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ASTRO Guideline

Radiation Therapy for Pancreatic Cancer: Executive Summary of an ASTRO Clinical Practice Guideline

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Abstract

Purpose: This guideline systematically reviews the evidence for treatment of pancreatic cancer with radiation in the adjuvant, neoadjuvant, definitive, and palliative settings and provides recommendations on indications and technical considerations.

Methods and Materials: The American Society for Radiation Oncology convened a task force to address 7 key questions focused on radiation therapy, including dose fractionation and treatment volumes, simulation and treatment planning, and prevention of radiation-associated toxicities. Recommendations were based on a systematic literature review and created using a predefined consensus-building methodology and system for grading evidence quality and recommendation strength.

Results: The guideline conditionally recommends conventionally fractionated or stereotactic body radiation for neoadjuvant and definitive therapy in certain patients and conventionally fractionated regimens for adjuvant therapy. The task force suggests a range of appropriate dose-fractionation schemes and provides recommendations on target volumes and sequencing of radiation and chemotherapy. Motion management, daily image guidance, use of contrast, and treatment with modulated techniques are all recommended. The task force supported prophylactic antiemetic medication, and patients may also benefit from medications to reduce acid secretion.

Conclusions: The role of radiation in the management of pancreatic cancer is evolving, with many ongoing areas of active investigation. Radiation therapy is likely to become even more important as new systemic therapies are developed and there is increased focus on controlling local disease. It is important that the nuances of available data are discussed with patients and families and that care be coordinated in a multidisciplinary fashion.

Preamble

As the leading organization in radiation oncology, the American Society for Radiation Oncology (ASTRO) is dedicated to improving quality of care and patient outcomes. A cornerstone of this goal is the development and dissemination of clinical practice guidelines based on systematic methods to evaluate and classify evidence, combined with a focus on patient-centric care and shared decision making. ASTRO develops and publishes guidelines without commercial support, and members volunteer their time.

Disclosure policy

ASTRO has detailed policies and procedures related to disclosure and management of industry relationships to avoid actual, potential, or perceived conflicts of interest. All task force members are required to disclose industry relationships and personal interests, from 12 months before initiation of the writing effort. Disclosures go through a rigorous review process with final approval by ASTRO's Conflict of Interest Review Committee. For the purposes of full transparency, task force members' comprehensive disclosure information is included in this publication. The complete disclosure policy for Formal Papers is available online.

Selection of task force members

The Guideline Subcommittee strives to avoid bias by selecting a multidisciplinary group of experts with variation in geographic region, gender, ethnicity, race, and

areas of expertise. Representatives from organizations and professional societies with related interests and expertise are also invited to serve on the task force.

Methodology

The task force uses evidence-based methodologies to develop guideline recommendations in accordance with the National Academy of Medicine (formerly Institute of Medicine) standards. The evidence identified from key questions (KQs) is assessed using the **P**opulation, **I**ntervention, **C**omparator, **O**utcome, **T**iming, **S**etting (PICOTS) framework. A systematic review of the KQs is completed, which includes creation of evidence tables that summarize the evidence base task force members use to formulate recommendations. Table 1 describes the recommendation grading system.

Consensus development

Consensus is evaluated using a modified Delphi approach. Task force members (except for the patient representative) confidentially indicate their level of agreement on each recommendation based on a 5-point Likert scale, from "strongly agree" to "strongly disagree." A prespecified threshold of $\geq$75% of raters that select "strongly agree" or "agree" indicates consensus is achieved. Recommendation(s) that do not meet this threshold are removed or revised. Recommendations edited in response to task force or reviewer comments are resurveyed before submission of the document for approval.

Annual evaluation and updates

Guidelines are evaluated annually beginning 2 years after publication for new potentially practice-changing studies that could result in a guideline update. In addition, the Guideline Subcommittee will commission a replacement or reaffirmation within 5 years of publication.

Full-text guideline

The reader is encouraged to consult the full-text guideline supplement (available online at https://doi.org/10.1016/j.prro.2019.06.016) for the supportive text, abbreviations list, and additional information on radiation therapy for pancreatic cancer because the executive summary contains limited information.

Introduction

In 2018 an estimated 55,440 new cases of pancreatic cancer were diagnosed in the United States, with 44,330 estimated deaths from the disease, making pancreatic

Table 1 ASTRO recommendation grading classification system

Strength of recommendation	Definition	Overall quality of evidence grade	Recommendation wording
Strong	• Benefits clearly outweigh risks and burden, or risks andburden clearly outweigh benefits. • All or almost all informed people would make the recommended choice for or against an intervention.	Any (usually high or moderate)	"Recommend/Should"
Conditional	• Benefits are finely balanced with risks and burden or appreciable uncertainty exists about the magnitude of benefits and risks. • Most informed people would choose the recommended course of action, but a substantial number would not. • There is a strong role for patient preferences and shared decision making.	Any (usually moderate to very low)	"Conditionally Recommend"

Overall quality of evidence grade	Definition
High	We are very confident that the true effect lies close to that of the estimate of the effect.
Moderate	We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low	Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate.
Very low	We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate.

cancer the fourth leading cause of cancer-related death.[1] Fewer than 20% of patients present with tumors amenable to resection and, even among patients with localized disease, the 5-year overall survival (OS) is typically <25%.[2] Historically, pancreatic cancer has been associated with high rates of local recurrence, but this has been overshadowed by the high rates of distant metastatic disease. Newer multidrug systemic therapy regimens have had efficacy in the metastatic setting and are now increasingly being incorporated into the locally advanced and localized settings.[3] With improvements in distant disease control, local control becomes increasingly important.

Previous pancreatic cancer guidelines from the American Society of Clinical Oncology have discussed multidisciplinary management in the potentially curable, locally advanced, and metastatic settings.[4-7] This guideline will focus on the role of radiation therapy (RT) in the treatment of pancreatic cancer, which is uncertain. For resected pancreatic cancer, adjuvant therapy has been supported by the early Gastrointestinal Tumor Study Group study, which found an OS and disease-free survival benefit.[8] However, subsequent European studies did not identify a benefit for chemoradiation[9,10] and there has since been a continental divide in adjuvant therapy. In the United States, adjuvant chemoradiation continues to be the subject of ongoing debate, and Radiation Therapy Oncology Group 0848 will serve to clarify this question.

Technical advances in respiratory motion assessment, respiratory management, and treatment planning and delivery have allowed for stereotactic body radiation therapy (SBRT), which has been found to provide promising local control and quality of life with acceptable rates of toxicity.[11,12] This RT modality is increasingly being used and investigated for patients with locally advanced pancreatic cancer and borderline resectable pancreatic cancer.

For all patients, the task force recommends multidisciplinary evaluation and engagement in decision making, taking into account their individual values and preferences.

Methods and Materials

Task force composition

The task force consisted of a multidisciplinary team of radiation oncologists, a medical physicist, a medical oncologist, a surgical oncologist, a radiation oncology resident, and a patient representative. The radiation oncologists were drawn from academic institutions, community or private practice, and the Veterans Affairs system. This guideline was developed in collaboration with the American Society of Clinical Oncology and the Society of Surgical Oncology who provided representatives and peer reviewers.

Document review and approval

The guideline was reviewed by 14 official peer reviewers (see Appendix 1 of the full guideline, available online at https://doi.org/10.1016/j.prro.2019.06.016) and revised accordingly. The modified guideline was posted on the ASTRO website for public comment in October and November 2018. The final guideline was approved by the ASTRO Board of Directors in March 2019. It is endorsed by the European Society for Radiotherapy & Oncology and supported by the Royal Australian and New Zealand College of Radiologists.

Evidence review

A systematic review was conducted of literature involving human subjects published in English and indexed in MEDLINE (through PubMed) from May 1, 2007, to June 5, 2017. KQs 1 through 6 evaluated patients with pancreatic cancer treated with RT, with or without chemotherapy, and KQ 7 focused on studies of prophylactic medications for acute or late toxicities from RT, primarily for abdominal or pelvic cancers. Both Medical Subject Headings (MeSH) terms and text words were used and terms common to all searches included *pancreatic neoplasms[Mesh]; pancreatic cancer; pancreas cancer; pancreatic neoplasm; pancreas neoplasm; radiotherapy[Mesh]; radiation;* and *radiotherapy.* Additional terms specific to the KQs were also used, and hand searches supplemented the electronic searches. For KQs 1 through 3 and KQ 6, only studies of conventional fractionation with $\geq$40 patients and studies of SBRT with $\geq$20 patients were included. For KQs 4 and 5, studies with $\geq$10 patients with pancreatic cancer were accepted. No size restrictions were placed on studies related to KQ 7.

Tables E1 through E3 (available online at https://doi.org/10.1016/j.prro.2019.06.016) summarize the evidence used by the task force to formulate recommendations. References selected and published in this document are representative and not all-inclusive. See the PRISMA diagram (Fig 1) and search protocol in the full-text guideline, which include additional details on the literature searches and the selected studies.

Scope of the guideline

This guideline covers only the subjects specified in the KQs. Outside the scope are many other important questions that may be subjects of other guidelines, including recurrent disease, intraoperative RT, and critical quality and safety considerations for SBRT in general, which are

addressed in the ASTRO white paper on stereotactic radiosurgery and SBRT.[14]

The guideline recommendations are based only on the published data during the literature review period. However, new data presented while the guideline was in development are discussed in the Emerging Data/Future Directions section.

Key Questions and Recommendations

Key question 1: Indications for conventionally fractionated RT or SBRT (Table 2)

In patients with pancreatic cancer, what are the appropriate indications for regimens that include conventionally fractionated RT or SBRT as:

- adjuvant therapy?
- neoadjuvant therapy?
- definitive therapy?

See Table E1 (available online at https://doi.org/10.1016/j.prro.2019.06.016) for the evidence supporting the recommendations.

Key question 2: Dose fractionation and target volumes (Table 3)

In patients with pancreatic cancer receiving RT, what are the appropriate dose fractionation schemes and target volumes for:

- conventionally fractionated RT and chemotherapy?
- SBRT?

See Table E1 (available online at https://doi.org/10.1016/j.prro.2019.06.016) for the evidence supporting the recommendations. For details on motion management and image guidance and their impact on appropriate margins, see KQ 4.

Table 2 Recommendations for indications for conventionally fractionated RT or SBRT

KQ 1 recommendations	Strength of recommendation	Quality of evidence	Consensus
1. Following surgical resection of pancreatic cancer, adjuvant conventionally fractionated RT with chemotherapy in select high-risk patients is conditionally recommended. Implementation Remark: High-risk clinical features would include positive lymph nodes and margins regardless of tumor location within the pancreas.	**Conditional**	**Low**	**92%***
2. Following surgical resection of pancreatic cancer, adjuvant SBRT is only recommended on a clinical trial or multi-institutional registry.	**Strong**	**Very low**	**100%***
3. For patients with resectable pancreatic cancer, neoadjuvant therapy is conditionally recommended.	**Conditional**	**Low**	**92%***
4. For patients with borderline resectable pancreatic cancer and select locally advanced pancreatic cancer appropriate for downstaging prior to surgery, a neoadjuvant therapy regimen of systemic chemotherapy followed by conventionally fractionated RT with chemotherapy is conditionally recommended.	**Conditional**	**Moderate**	**85%***
5. For patients with borderline resectable pancreatic cancer and select locally advanced pancreatic cancer appropriate for downstaging prior to surgery, a neoadjuvant therapy regimen of systemic chemotherapy followed by multifraction SBRT is conditionally recommended.	**Conditional**	**Low**	**77%***
6. For patients with locally advanced pancreatic cancer not appropriate for downstaging to eventual surgery, a definitive therapy regimen of systemic chemotherapy followed by either (1) conventionally fractionated RT with chemotherapy, (2) dose-escalated chemoradiation, or (3) multifraction SBRT without chemotherapy is conditionally recommended.	**Conditional**	**Low**	**85%***

Abbreviations: KQ = key question; RT = radiation therapy; SBRT = stereotactic body radiation therapy.
* The medical physics representative abstained from rating these recommendations.

Table 3 Recommendations for dose fractionation and target volumes

KQ 2 recommendations	Strength of recommendation	Quality of evidence	Consensus
1. For patients with resected pancreatic cancer selected for adjuvant conventionally fractionated RT and chemotherapy, 4500-5400 cGy in 180-200 cGy fractions with concurrent 5-fluorouracil–based chemotherapy is recommended.	**Strong**	**Moderate**	**85%** *
2. For patients with borderline resectable pancreatic cancer selected for neoadjuvant conventionally fractionated RT and chemotherapy, 4500-5040 cGy in 180-200 cGy fractions is conditionally recommended.	**Conditional**	**Low**	**92%** *
3. For patients with locally advanced pancreatic cancer selected for definitive conventionally fractionated or dose-escalated RT with chemotherapy, 5040-5600 cGy in 175-220 cGy fractions with concurrent chemotherapy is conditionally recommended. Implementation Remark: A number of fractionation schemes are used for locally advanced disease; see Appendix Table 1 in full-text guideline for a selection of the regimens tested in trials.	**Conditional**	**Low**	**100%** †
4. For patients with borderline resectable pancreatic cancer selected for SBRT, 3000-3300 cGy in 600-660 cGy fractions with a consideration for a simultaneous integrated boost of up to 4000 cGy to the tumor vessel interface is conditionally recommended.	**Conditional**	**Moderate**	**100%** †
5. For patients with locally advanced pancreatic cancer selected for SBRT, 3300-4000 cGy in 660-800 cGy fractions is recommended.	**Strong**	**Moderate**	**100%** †
6. For patients with resected pancreatic head cancer receiving adjuvant RT, use of the NRG Oncology consensus panel guidance[1] for clinical target volume delineation is recommended.	**Strong**	**Moderate**	**100%** †
7. For patients with resected pancreatic body and tail tumors receiving adjuvant RT, a clinical target volume including the pancreatic resection margin and regional nodal basins indicated in the NRG Oncology consensus panel guidance[1] for pancreatic head lesions but excluding the periportal/liver hilum nodal region is recommended.	**Strong**	**Moderate**	**100%** †
8. For patients with borderline resectable pancreatic cancer selected for SBRT, a treatment volume including the gross tumor volume with a small margin is recommended. Implementation Remark: SBRT does not routinely treat elective nodes.	**Strong**	**High**	**92%** †
9. For patients with locally advanced pancreatic cancer selected for SBRT, a treatment volume including the gross tumor volume with a small margin is recommended. Implementation Remark: SBRT does not routinely treat elective nodes.	**Strong**	**High**	**100%** †
10. For patients with locally advanced pancreatic cancer selected for definitive conventionally fractionated RT and chemotherapy, elective nodal treatment is conditionally recommended.	**Conditional**	**Moderate**	**83%** †

Abbreviations: KQ = key question; RT = radiation therapy; SBRT = stereotactic body radiation therapy.

* The medical physics representative abstained from rating these recommendations.

† The medical physics and surgical oncology representatives abstained from rating this recommendation.

[1] Goodman KA, Regine WF, Dawson LA, et al. Radiation Therapy Oncology Group consensus panel guidelines for the delineation of the clinical target volume in the postoperative treatment of pancreatic head cancer. *Int J Radiat Oncol Biol Phys.* 2012; 83:901-908.[18]

Key question 3: Sequencing of chemotherapy and RT (Table 4)

In patients with pancreatic cancer receiving RT, what is the appropriate sequencing of chemotherapy with RT as:

- adjuvant therapy?
- neoadjuvant therapy?
- definitive therapy?

See Table E1 (available online at https://doi.org/10.1016/j.prro.2019.06.016) for the evidence supporting the recommendations.

Table 4 Recommendations for sequencing of chemotherapy and RT in patients receiving RT

KQ 3 recommendations	Strength of recommendation	Quality of evidence	Consensus
1. For patients with resected pancreatic cancer receiving adjuvant therapy, delivery of chemoradiation following 4-6 months of systemic chemotherapy is recommended.	**Strong**	**Moderate**	**92%***
2. For patients with borderline resectable pancreatic cancer receiving neoadjuvant therapy, delivery of RT following 2-6 months of systemic chemotherapy is recommended.	**Strong**	**Moderate**	**92%***
3. For patients with unresectable or locally advanced pancreatic cancer without systemic progressionfollowing 4-6+ months of chemotherapy, definitive RT is recommended.	**Strong**	**Moderate**	**85%***

Abbreviations: KQ = key question; RT = radiation therapy.
* The medical physics representative abstained from rating these recommendations.

Key question 4: Simulation considerations (Table 5)

In patients with pancreatic cancer receiving RT, how do the following impact target and normal tissue delineation, treatment planning techniques, and treatment delivery accuracy for conventionally fractionated RT and SBRT:

- motion management
- image guidance
- contrast administration during computed tomography (CT) simulation

See Table E2 (available online at https://doi.org/10.1016/j.prro.2019.06.016) for the evidence supporting the recommendations.

Key question 5: Treatment planning techniques (Table 6)

In patients with pancreatic cancer receiving RT, how do different treatment planning techniques (3-dimensional conformal RT, intensity modulated, volumetric-modulated arc therapy) impact treatment delivery and dose to organs at risk (OARs)?

Table 5 Recommendations for simulation considerations

KQ 4 recommendations	Strength of recommendation	Quality of evidence	Consensus
1. For patients with pancreatic cancer receiving conventionally fractionated pancreatic RT or SBRT without breath-hold, a patient-specific respiratory motion assessment (eg, 4-dimensional [4-D] CT simulation) is recommended. Implementation Remark: For palliative or postoperative RT, motion assessment and management may not be required.	**Strong**	**High**	**100%***
2. For patients with pancreatic cancer receiving conventionally fractionated RT for whom free-breathing target motion is significant (>1 cm), a respiratory motion reduction technique is conditionally recommended. Implementation Remarks: • For palliative or postoperative RT, motion assessment and management may not be required. • For respiratory motion management techniques, the end-exhalation position may be more reproducible than inhalation positions.	**Conditional**	**Moderate**	**100%***
3. For patients with pancreatic cancer receiving SBRT, a respiratory motion management technique is recommended.	**Strong**	**High**	**100%***

(*continued on next page*)

Table 5 (*continued*)

KQ 4 recommendations	Strength of recommendation	Quality of evidence	Consensus
Implementation Remarks: • For palliative or postoperative RT, motion assessment and management may not be required. • For respiratory motion management techniques, the end-exhalation position may be more reproducible than inhalation positions.			
4. For patients receiving conventionally fractionated RT for pancreatic cancer, daily image guidance is recommended. Implementation Remarks: • Bony anatomy and surgical stents are each poor surrogates for pancreas target positioning; if used for image guidance, large internal target volume margins are necessary. • Where possible, the cine (fluoroscopic) imaging is useful, in addition to 2-D or 3-D image guidance, to confirm that the ITV adequately accounts for respiratory motion variations or intra−breath-hold drift.	**Strong**	**Moderate**	**100%***
5. For patients receiving SBRT for pancreatic cancer, daily image guidance with fiducial markers and volumetric imaging is recommended. Implementation Remarks: • Bony anatomy and surgical stents are each poor surrogates for pancreas target positioning; if used for image guidance, large internal target volume margins are necessary. • Where possible, the use of cine (fluoroscopic) imaging is suggested, in addition to 2-D or 3-D image guidance, to confirm that the ITV adequately accounts for respiratory motion variations or intra−breath-hold drift.	**Strong**	**Moderate**	**100%***
6. Unless there is a contraindication to IV contrast, patients with pancreatic cancer treated with RT should receive IV contrast at CT simulation; multiphasic CT with a high contrast flow rate and injection volume and patient-specific scan timing is recommended.	**Strong**	**High**	**100%***

Abbreviations: CT = computed tomography; ITV = internal target volume; IV = intravenous; KQ = key question; RT = radiation therapy; SBRT = stereotactic body radiation therapy.
* The surgical oncology representative abstained from rating these recommendations.

See Table E2 (available online at https://doi.org/10.1016/j.prro.2019.06.016) for the evidence supporting the recommendation.

Key question 6: Indications for palliative RT (Table 7)

In patients with metastatic pancreatic cancer, what are the appropriate indications for RT in palliative therapy?

See Table E1 (available online at https://doi.org/10.1016/j.prro.2019.06.016) for the evidence supporting the recommendation.

Key question 7: Prophylactic medications for toxicity (Table 8)

In patients with pancreatic cancer receiving RT, how do prophylactic medications affect the incidence and severity of acute and late toxicities?

Table 6 Recommendation for treatment planning

KQ 5 recommendation	Strength of recommendation	Quality of evidence	Consensus
1. For treatment of localized pancreatic cancer, modulated treatment techniques such as IMRT and VMAT for planning and delivery of both conventionally fractionated and hypofractionated RT are recommended.	**Strong**	**Moderate**	**100%***

Abbreviations: IMRT = intensity modulated radiation therapy; KQ = key question; RT = radiation therapy; VMAT = volumetric-modulated arc therapy.
* The medical physics and surgical oncology representatives abstained from rating this recommendation.

Table 7 Recommendation for palliative RT

KQ 6 recommendation	Strength of recommendation	Quality of evidence	Consensus
1. For selected patients with metastatic pancreatic cancer, palliative RT to either the primary or select metastatic sites for symptom management is recommended.	**Strong**	**Moderate**	**100%***

Abbreviations: KQ = key question; RT = radiation therapy.
* The medical physics representative abstained from rating this recommendation.

See Table E3 (available online at https://doi.org/10.1016/j.prro.2019.06.016) for the evidence supporting the recommendations.

Emerging Data and Future Directions

A number of pancreatic cancer clinical trials are ongoing or recently completed. These trials seek to clarify indications for RT for this malignancy and may alter currently presented recommendations or the quality of evidence supporting recommendations.

There are few completed prospective studies to define the role of neoadjuvant SBRT for borderline resectable pancreatic cancer. The ALLIANCE trial (NCT 02839343) was designed to randomly allocate patients to either modified 5-fluorouracil, leucovorin, irinotecan, oxaliplatin (FOLFIRINOX) times 8 cycles alone before surgical resection or 7 cycles of modified FOLFIRINOX plus SBRT consisting of 3300 cGy in 5 fractions to evaluate the primary endpoint of OS at 18 months. Patients also receive adjuvant leucovorin, fluorouracil, and oxaliplatin.[15] The SBRT arm of the study was closed to accrual, and we await the trial results from the investigators. With retrospective data for patients with locally advanced disease indicating improved local control with higher biologically effective dose, future prospective dose escalation studies are needed.[16,17]

The Unicancer GI PRODIGE 24/CCTGPA.6 trial is a recently published multicenter phase III study of adjuvant gemcitabine or modified FOLFIRINOX. Between 2012 and 2016, 493 patients were enrolled on this multicenter study. An improvement in disease-free survival, metastasis-free survival, and OS was observed with the use of adjuvant modified FOLFIRINOX. With median follow-up of 33.6 months, the median OS with adjuvant gemcitabine was 35 months compared with 54.4 months in modified FOLFIRINOX arm.[3] These data are likely to alter the adjuvant therapy landscape, and Radiation Therapy Oncology Group 0848 will have to be interpreted with these results in mind.

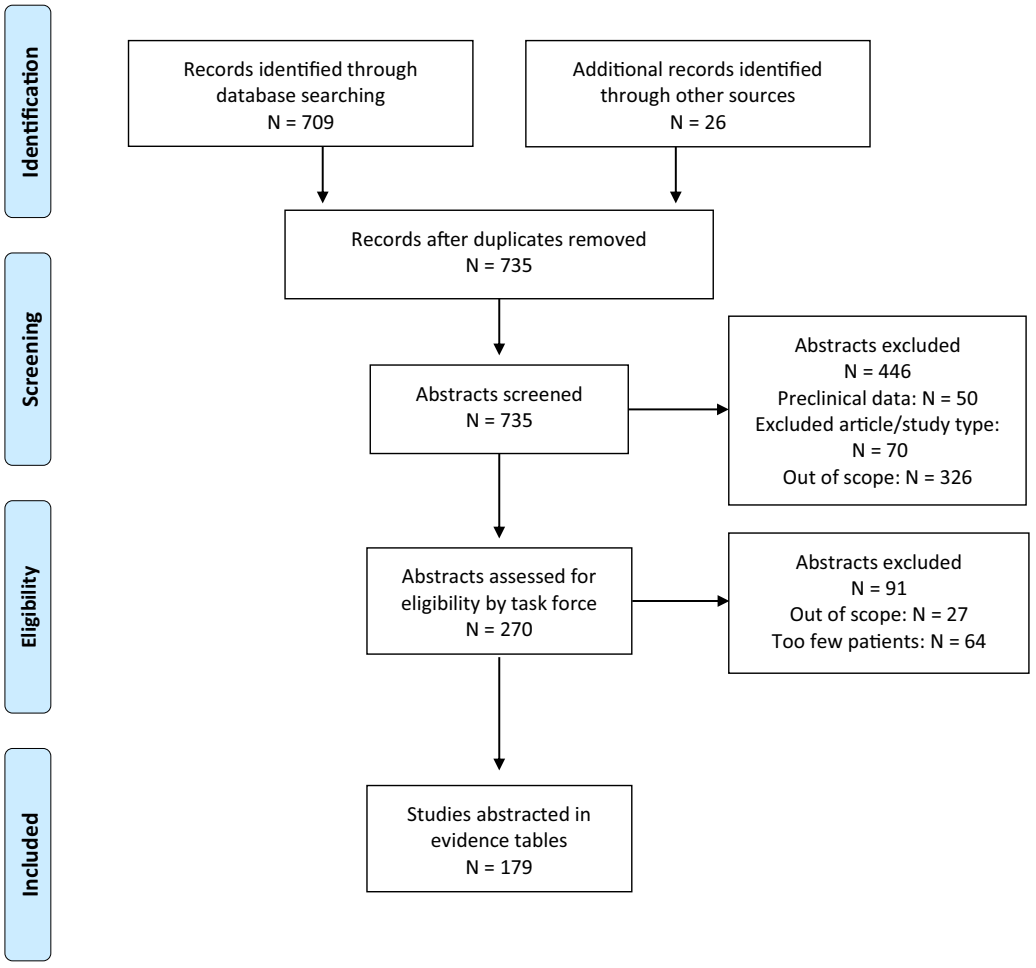
At the 2018 American Society of Clinical Oncology Annual Meeting, a number of abstracts were presented that could affect the management of pancreatic cancer in the coming years. In the area of neoadjuvant treatment, the preoperative chemoradiation versus immediate surgery for resectable and borderline resectable disease trial (PREOPANC-1) will provide the first prospective, phase III data for this patient subgroup. At the time of presentation, 246 patients were accrued between 2013 to 2017 and randomly assigned to immediate surgery or preoperative chemoradiation. The preoperative regimen consisted of 3600 cGy in 15 fractions with concurrent gemcitabine 1000 mg/m^2. For the primary endpoint of OS, median OS was 17.1 months in the chemoradiation arm compared with 13.5 months.[19]

Although this list is not intended to be comprehensive, these trials are likely to influence future versions of the ASTRO pancreatic cancer guideline.

Table 8 Recommendations for prophylactic medications for toxicity

KQ 7 recommendations	Strength of recommendation	Quality of evidence	Consensus
1. For patients with pancreatic cancer undergoing RT, prophylactic use of antiemetic medications to reduce the rate of nausea is recommended.	**Strong**	**Low**	**100%***
2. For patients with pancreatic cancer undergoing RT, prophylactic use of medications to reduce acid is conditionally recommended.	**Conditional**	**Very Low**	**100%***

Abbreviations: KQ = key question; RT = radiation therapy.
* One task force member was recused from voting on this KQ based on his disclosures.



PRISMA = Preferred Reporting Items for Systematic Reviews and Meta-Analyses.
Created based on Moher D, Liberati A, Tetzlaff J, and AltmanDG, 2009.[13]

Figure 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) diagram.

Conclusion

The role of radiation in the management of pancreatic cancer is evolving in the adjuvant, neoadjuvant, and definitive settings, as is the use of dose escalation and ablative RT, with advances in motion management, target delineation, treatment planning, and image guidance. The role of RT is likely to become even more important as new systemic therapies are developed and there is increased focus on controlling local disease. It is critical that the nuances of available data are discussed with patients and families and that care for patients with pancreatic cancer be coordinated in a multidisciplinary fashion.

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Supplementary Material

Supplementary material for this article can be found at https://doi.org/10.1016/j.prro.2019.06.016.

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