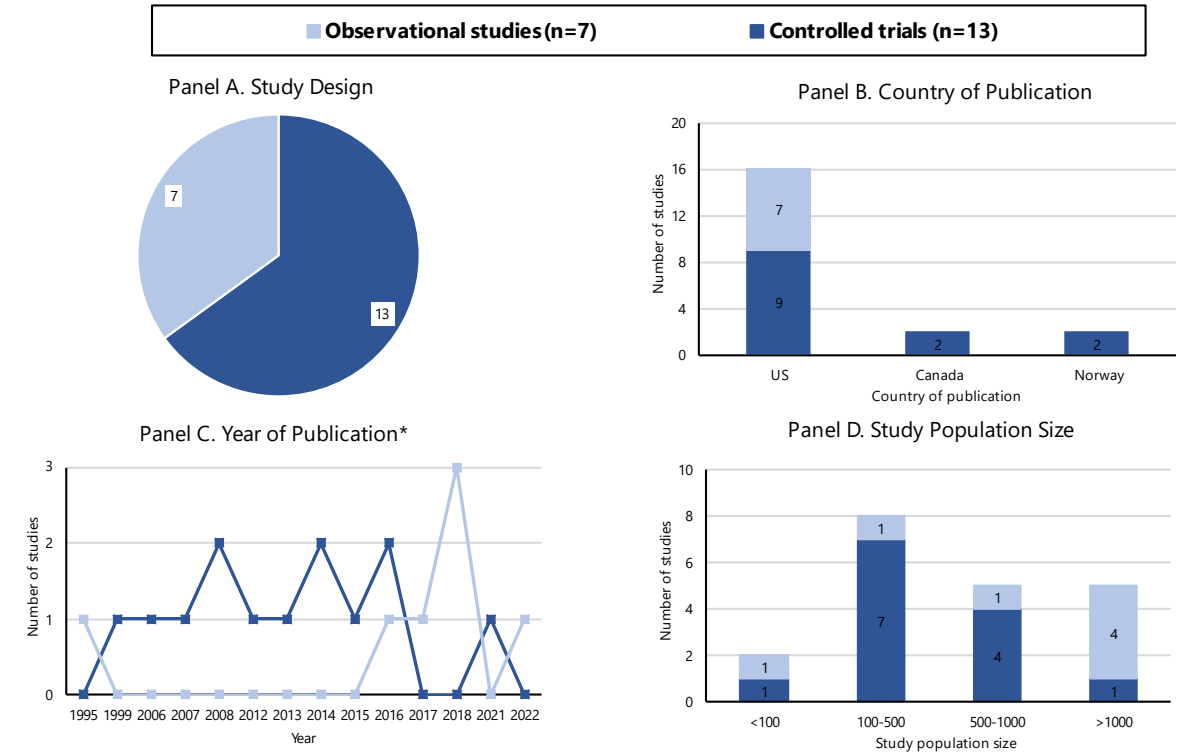


Figure 1. PRISMA for systematic review



*Only the 14 years with at least one publication are shown

Figure 2. Summary characteristics of included studies

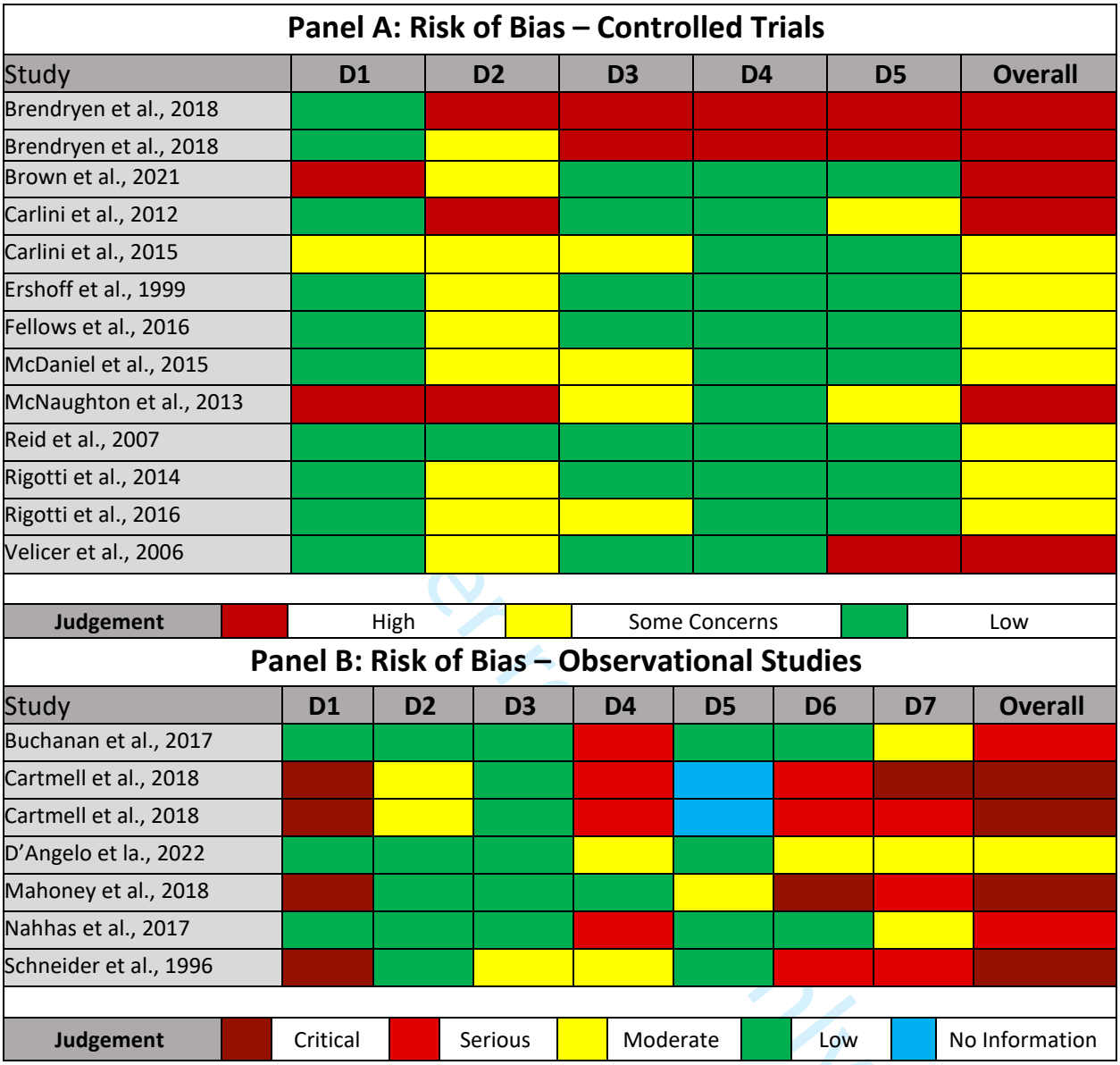


Figure 3. Quality assessment for included studies

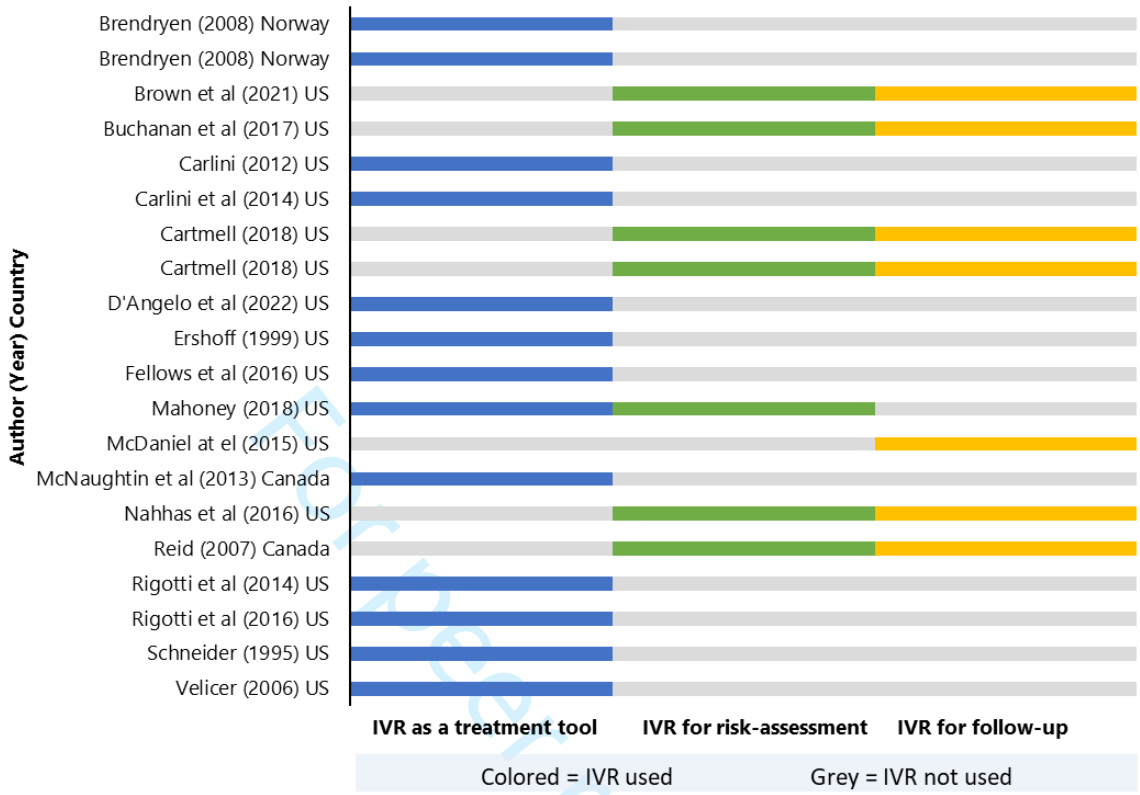


Figure 4. Timing of IVR use in the care trajectory

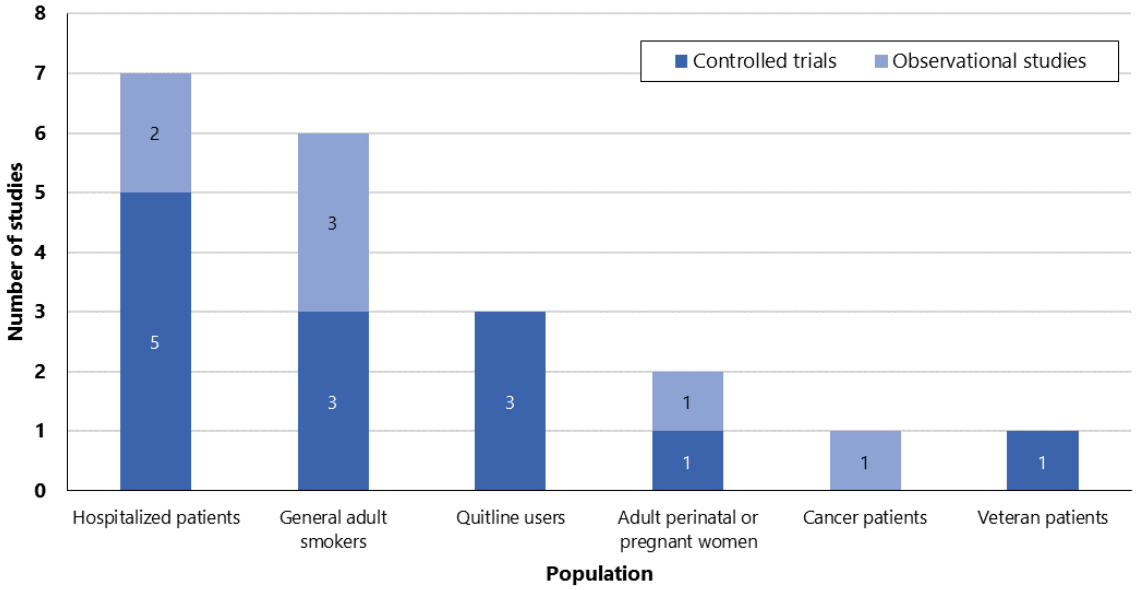


Figure 5. Populations assessed in systematic review

Appendix A. Final search strategies

2023 May 3

Ovid Multifile

Database: Embase <1974 to 2023 May 02>, APA PsycInfo <1806 to April Week 4 2023>, Ovid MEDLINE(R) ALL <1946 to May 02, 2023>
Search Strategy:
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1 Smoking Cessation/ (115928)
2 Smoking Reduction/ (519)
3 "Tobacco Use Cessation"/ (70076)
4 Smoking Cessation Agents/ (314)
5 "Tobacco Use Cessation Devices"/ (5573)
6 Smoking/th [therapy] (2353)
7 exp Tobacco Smoking/th [therapy] (561)
8 "Tobacco Use Disorder"/th [therapy] (3548)
9 Vaping/th [therapy] (17)
10 ((smoking or smoker* or tobacco* or nicotine or cigar? or cigarette* or cigarillo? or vape$1 or vaping or ecig* or e-cig* or e-vape$1 or e-vaping or evape$1 or evaping or snuff or snus or gutka or gutkas or naswar) adj5 (abstain* or abstinen* or cease or ceased or ceases or cessation* or dehabituat* or desist* or discontinu* or end or ended or ending or ends or "give up" or "giving up" or "gives up" or "gave up" or halt* or quit* or stop*)).tw,kw,kf. (135877)
11 ((smoking or smoker* or tobacco* or nicotine or cigar? or cigarette* or cigarillo? or vape$1 or vaping or ecig* or e-cig* or e-vape$1 or e-vaping or evape$1 or evaping or snuff or snus or gutka or gutkas or naswar) adj5 (curb* or curtail* or decreas* or diminish* or lessen* or limit* or lower* or reduc* or taper* or cut back or cuts back or cutting back)).tw,kw,kf. (111997)
12 or/1-11 [TOBACCO CESSATION] (243977)
13 ((interactive or inter-active) adj voice record*).tw,kw,kf. (60)
14 ((interactive or inter-active) adj voice respon*).tw,kw,kf. (2573)
15 voice response unit?.tw,kw,kf. (5)
16 (IVR adj5 (call* or cellphon* or cell-phon* or dialogue* or mobile? or phon* or record* or smartphon* or smart-phon* or system? or technolog* or telephon*)).tw,kw,kf. (1220)
17 ((IVR or IVRS) and (interactive or inter-active or voice or record* or respons*)).tw,kw,kf. (2376)
18 AI-IVR.tw,kw,kf. (2)
19 ((automated or digital* or intelligent or interactive or inter-active or smart or virtual) adj3 (assistant? or PDA or PDAs)).tw,kw,kf. (4153)
20 (Alexa or Bixby or Cortana or Siri or Google Assistant).tw,kw,kf. (8019)
21 Reminder Systems/ (6619)
22 Speech Recognition Software/ (2074)
23 or/13-22 [IVR] (24377)
24 12 and 23 [TOBACCO CESSATION - IVR] (334)
25 24 use medall [MEDLINE RECORDS] (146)
26 smoking cessation/ (115928)
27 smoking cessation program/ (3867)
28 smoking reduction/ (519)
29 smoking cessation agent/ (314)

30 nicotine gum/ (3087)
31 smoking/th [therapy] (2353)
32 tobacco dependence/th [therapy] (4751)
33 ((smoking or smoker* or tobacco* or nicotine or cigar? or cigarette* or cigarillo? or vape$1 or vaping or ecig* or e-cig* or e-vape$1 or e-vaping or evape$1 or evaping or snuff or snus or gutka or gutkas or naswar) adj5 (abstain* or abstinen* or cease or ceased or ceases or cessation* or dehabituat* or desist* or discontinu* or end or ended or ending or ends or "give up" or "giving up" or "gives up" or "gave up" or halt* or quit* or stop*)).tw,kw,kf. (135877)
34 ((smoking or smoker* or tobacco* or nicotine or cigar? or cigarette* or cigarillo? or vape$1 or vaping or ecig* or e-cig* or e-vape$1 or e-vaping or evape$1 or evaping or snuff or snus or gutka or gutkas or naswar) adj5 (curb* or curtail* or decreas* or diminish* or lessen* or limit* or lower* or reduc* or taper* or cut back or cuts back or cutting back)).tw,kw,kf. (111997)
35 or/26-34 [TOBACCO CESSATION] (244250)
36 ((interactive or inter-active) adj voice record*).tw,kw,kf. (60)
37 ((interactive or inter-active) adj voice respon*).tw,kw,kf. (2573)
38 voice response unit?.tw,kw,kf. (5)
39 (IVR adj5 (call* or cellphon* or cell-phon* or dialogue* or mobile? or phon* or record* or smartphon* or smart-phon* or system? or technolog* or telephon*)).tw,kw,kf. (1220)
40 ((IVR or IVRS) and (interactive or inter-active or voice or record* or respons*)).tw,kw,kf. (2376)
41 AI-IVR.tw,kw,kf. (2)
42 ((automated or digital* or intelligent or interactive or inter-active or smart or virtual) adj3 (assistant? or PDA or PDAs)).tw,kw,kf. (4153)
43 (Alexa or Bixby or Cortana or Siri or Google Assistant).tw,kw,kf. (8019)
44 reminder system/ (6830)
45 automatic speech recognition/ (1338)
46 or/36-45 [IVR] (23924)
47 35 and 46 [TOBACCO CESSATION - IVR] (340)
48 47 use oemezd [EMBASE RECORDS] (156)
49 Smoking Cessation/ (115928)
50 "Tobacco Use Disorder"/ (26295)
51 ((smoking or smoker* or tobacco* or nicotine or cigar? or cigarette* or cigarillo? or vape$1 or vaping or ecig* or e-cig* or e-vape$1 or e-vaping or evape$1 or evaping or snuff or snus or gutka or gutkas or naswar) adj5 (abstain* or abstinen* or cease or ceased or ceases or cessation* or dehabituat* or desist* or discontinu* or end or ended or ending or ends or "give up" or "giving up" or "gives up" or "gave up" or halt* or quit* or stop*)).tw,id. (134325)
52 ((smoking or smoker* or tobacco* or nicotine or cigar? or cigarette* or cigarillo? or vape$1 or vaping or ecig* or e-cig* or e-vape$1 or e-vaping or evape$1 or evaping or snuff or snus or gutka or gutkas or naswar) adj5 (curb* or curtail* or decreas* or diminish* or lessen* or limit* or lower* or reduc* or taper* or cut back or cuts back or cutting back)).tw,id. (111682)
53 or/49-52 [TOBACCO CESSATION] (252880)
54 ((interactive or inter-active) adj voice record*).tw,id. (58)
55 ((interactive or inter-active) adj voice respon*).tw,id. (2522)
56 voice response unit?.tw,id. (5)
57 (IVR adj5 (call* or cellphon* or cell-phon* or dialogue* or mobile? or phon* or record* or smartphon* or smart-phon* or system? or technolog* or telephon*)).tw,id. (1210)
58 ((IVR or IVRS) and (interactive or inter-active or voice or record* or respons*)).tw,id. (2327)
59 AI-IVR.tw,id. (2)

60 ((automated or digital* or intelligent or interactive or inter-active or smart or virtual) adj3 (assistant? or PDA or PDAs)).tw,id. (4035)
61 (Alexa or Bixby or Cortana or Siri or Google Assistant).tw,id. (7941)
62 Automated Speech Recognition/ (2494)
63 or/54-62 [IVR] (18078)
64 53 and 63 [TOBACCO CESSATION - IVR] (228)
65 64 use psyh [PSYCINFO RECORDS] (38)
66 25 or 48 or 65 [ALL DATABASES] (340)
67 remove duplicates from 66 (201) [TOTAL UNIQUE RECORDS]
68 67 use medall [MEDLINE UNIQUE RECORDS] (145)
69 67 use oemezd [EMBASE UNIQUE RECORDS] (50)
70 67 use psyh [PSYCINFO UNIQUE RECORDS] (6)

****
CINAHL

#	Query	Limiters/Expanders	Last Run Via	Results
S24	S19 OR S23	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	112
S23	S7 AND S22	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	66
S22	S20 OR S21	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search	1,199

			Database - CINAHL Plus with Full Text	
S21	TX "interactive voice" W0 record*	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	23
S20	TX "interactive voice response"	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	1,181
S19	S7 AND S18	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	82
S18	S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	6,342

S17	(MH "Voice Recognition Systems")	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	1,311
S16	(MH "Reminder Systems")	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	3,117
S15	TI (Alexa or Bixby or Cortana or Siri or "Google Assistant") OR AB (Alexa or Bixby or Cortana or Siri or "Google Assistant")	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	426
S14	TI ((automated or digital* or intelligent or interactive or inter-active or smart or virtual) N3 (assistant# or PDA or PDAs)) OR AB ((automated or digital* or intelligent or interactive or inter-active or smart or virtual) N3 (assistant# or PDA or PDAs))	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	950
S13	TI "AI-IVR" OR AB "AI-IVR"	Search modes - Find all my search terms	Interface - EBSCOhost Research	0

			Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	
S12	TI ((IVR or IVRS) and (interactive or inter-active or voice or record* or respons*)) OR AB ((IVR or IVRS) and (interactive or inter-active or voice or record* or respons*))	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	290
S11	TI (IVR N5 (call* or cellphon* or cell-phon* or dialogue* or mobile# or phon* or record* or smartphon* or smart-phon* or system# or technolog* or telephon*)) OR AB (IVR N5 (call* or cellphon* or cell-phon* or dialogue* or mobile# or phon* or record* or smartphon* or smart-phon* or system# or technolog* or telephon*))	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	217
S10	TI "voice response" W0 unit# OR AB "voice response" W0 unit#	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	1
S9	TI (((interactive or inter-active) W0 voice respon*)) OR AB (((interactive or inter-active) W0 voice respon*))	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced	629

			Search Database - CINAHL Plus with Full Text	
S8	TI (((interactive or inter-active) W0 voice record*)) OR AB (((interactive or inter-active) W0 voice record*))	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	91
S7	S1 OR S2 OR S3 OR S4 OR S5 OR S6	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	45,557
S6	TI ((smoking or smoker* or tobacco* or nicotine or cigar# or cigarette* or cigarillo# or vape or vaped or vapes or vaping or ecig* or e-cig* or e-vape* or e-vaping or evape* or evaping or snuff or snus or gutka or gutkas or naswar) N5 (curb* or curtail* or decreas* or diminish* or lessen* or limit* or lower* or reduc* or taper* or "cut back" or "cuts back" or "cutting back")) OR AB ((smoking or smoker* or tobacco* or nicotine or cigar# or cigarette* or cigarillo# or vape or vaped or vapes or vaping or ecig* or e-cig* or e-vape* or e-vaping or evape* or evaping or snuff or snus or gutka or gutkas or naswar) N5 (curb* or curtail* or decreas* or diminish* or lessen* or limit* or lower* or reduc* or taper* or "cut back" or "cuts back" or "cutting back"))	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	16,852
S5	TI ((smoking or smoker* or tobacco* or nicotine or cigar# or cigarette* or cigarillo# or vape or vaped or vapes or vaping or ecig* or e-cig* or e-vape* or	Search modes - Find all my search terms	Interface - EBSCOhost Research	25,644

	e-vaping or evape* or evaping or snuff or snus or gutka or gutkas or naswar) N5 (abstain* or abstinen* or cease or ceased or ceases or cessation* or dehabituat* or desist* or discontinu* or end or ended or ending or ends or "give up" or "giving up" or "gives up" or "gave up" or halt* or quit* or stop*)) OR AB ((smoking or smoker* or tobacco* or nicotine or cigar# or cigarette* or cigarillo# or vape or vaped or vapes or vaping or ecig* or e-cig* or e-vape* or e-vaping or evape* or evaping or snuff or snus or gutka or gutkas or naswar) N5 (abstain* or abstinen* or cease or ceased or ceases or cessation* or dehabituat* or desist* or discontinu* or end or ended or ending or ends or "give up" or "giving up" or "gives up" or "gave up" or halt* or quit* or stop*))		Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	
S4	(MH "Smoking/TH") OR (MH "Vaping/TH")	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	981
S3	(MH "Tobacco Use Cessation Products+")	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	3,979
S2	(MH "Smoking Cessation Programs")	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search	2,617

			Database - CINAHL Plus with Full Text	
S1	(MH "Smoking Cessation")	Search modes - Find all my search terms	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	22,734

Web of Science

Set #	Search Query	Results
1	(smoking or smoker* or tobacco* or nicotine or cigar or cigars or cigarette* or cigarillo* or vape or vaped or vapes or vaping or ecig* or e-cig* or e-vape* or e-vaping or evape* or evaping or snuff or snus or gutka or gutkas or naswar) NEAR/5 (abstain* or abstinen* or cease or ceased or ceases or cessation* or dehabituat* or desist* or discontinu* or end or ended or ending or ends or "give up" or "giving up" or "gives up" or "gave up" or halt* or quit* or stop*) (Topic)	53731
2	(smoking or smoker* or tobacco* or nicotine or cigar or cigars or cigarette* or cigarillo* or vape or vaped or vapes or vaping or ecig* or e-cig* or e-vape* or e-vaping or evape* or evaping or snuff or snus or gutka or gutkas or naswar) NEAR/5 (curb* or curtail* or decreas* or diminish* or lessen* or limit* or lower* or reduc* or taper* or "cut back" or "cuts back" or "cutting back") (Topic)	49489
3	#2 OR #1	89674
4	(interactive or inter-active) NEAR/0 ("voice record" or "voice recorded" or "voice recording" OR "voice recordings" or "voice records") (Topic)	20
5	(interactive or inter-active) NEAR/0 ("voice response" or "voice responses" or "voice respond" or "voice responded" OR "voice responding" or "voice responds") (Topic)	1288
6	"voice response unit" or "voice response units" (Topic)	8
7	IVR NEAR/5 (call* or cellphon* or cell-phon* or dialogue* or mobile or mobiles or phon* or record* or smartphon* or smart-	716

	phon* or system or systems or technolog* or telephon*) (Topic)	
	(IVR or IVRS) and (interactive or inter-active or voice or record*	
8	or respons*) (Topic)	1165
9	"AI-IVR" (Topic)	1
	(automated or digital* or intelligent or interactive or inter-active or smart or virtual) NEAR/3 (assistant or assistants or PDA	
10	or PDAs) (Topic)	6484
11	Alexa or Bixby or Cortana or Siri or "Google Assistant" (Topic)	4778
12	#11 OR #10 OR #9 OR #8 OR #7 OR #6 OR #5 OR #4	12886
13	#12 AND #3	101

Web of Science

Set #	Search Query	Results
	(smoking or smoker* or tobacco* or nicotine or cigar or cigars or cigarette* or cigarillo* or vape or vaped or vapes or vaping or ecig* or e-cig* or e-vape* or e-vaping or evape* or evaping or snuff or snus or gutka or gutkas or naswar) NEAR/5 (abstain* or abstinen* or cease or ceased or ceases or cessation* or dehabituat* or desist* or discontinu* or end or ended or ending or ends or "give up" or "giving up" or "gives up" or "gave up" or	
1	halt* or quit* or stop*) (Topic)	53731
	(smoking or smoker* or tobacco* or nicotine or cigar or cigars or cigarette* or cigarillo* or vape or vaped or vapes or vaping or ecig* or e-cig* or e-vape* or e-vaping or evape* or evaping or snuff or snus or gutka or gutkas or naswar) NEAR/5 (curb* or curtail* or decreas* or diminish* or lessen* or limit* or lower* or reduc* or taper* or "cut back" or "cuts back" or "cutting	
2	back") (Topic)	49489
3	#2 OR #1	89674
	(interactive or inter-active) NEAR/0 ("voice record" or "voice recorded" or "voice recording" OR "voice recordings" or "voice	
4	records") (Topic)	20
	(interactive or inter-active) NEAR/0 ("voice response" or "voice responses" or "voice respond" or "voice responded" OR "voice	
5	responding" or "voice responds") (Topic)	1288
6	"voice response unit" or "voice response units" (Topic)	8
	IVR NEAR/5 (call* or cellphon* or cell-phon* or dialogue* or mobile or mobiles or phon* or record* or smartphon* or smart-phon* or system or systems or technolog* or telephon*)	
7	(Topic)	716

8	(IVR or IVRS) and (interactive or inter-active or voice or record* or respons*) (Topic)	1165
9	"AI-IVR" (Topic)	1
10	(automated or digital* or intelligent or interactive or inter-active or smart or virtual) NEAR/3 (assistant or assistants or PDA or PDAs) (Topic)	6484
11	Alexa or Bixby or Cortana or Siri or "Google Assistant" (Topic)	4778
12	#11 OR #10 OR #9 OR #8 OR #7 OR #6 OR #5 OR #4	12886
13	#12 AND #3	101

Cochrane Library

Search Name:
Date Run: 04/05/2023 05:20:45
Comment:

ID	Search	Hits
#1	[mh "Smoking Cessation"]	5599
#2	[mh "Smoking Reduction"]	42
#3	[mh "Tobacco Use Cessation"]	156
#4	[mh "Smoking Cessation Agents"]	66
#5	[mh "Tobacco Use Cessation Devices"]	764
#6	[mh ^Smoking/TH]	598
#7	[mh "Tobacco Smoking"/TH]	89
#8	[mh "Tobacco Use Disorder"/TH]	472
#9	[mh Vaping/TH]	3
#10	((smoking or smoker* or tobacco* or nicotine or cigar or cigars or cigarette* or cigarillo* or vape or vaped or vapes or vaping or ecig* or e-cig* or e-vape* or e-vaping or evape* or evaping or snuff or snus or gutka or gutkas or naswar) NEAR/5 (abstain* or abstinen* or cease or ceased or ceases or cessation* or dehabituat* or desist* or discontinu* or end or ended or ending or ends or "give up" or "giving up" or "gives up" or "gave up" or halt* or quit* or stop*)):ti,ab,kw	14748
#11	((smoking or smoker* or tobacco* or nicotine or cigar or cigars or cigarette* or cigarillo* or vape or vaped or vapes or vaping or ecig* or e-cig* or e-vape* or e-vaping or evape* or evaping or snuff or snus or gutka or gutkas or naswar) NEAR/5 (curb* or curtail* or decreas* or diminish* or lessen* or limit* or lower* or reduc* or taper* or "cut back" or "cuts back" or "cutting back")):ti,ab,kw	6686
#12	{or #1-#11}	17438
#13	((interactive or inter-active) NEXT voice record*):ti,ab,kw	210
#14	((interactive or inter-active) NEXT voice respon*):ti,ab,kw	1052
#15	("voice response" NEXT (unit# or units)):ti,ab,kw	0
#16	(IVR NEAR/5 (call* or cellphon* or cell-phon* or dialogue* or mobile* or phon* or record* or smartphon* or smart-phon* or system or systems or technolog* or telephon*)):ti,ab,kw	276
#17	((IVR or IVRS) and (interactive or inter-active or voice or record* or respons*)):ti,ab,kw	554
#18	"AI-IVR":ti,ab,kw	3
#19	((automated or digital* or intelligent or interactive or inter-active or smart or virtual) NEAR/3 (assistant# or PDA or PDAs)):ti,ab,kw	231
#20	(Alexa or Bixby or Cortana or Siri or "Google Assistant"):ti,ab,kw	166
#21	[mh "Reminder Systems"]	1108

#22	[mh "Speech Recognition Software"]	30
#23	{or #13-#22}	2734
#24	#12 AND #23	112

CDSR – 6 reviews
CENTRAL – 106 trials

Appendix B: Table of Study Characteristics

	Study information	Intervention	Patient characteristics	Primary Outcomes	Other outcomes
Brendryen et al. (2008) Norway Trial #: Not reported Funder: Norwegian Research Council Industry sponsored: No	Study design: Controlled Study setting: Digital/Quitline Inclusion criteria: Wanting to attempt quitting, 18 or older, smoking 5+ cigarettes a day, attempt quit without nicotine replacement therapy	Purpose of IVR: Intervention Description of intervention: Happy Ending program is an internet-based multimedia intervention that used CBT techniques to help people quit smoking without the use of nicotine replacement therapies. IVR is an aspect of the intervention, along with website-based activities and SMS messages. Standalone or adjunct: Adjunct IVR/Follow-up Schedule: Regular IVR	Population: Adult Smokers Comparator: Usual care N: 144 Control: 146 Age: 39.5 % female: 50%	Reach: 62% of participants answered log-in calls. 87 intervention participants completed treatment. Abstinence at follow-up: Repeated point abstinence was 20% for intervention group and 7% for control group (p=0.002)	At 1 month, 51% of participants found HE to be “helpful,” and 32% reported HE to be “very helpful”.

		calls depending on participants' needs; follow up at 1, 3, 6 and 12 months			
Brendryen et al. (2008) Norway Trial #: Not reported Funder: Norwegian Research Council, Pfizer Industry sponsored: Yes	Study design: Controlled Study setting: Digital/Quitline Inclusion criteria: Wanting to attempt to quit smoking, aged 18+, smoking 10+ cigarettes a day and have access to the internet, email and cellphone	Purpose of IVR: Intervention Description of intervention: Happy Ending program is an internet-based multimedia intervention that used CBT techniques to help people quit smoking. IVR is an aspect of the intervention, along with website-based activities and SMS messages. Participants were given and allowed to use NRT products if they wanted. Standalone or adjunct: Adjunct IVR/Follow-up Schedule: Regular IVR	Population: Adult Smokers Comparator: Usual Care N: 197 Control: 199 Age: 35.9 % female: 50.8%	Reach: 71% of participants answered log-in calls. 152 participants completed treatment. Abstinence at follow-up: Repeated point abstinence was significantly higher in treatment group (22.3%) vs. control (13.1%) (p = 0.02. At the 12 month follow up, 74 treatment participants reported abstinence vs. 48 control participants (p = 0.005)	At 1 month, 48.2% found HE to be 'helpful' and 44.7% reported HE to be 'very helpful'. Most participants in both groups opted for NRT therapy (93% intervention vs. 87% control - p = 0.07). At 1 month, the mean number of days of NRT use was significantly higher in treatment group (M = 5.1 vs. 3.9; p = 0.02).

		calls depending on participants' needs; follow up at 1, 3, 6 and 12 months			
Brown et al. (2021) US Trial #: NCT02204956 Funder: National Institute of Mental Health Industry sponsored: No	Study design: Controlled Study setting: Acute care private Psychiatric hospital Inclusion criteria: Inpatient psychiatric patients aged 18 or older who smoked at least 5 cigarettes per day Exclusion: a current diagnosis of non-nicotine substance use disorder, dementia, intellectual disability, autistic spectrum or other cognitive impairment, an inability to provide consent, medical	Purpose of IVR: Follow-up monitoring Description of intervention: Patients received in-patient tobacco cessation counselling. Following discharge, IVR asked about participants' smoking, intentions to quit, desire for an additional 4 weeks of transdermal nicotine patches (ie, 8weeks total), and interest in connecting with free telephone quitline counseling. Standalone or adjunct: Adjunct IVR/Follow-up Schedule: 8 times over	Population: Hospitalized Patients Comparator: Usual Care N: 174 Control: 179 Age: 36.1 % female: 46.7%	Abstinence at follow-up: 8.9% intervention reported abstinence vs. 4.5% of control, p=0.07, verified at 6 months by saliva cotinine analysis	Use of any smoking cessation treatment: 74.6% of intervention vs. 40.5% of control at 6 months, p<0.001 Use of counselling: 37.3% of intervention vs. 11.0% of control at 6 months, p<0.001 Use of pharmacotherapy: 71.0% vs. 37.0% at 6 months, p<0.001

	contraindication to the use of NRT or a current pregnancy.	12 weeks post-discharge			
Buchanan et al. (2017) US Funder: MUSC, NIDA Industry sponsored: No	Study design: Observational Study setting: Academic medical center Inclusion criteria: Adult women admitted to the peripartum, delivery, and postpartum units Exclusion criteria: Women over 41 and admitted for something non-pregnancy-related	Purpose of IVR: Follow-up monitoring and transfer Description of intervention: Patients counselled in-hospital by a tobacco treatment specialist; Post-discharge, IVR collected info on smoking status, frequency, quit attempts, motivation to quit, use of nicotine replacement therapy (NRT) and whether the patient wanted to be transferred to the quitline Standalone or adjunct: Adjunct IVR/Follow-up Schedule: 3-, 14-, and 30-days post-discharge	Population: Adult perinatal women Comparator: Bedside Cessation Counselling + IVR N: 421 Age: 29 % female: 100%	Reach: 35.5% of patients reached by IVR Abstinence at follow-up: 12.8% of those who received both counselling and IVR reported abstinence vs. 4.1% of those who received IVR only	15.4% of IVR + counselling participants used NRT vs. 4% of IVR only 10.8% of IVR + counselling participants were transferred to the quitline vs. 14.0% of IVR only

Carlini et al. (2012) USA Trial #: NCT0126059 Funder: National Cancer Institute Industry sponsored: No	Study design: Controlled Study setting: Quitline Inclusion criteria: Previously enrolled in quitline, Medicaid or uninsured, 18 or older, sought help for cigarette/tobacco use	Purpose of IVR: Intervention Description of intervention: Recruited participants who were previously enrolled in a quitline intervention; IVR call assessed smoking behaviours, current smoking status; if participants were interested in reattempting quit, they were enrolled into connected with quitline specialist and reenrolled into IVR intervention. Standalone or adjunct: Standalone IVR/Follow-up Schedule: One IVR call to assess and/or recruit into intervention. Up to 20 call attempts made.	Population: Quitline users Comparator: Usual Care N: 245 Control: 276 Age: 42.2 % female: 66.5%	Reach: 23.6% of previous quitline users reached Re-enrollment rate was 28.2% for intervention vs. 3.3% for control (< 0.001) IVR participants were 11.2 times more likely to re-enroll than comp. (OR - $p < 0.001$)	

Carlini et al. (2014) US Trial #: Funder: Quitline Registries for Continuously Engaging Participants in Cessation from the Centers for Disease Control and Prevention Industry sponsored: No	Study design: Controlled Study setting: Quitline Inclusion criteria: 18 or older, having received services in English, providing verbal consent, being a cigarette smoker, not being incarcerated, and not having received quitline services for at least 5 months before the study launch	Purpose of IVR: Intervention Description of intervention: IVR system delivered a set of questions to identify motivational and informational barriers to recycling into a new quit attempt and provided tailored messages to specifically address these barriers Standalone or adjunct: Standalone IVR/Follow-up Schedule: Two cycles of 6 IVR attempts each; follow-up at 90 days	Population: Quitline Users Comparator: Usual Care N: 3,510 Control: 22,824 Age: 65.2% over 40 % female: 53.8%	Abstinence at follow-up: 24.0% reported abstaining from tobacco in the last 7 days Quit rate: 79.9% those followed with reported making a quit attempted lasted 24 hours or more in the last 90 days	
Cartmell et al. (2018) USA Funder: Agency of Healthcare Research and Quality, Pfizer	Study design: Observational Study setting: Hospital Inclusion criteria: 18+ smokers	Purpose of IVR: Follow-up monitoring and transfer Description of intervention: IVR call at discharge determined	Population: Hospitalized patients Comparator: Usual Care N: 764	Cost/Cost-effectiveness: Total mean healthcare cost post-discharge: $51,937 IVR vs. $59,132 control, p=0.03.	

Industry sponsored: Yes	admitted to the hospital Exclusion criteria: Those admitted for psychiatric care, same day surgery, <24-hour observation or not discharged	smoking status and referred to the tobacco treatment specialist that assessed patients' behaviour and developed a treatment plan with the patient. IVR also conducts follow-up calls to evaluate smoking status and transfer to counsellor if needed. Standalone or adjunct: Adjunct IVR/Follow-up Schedule: At discharge, 3, 14, 30 days post-discharge	Control: 1439 Age: 49.4 % female: 47.5%	Comparing overall health care charges for the TDTS low exposed (IVR) versus unexposed patient groups, the mean charges in the IVR group were $8006 lower than for the control group (P=0.08). Intervention implementation costs were $34.21 per participant in 12-month period (incl. start-up cost) with total intervention cost being $158,140.	
Cartmell et al. (2018) USA Funder: Agency of Healthcare Research and Quality, Pfizer	Study design: Observational Study setting: Hospital	Purpose of IVR: Follow-up monitoring and transfer Description of intervention: IVR call at discharge determined	Population: Hospitalized patients Comparator: Usual Care	Readmission rates 30-day - 9.8% IVR vs. 11.9% control (p=0.05), 90 day - 17.3% IVR vs. 18.6% control (p = 0.258), 180 day -	

Industry sponsored: Yes	Inclusion criteria: 18+ smokers admitted to the hospital Exclusion criteria: Those admitted for psychiatric care, same day surgery, <24-hour observation or not discharged	smoking status and referred to the tobacco treatment specialist that assessed patients' behaviour and developed a treatment plan with the patient. IVR also conducts follow-up calls to evaluate smoking status and transfer to counsellor if needed. Standalone or adjunct: Adjunct IVR/Follow-up Schedule: At discharge, 3, 14, 30 days post-discharge; Follow-up at 30-, 90- and 180-day post-discharge.	N: 764 Control: 1439 Age: 49.4 % female: 47.5%	22.4% IVR vs. 24.3% control (p=0.239).	
D'Angelo et al. (2022) US Funder: National Cancer Institute	Study design: Observational Study setting: Cancer Centers	Purpose of IVR: Intervention Description of intervention: IVR used to automatically identify and contact	Population: Cancer Patients Comparators: Other smoking cessation intervention	Reach: IVR had the highest average reach with an average of 55.8% of patients reached.	21.7% of patients had not smoked in the past 7 days and 18.6% had not smoked in the past 30 days, however, this result applies to

Industry sponsored: No	Inclusion criteria: Adults 18 years and older	patients who smoked to provide treatment. Implemented in 4/38 cancer centers. Standalone or adjunct: Unclear IVR/Follow-up Schedule: Not reported	including telephone counselling, in-person counselling, cessation medication and access to a quitline. N: 38 Cancer centers Age: N/A % female: N/A		all cancer centers, across all implemented interventions and is not specific to IVR.
Ershoff et al. (1999) USA Trial #: Not reported Funder: Not reported Industry sponsored: No	Study design: Controlled Study setting: Hospital Exclusion criteria: Women under the age of 18, and those who began prenatal care past the 26th week of pregnancy, smoked less than 7 cigarettes week pre-	Purpose of IVR: Intervention Description of intervention: For the IVR subgroup, participants were given informational booklet along with access to computerized IVR support system that they had access to 24/7 toll-free. IVR would ask	Population: Adults Perinatal women Comparators: Cessation booklet, Motivational Interviewing N: 120 Control: 111 Age: 29.6	Reach: 285 participants successfully reached for follow up at the 34th week of pregnancy (IVR only group not specified) Quit rate: 16.7% of IVR intervention group were biochemically	Only 20.8% of IVR patients placed one or more calls to the system and it had no impact on their quit status

	pregnancy, had experienced a miscarriage/ abortion, and had not smoked prior to the baseline interview	about smoking behaviour and readiness to change as well as stage-appropriate, customized motivational messages, interactive activities and reinforcement. Standalone or adjunct: Adjunct IVR/Follow-up Schedule: Available 24/7 for participants to utilize as needed; Follow-up at 32 weeks pregnancy	% female: 100%	confirmed end-of-pregnancy quitters, - not statistically significant	
Fellows et al. (2016) US Trial #: NCT01236079 Funder: National Heart, Lung, and Blood Institute Industry sponsored: No	Study design: Controlled Study setting: Hospitals Inclusion criteria: Adult patients admitted to one of the hospitals who reported having	Purpose of IVR: Intervention Description of intervention: Patients were counselled in-hospital and created a tailored discharge treatment recommendation; medications; IVR	Population: Hospitalized patients Comparator: Usual Care N: 597 Control: 301 Age: 53	Reach: 50.6% of patients completed call 1, 31.3% completed call 4; mean total calls completed = 2 (SD 1.7) Abstinence at follow-up: 30-day abstinence = 18%	Use of any quit program: 8.4% in intervention, 5.0% in control, p=0.096 Use of telephone quitline: 6.9% intervention vs. 2.5% control, p=0.014

	smoked a cigarette in the previous 30 days, spoke English, had a working phone, and were interested in remaining abstinent post-discharge Exclusion criteria: Patients living more than 50 miles away, admitted to a critical care, labor/delivery, or psychiatric unit, were pregnant or breastfeeding, were physically too ill or cognitively unable to provide informed consent	contacted patients for smoking status, cessation program enrollment status, and cessation medication use, and received tips for quitting Standalone or adjunct: Adjunct IVR/Follow-up Schedule: 4, 14, 28, and 49 days; Follow-up at 6 months	% female: 56.6%	for intervention, 17% for control, p=0.569	Use of any medication: 47.9% intervention vs. 38.0% control, p=0.013
Mahoney et al. (2018) USA Funder: Western New York Cancer Coalition Center, Roswell Park	Study design: Observational Study setting: Telephone Inclusion criteria: 18 years or older,	Purpose of IVR: Intervention, transfer Description of intervention: Looks at AVR system (same as IVR). Following chart review of smokers in	Population: Adult Smokers Comparator: Usual Care N: 1049 (opt-in)	Reach: 32% of patients reached following chart review, 55% of these opted in to AVR program.	Females (OR = 0.78, CI 0.65-0.95) and those over 40 were less likely to opt out, while rural smokers (OR = 3.84, CI 3.01-3.90) were more likely to opt out.

Comprehensive Cancer Center, National Cancer Institute Industry sponsored: No	visited an urban/rural primary care office community health center, academic site or private practice in a medically underserved communities of interest	area, baseline AVR call was made to all eligible patients. Opt-in participants received AVR calls every day. AVR customized motivational messages, activities and questions during call to specific stage of change. If participant relapsed, they were transferred to primary care office or state quitline for counselling. Standalone or adjunct: Standalone IVR/Follow-up Schedule: IVR calls every day for study period (undefined)	Control: 850 (opt-out) Age: 59.1% over 50 % female: 51.9%	Abstinence at follow-up: 30% of intervention group that completed the AVR program reported abstinence	Smokers from rural medical offices were more likely to report being smoke free (OR, 1.41, CI 1.01-1.97) - smoke free status did not differ by sex, racial group or age.
McDaniel et al. (2015) US Trial #: NCT0088899	Study design: Controlled Study setting: QFL program	Purpose of IVR: Risk Assessment Description of intervention: All participants received	Population: Quitline users Comparators: Standard	Abstinence at follow-up: At 6 months: No smoking in last 7 days = 66.0% of control, 69.6% of	98% were satisfied, 98% would recommend the programme to others; overall, 87% said IVR was helpful

Funder: National Institutes for Health Industry sponsored: No	Inclusion criteria: Tobacco users enrolled in the Quit For Life (QFL) programme who were quit for 24 hours or more, English-speaking, 18 or older, having access to a touch-tone phone Exclusion criteria: Smokeless tobacco users, actively participating in another tobacco cessation programme, had previously enrolled in QFL during the past 6 months, had limited phone access	five counselling calls from a Quit Coach; IVR calls delivered risk assessments, and high-risk participants were transferred to a Quit Coach Standalone or adjunct: Adjunct IVR/Follow-up Schedule: TEQ-10 = twice weekly for 2 weeks, then weekly for 6 weeks; TEQ-20 = daily for 2 weeks, then weekly for 6 weeks; follow-up at 6 and 12 months	quitline uses, TEQ-10, TEQ-20 N: 602 in TEQ-10, 591 in TEQ-20 Control: 592 Age: 43.4 % female: 54.2%	TEQ-10 (p=0.3051 vs. control), 67.3% of TEQ-20 (p=0.7121 vs. control); Did not smoke in the last 30 days: 60.6% of control, 65.2% of TEQ-10 (p=0.1946), 61.7% of TEQ-20 (p=0.8947); At 12 months: 7-D smoking in last 7 days = 65.3% of control, 67.0% of TEQ-10 (p=1691), 62.2% of TEQ-20 (p=0.4655); in last 30 days: 61.6% of control, 63.1% of TEQ-10 (p=0.6821), 56.6% of TEQ-20 (p=0.1871)	
McNaughton et al. (2013) Canada	Study design: Controlled	Purpose of IVR: Intervention	Population: Adult Smokers	Abstinence at follow-up: Of patients who had quit smoking at 12	

Trial #: NCT00832806 Funder: Pfizer Canada Industry sponsored: Yes	Study setting: Outpatient Clinic Inclusion criteria: Smoking ≥35 cigarettes per week or ≥5 cigarettes per day for at least 2 years with no period of abstinence longer than 3 months Exclusion criteria: Use of any smoking cessation drugs or nicotine replacement in the last 3 months, use of medications to treat depression or any psychiatric illness, history of depression or an unstable medical condition	Description of intervention: All participants received a 12-week supply of varenicline; IVR asked about cigarette use, side effects, confidence in maintaining abstinence, and motivational messages; at 12 weeks, all participants who were still abstinent were randomized to receive either further IVR or no IVR Standalone or adjunct: Adjunct IVR/Follow-up Schedule: Days 1, 3, 8 and 11 post-quit then every 2 weeks for following 39 weeks; follow-up at 52 weeks and 2 years	Comparator: Participants who only received IVR for 12 weeks. N: 101 initially and then 44 IVR only Control: 41 Age: 52.6 overall % female: 33%	weeks, 59% were smoke-free at 52 weeks, 52% of intervention and 66.7% of control (p=0.33) At two years, 1[illegible] of overall population, 30% those abstinent 12 weeks, and [illegible] of those abstinent at 52 weeks (n=40) were confirmed to be non-smokers; of these, 21% had received extended IVR (so 21.7% of intervention vs 42.9% of control, p=0.13, were smoke-free at two years)	

Nahhas et al. (2016) US Funder: Medical University of South Carolina Health Industry sponsored: No	Study design: Observational Study setting: Medical University Inclusion criteria: Adult cigarette smokers Exclusion criteria: Patients who died during hospitalization, receiving hospice care, not discharged back home, and psychiatric inpatients	Purpose of IVR: Follow-up monitoring and transfer Description of intervention: Patients counselled in-hospital by tobacco treatment specialist and developed an individualized tobacco-treatment plan; IVR collected info on smoking status and provide additional support through the offer of a direct immediate referral "warm transfer" to a quitline Standalone or adjunct: Adjunct IVR/Follow-up Schedule: 3-, 14-, and 30-days post-discharge	Population: Hospitalized Patients Comparator: Bedside Counselling + IVR N: Not reported Age: Not reported % female: Not reported	Reach: 42.8% were reached at least once within 30 days Abstinence at follow-up: 36.4% those who were reached reported not smoking at time of their last phone contact; based on intention to treat, 13.5% of patients were classified as not smoking based on their most recent follow-up call	19.6% who were reached asked to be transferred to the quitline Bedside counselling was associated with a 13% increase in response to IVR (55% vs. 49%), a 90% increase in reported abstinence (51% vs. 27%), and double the rate of those using medications (21% vs. 8%)

Reid et al. (2007) Canada Trial #: Not reported Funder: Canadian Tobacco Control Research Initiative Industry sponsored: No	Study design: Controlled Study setting: Hospital Inclusion criteria: Current smokers (5 or more cigarettes per day), 18+, hospitalized for acute coronary syndrome	Purpose of IVR: Follow-up monitoring and risk assessment Description of intervention: IVR system called participants post-discharge and asked about smoking status, confidence in staying smoke free until next call, and use of self-help materials and pharmacotherapies. Patients were flagged and connected with nurse specialists if they reported relapse but interest in quit reattempt or if they were not confident in their ability to stay smoke free. Further telephone counselling was given. Standalone or adjunct: Standalone	Population: Hospitalized patients Comparator: Usual Care N: 50 Control: 50 Age: 54 % female: 39%	Reach: At 3-day follow-up, 70 participants answered IVR calls. Abstinence at follow-up: At the 52-week follow-up, 46% of the IVR group and 34.7% of the control group were abstinent (p = 0.07).	

		IVR/Follow-up Schedule: 3-, 14- and 30-days post-discharge; 12- and 52-weeks post-discharge (by telephone, not IVR)			
Rigotti et al. (2014) US Trial #: NCT01177176 Funder: National Institutes of Health/National Heart, Lung, and Blood Institute Industry sponsored: No	Study design: Controlled Study setting: Hospital Inclusion criteria: 18 or older, smoked ≥1 cigarette/day during the month before admission, received smoking cessation counseling in the hospital, stated that they planned to try to quit smoking after discharge Exclusion criteria: Expected hospital stay of <24 hours, substance use in the	Purpose of IVR: Intervention Description of intervention: Participants give a 30-day supply of tobacco cessation medication, refillable for up to 90 days of treatment; 5 IVR calls provided advice and support messages that prompted smokers to stay quit, encouraged proper use and adherence to cessation medication, offered medication refills, and triaged smokers to a return telephone call from a live counselor	Population: Hospitalized patients Comparator: Usual Care N: 198 Control: 199 Age: 53.9 % female: 48.5%	Abstinence at follow-up: Biochemically confirmed abstinence for 7 days = 25.8% of intervention, 11.1% of control, p=0.009 Self-reported abstinence in past 7 days: At 1 month = 52.0% of intervention, 39.2% of control, p=0.01; at 6 months = 40.9% of intervention, 28.1% of control, p=0.008 Abstinent since hospital discharge	Any smoking cessation use: at 1 month = 82.8% of intervention, 62.8% of control, p<0.001; at 6 months = 89.9% of intervention, 80.4% of control, p=0.01

	past 12 months other than tobacco, alcohol, or marijuana, admitted for an alcohol or drug overdose, could not consent or participate in counselling, admitted to obstetric or psychiatric units, life expectancy <12 months, medical instability	Standalone or adjunct: Adjunct IVR/Follow-up Schedule: 2, 14, 30, 60, and 90 days; follow-up at 6 months		at 1 month = 46.0% of intervention, 33.2% of control, p<0.01; at 6 months = 27.3% of intervention, 19.1% of control, p=0.03 Reducing costs: Hospital cost per quit: = $4,910 in year 1, $2,670 in subsequent years Incremental per-patient costs: $540 in year 1, $294 in subsequent years (year 1 costs were primarily for building the phone system and training staff)	
Rigotti et al. (2016) US Trial #: NCT0171432	Study design: Controlled Study setting: Hospitals	Purpose of IVR: Intervention Description of intervention: Intervention patients	Population: Adult smokers Comparator: Usual Care	Reach: Intervention participants answered (62%) of IVR calls; median = 3 of 5 planned calls per person	59% requested transfer to a Quit Coach Any use of smoking-cessation treatment

Funder: NIH/NHLBI Industry sponsored: No	Inclusion criteria: Adults 18 or older who smoke one or more cigarettes daily, had >5 minutes of smoking cessation counselling in the hospital, stated they planned to try to quit smoking post-discharge Exclusion criteria: Had no telephone, could not give informed consent or participate in counselling, were admitted to obstetric or psychiatric units, were admitted for IV drug overdose, had medical instability, had <1 year of estimated life expectancy.	receive a 30-day supply of free FDA-approved tobacco cessation medication, refillable for up to 90 days of treatment; IVR calls prompted smokers to quit or stay quit, offered support messages, encouraged adherence to cessation medication, and offered smokers the option of a direct two-step transfer to a telephone quitline Standalone or adjunct: Adjunct IVR/Follow-up Schedule: 2, 12-, 28-, 58-, and 88-days post-discharge; follow-up at 6 months	N: 680 Control: 677 Age: 49.6 % female: 48.8%	Abstinence at follow-up: Abstinent for past 7 days, at 1 month = 43.4% intervention, 3[illegible] control, p<0.00[illegible] at 6 months: 3[illegible] intervention, 2[illegible] control, p<0.10 abstinent since hospital discharge, at 1 month: 31.0% intervention, 26.4% control, p<0.10; at 6 months: 17.8% intervention, 14.9% control, not significant Quit rate: Biochemically confirmed tobacco abstinence immediately post-discharge = 16.6% of intervention,	at 6 months: 85.3% of intervention, 66.2% of control, p<0.001

				15.5% of control, not significant	
Schneider et al. (1995) USA Funder: National Institute of Health Industry sponsored: No	Study design: Observational Study setting: Telephone Inclusion criteria: 18 or older, smoke daily	Purpose of IVR: Intervention Description of intervention: Early IVR system monitored participants progress, provided motivation, helpful techniques and coping mechanisms and interactive activities (smoking diary). Standalone or adjunct: Standalone IVR/Follow-up Schedule: Participants called as needed following the initiation call; follow-up at 1, 3 and 6 months after initiation call (letter and post-card for data collection)	Population: Adult Smokers Comparator: Self-Comparison N: 571 Age: Not reported % female: Not reported	Reach: 610 called program at least once, 571 were included in the final analysis. Of these 473 participants made 2 or more calls, 262 participant made 5 or more calls. Abstinence at follow-up: Of those that reported abstinence at 1-month follow-up, 47.1% were still abstinent at 3-month follow-up and 37.3% were abstinent at 3- and 6-month follow-ups.	Those who used IVR more often were more likely to remain abstinent at 6 month follow up (m = 17.67 calls vs. 7.65 calls; p < .001). Similar results found at 1- and 3-month follow-ups.

Velicer et al. (2006) USA Trial #: Not reported Funder: Not reported Industry sponsored: No	Study design: Controlled Study setting: Telephone Inclusion criteria: Regularly smoke 10+ cigs a day	Purpose of IVR: Intervention Description of intervention: IVR was used in conjunction with a manual, expert system feedback report and NRT. With the addition of IVR, calls were made on a schedule depending on NRT acceptance. IVR system asked questions and provided support according to participant responses. Standalone or adjunct: Adjunct IVR/Follow-up Schedule: 2 contact schedules depending on NRT acceptance: if not accepted, IVR calls made monthly for 6 months; if accepted, IVR calls made weekly	Population: Veteran Smokers Comparators: Cessation booklet, Cessation booklet + NRT, Cessation booklet + NRT + expert system feedback report N: 500 Control: 523 Age: 49.9 % female: 24.2%	Reach: 30% of participants used IVR multiple times, 30% used it once and 40% did not use it at all. Abstinence at follow-up: The 6-month prolonged abstinence rate at month 10 = 6.6% intervention group, at month 20 = 3% of intervention group and at month 30 = 15% of intervention group.	

		for 1st month, biweekly for second month and monthly for months 3-6. Follow-up at month 10, 20 and 30.			

	Bias from randomization				Bias from deviation (effect of assignment					
Author	1.1	1.2	1.3	RoB	2.1	2.2	2.3	2.4	2.5	2.6
Brendryen (2008) Norway	Y	PY	PN	Low	NI	PN	PN			PN
Brendryen (2008) Norway	Y	Y	PN	Low	PN	PN				PN
Brown et al (2021), US	N	PN	N	High	Y	PY	PN			Y
Carlini (2012) USA	Y	Y	PN	Low	PN	PY	PN			PN
Carlini (2014) USA	Y	PY	PY	Some Con	PY	PY	PN			PY
Ershoff (1999) USA	Y	Y	N	Low	PN	PY	N			PN
Fellows et al (2016) US	Y	Y	N	Low	Y	N	PN			Y
McDaniel at el (2015) US	Y	Y	N	Low	PY	PY	PN			Y
McNaughtin et al (2013) Canada	NI	NI	PY	High	PY	PY	PN			PN
Reid (2007) Canada	Y	Y	PN	Low	PY	PY	PN			Y
Rigotti et al (2014) US	Y	PY	N	Low	PY	PY	PN			Y
Rigotti et al (2016) US	PY	PY	N	Low	Y	Y	PN			Y
Velicer (2006) USA	Y	Y	N	Low	Py	Py	N			Y

)		Bias from deviation (effect of adhering)							Bias from missing data				
2.7	RoB	2.1	2.2	2.3	2.4	2.5	2.6	RoB	3.1	3.2	3.3	3.4	RoB
PY	High	PY	PN	N	PY	Y	PN	High	PN	PN	Y	PY	High
PN	Some Con	PY	PN	PY	PN	PY	N	High	N	PN	Y	PY	High
	Low	PY	PY	NA	N	PY	Y	Some conc	Y				Low
PY	High	PY	PN	PY	PY	N	PN	High	PY				Low
	Low	Y	Y	Y	N	Y	Py	Some conc	PN	PN	Y	PN	Some conc
PN	Some Con	PY	PY	Y	PN	PN		Low	Py				Low
	Low	PY	N	NA	N	PY	Y	Some conc	PN	Y			Low
	Low	PY	PY	NA	N	PY	Y	Some conc	N	PN	Y	PN	Some conc
PY	High	PY	PY	NA	PN	PY	NI	High	N	N	Y	PN	Some conc
	Low	PY	PY	Y	PN	PN		Low	PY				Low
	Low	Y	PY	NA	PN	PY	PY	Some conc	PY				Low
	Low	Y	Y	NA	N	PY	Y	Some conc	PN	PN	Y	PN	Some conc
PN	Low	Y	PY	Y	N	PY	NI	High	PY				Low

Bias from measurement						Bias in reported results				Overall
4.1	4.2	4.3	4.4	4.5	RoB	5.1	5.2	5.3	RoB	RoB
PN	PY				High	Y	PY	PN	High	High
PN	PY				High	Y	PY	PN	High	High
N	N	PY	PN		Low	Y	N	PN	Low	High
PN	PN	PY	PN		Low	PY	NI	PN	Some Con	High
N	N	Y	N		Low	Y	N	N	Low	Some cons
PN	PN	PY	PN		Low	Y	PN	N	Low	Some Cons
N	N	N			Low	PY	N	PN	Low	Some cons
N	PN	N			Low	Y	N	PN	Low	Some cons
N	PN	Y	PN		Low	PN	PN	PN	Some conc	High
PN	N	NI	N		Low	Y	PN	N	Low	Some Cons
N	N	PY	PN		Low	PY	N	PN	Low	Some cons
N	N	Y	PN		Low	PY	N	PN	Low	Some cons
N	N	PY	N		Low	Y	PY	N	High	High

	Bias due to confounding									Bias in selec	
Author	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	RoB	2.1	2.2
Buchanan et al (2017) US	PN								Low	N	
Cartmell (2018a) USA	Y	N		PN		N	PN		Critical	N	
Cartmell (2018b) USA	Y	N		PY	PN	Y	PN		Critical	N	
D'Angelo et al (2022) US	PY	N		NI	NI	PN			Low	N	
Mahoney (2018) USA	Y	N		PN		PN	PN		Critical	N	
Nahhas et al (2016) US	PN									N	
Schneider (1995) USA	Y	N		PN		N	PN		Critical	N	

tion of participants into the study				Bias in classification of interventions				Bias due to deviation from intended interventions					
2.3	2.4	2.5	RoB	3.1	3.2	3.3	RoB	4.1	4.2	4.3	4.4	4.5	4.6
	Y		Low	Y	Y	PN	Low	N		Y		PN	Y
	NI		Moderate	NI	Y	PN	Low			NI		NI	
	NI	Y	Moderate	NI	Y	PN	Low			NI		NI	
	Y		Low	Y	Y	N	Low			N		PY	PY
	PY		Low	Y	Y	N	Low			PY		Y	
	Y		Low	Y	Y	PN	Low	N		Y		PN	Y
	PY		Low	Pn	Y	NI	Moderate			NI		PY	

	Bias due to missing data						Bias in measurement of outcome					Bias in selection of	
RoB	5.1	5.2	5.3	5.4	5.5	RoB	6.1	6.2	6.3	6.4	RoB	7.1	7.2
Serious	N	N	N	Y	Y	Low	N	N	Y	N	Low	N	PN
Serious	NI	NI	NI	NI	NI	NA	PN	Y	Y	PN	Serious	PN	PY
Serious	NI	NI	NI	NI	NI	NA	PN	Y	Y	PN	Serious	PN	PN
Moderate	Y	N	N			Low	PN	Y	Y	N	Moderate	N	PN
Low	Y	Y	PN	Y	Y	Moderate	PN	Y	Y	PY	Critical	N	N
Serious	N	N	N	Y	Y	Low	PN	N	Y	N	Low	N	N
Moderate	Y	N	PN			Low	N	Y	Y	PN	Serious	PN	PN

the reported result	Overall Bia
7.3 RoB	RoB
PY Moderate	Serious
PY Critical	Critical
Y Serious	Critical
PY Moderate	Moderate
Y Serious	Critical
PY Moderate	Serious
Y Serious	Critical

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	Ln. 2
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	Pg. 2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Pg. 3 - 4
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Pg. 4
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Pg. 5
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Pg. 4
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Pg. 4, Appendix A
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	Pg. ~~4 -~~ 5
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	Pg. 5
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Pg. 4 - 5
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	~~Table. A~~Appendix B
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Pg. 5, 7
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	Pg. 9 - ~~126~~
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Pg. 6
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	Pg. 6
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Pg. 6
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	Pg. 6
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	N/A
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	N/A
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	~~Pg. 5~~N/A

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	~~Pg. 5~~N/A
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Fig. 1
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Fig. 1, pg. 6
Study characteristics	17	Cite each included study and present its characteristics.	~~Table. A~~Appendix B
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Fig. 3
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	~~Table. A~~Appendix B
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Pg. 6 - 12
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	N/A
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	N/A
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	N/A
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	Pg. 7
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	~~Pg. 7~~N/A
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Pg. 12 - ~~13~~3
	23b	Discuss any limitations of the evidence included in the review.	Pg. 14
	23c	Discuss any limitations of the review processes used.	Pg. 14
	23d	Discuss implications of the results for practice, policy, and future research.	Pg. 14
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	Pg. 4
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	N/A
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	N/A
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	Pg. 15
Competing interests	26	Declare any competing interests of review authors.	Pg. 15
Availability of data, code and	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	Pg. 15

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
other materials			

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

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